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Matching geothermal potential and heat demand of Europe: the web-map tool of the Geo-DH project to promote geothermal district heating

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ABSTRACT

The Geo-DH project aims to increase the share of geothermal-based district heating systems in 14 countries of Europe. As one of the core outputs of the project, a web-map viewer was established which gives an overview on the geothermal potential for district-heating on a European scale, to be coupled with areas of heat load adequacy, thus geographically matching the resources and the demands, outlining areas for future developments. In addition to the large-scale overview of potential areas based on the integrated interpretation of pan-European maps showing the geology and geothermal conditions in a uniform system with harmonized datasets, the detailed evaluation of the Geo-DH potential of the targeted countries made it possible to further adjust the prosperous regions. Some country examples representing various geological settings and market conditions underline the future development potentials and also raise attention that the most advanced Geo-DH markets had grown not only due to favorable geothermal potentials, but as a result of exhaustive financial and regulatory supporting schemes.

1. INTRODUCTION

In the EU-27 countries there are 3550 district-heating (DH) systems providing heat for 2160 cities and towns over 5000 inhabitants, thus satisfying 12% of total heat demand of the population (Connolly et al 2012). DH achieves higher energy, economic and environmental performance compared to the traditional central heating systems, as heat supply is best adjusted to users demand. Last but not least, it reduces greenhouse gas emissions and excess heat losses, thus significantly contributes to the climate and energy policy targets.

The majority of the European DH systems are supplied by gas and only ~1% by renewables (mostly biomass). In 2012 there were 216 DH systems fed by geothermal representing appr. 4900 MW_{th}, out of which 157 systems installed in the EU-27 with a total installed capacity of 1622 MW_{th} (EGEC 2012). Although after 20 years of slower development the Geo-DH market has experienced a renewed growth, geothermal still only contributes to ~0,001% of the total DH systems, however Europe's geothermal potential would make it possible to significantly increase its share, contributing to the de-carbonization of the DH sector. The current major Geo-DH markets are in France, Iceland, Germany and Hungary, however almost all European countries foresee to have Geo-DH systems by 2020, also in line with their NREAP targets.

The existing utilization schemes involve shallow geothermal resources assisted by large heat-pumps, smaller "town-heating systems" developed and operated by municipalities and local authorities, as well as large systems with high capital costs developed by utility companies.

The Geo-DH project (Promote Geothermal District Heating Systems in Europe) running in the frame of the Intelligent Energy Europe Programme focuses on 14 European countries with juvenile (Netherlands, UK, Ireland, Bulgaria, Romania), transitional (Hungary, Slovenia, Slovakia, Czech Republic, Poland, Denmark) and mature markets (Germany, France and Italy). It aims to increase the share of geothermal-based district heating systems in regions rich in geothermal energy by providing effective tools and guidance for stakeholders to reach the ambitious 2020 targets of increasing the number of Geo-DH schemes. In addition to remove regulatory barriers, develop innovative financial models, training of stakeholders which are the project's main goals, one such tool is the visualization of areas with good geothermal potential combined with areas of favorable heat market conditions, i.e. to match the supply and the demand.

2. THE GEO-DH WEB-MAP VIEWER AS A SUPPORTING TOOL TO PROMOTE GEOTHERMAL DISTRICT HEATING

The web-map service established in the frame of the Geo-DH project (currently available at: http://loczy.mfgi.hu/flexviewer/geo_dh) provides a regional overview of those areas, where geothermal potential is good for DH developments, which have been outlined on the basis of integrated evaluation of existing and published European, as well as country specific geological, hydrogological and geothermal thematic maps and models. The ArcGIS based system also incorporates data of the currently existing Geo-DH systems and will show areas with favourable heat market conditions, too. The web-map service intends to provide a general overview on the geothermal potential for district heating in the 14 project countries, however should not be used for local assessments. This limitation is underlain by the fact that information available is strongly depending on the underlying datasets, which in this case were mostly pan-European and national large-scale maps. Therefore it is not a tool for selecting new drilling sites, but serves as a guide to outline prosperous regions for future developments and investments in geothermal district heating, raise the awareness of decision-makers and contribute to regional development policies.

2.1. Criteria for delineating potential areas

First the geology-related criteria had to be defined, i.e. those boundary conditions which make a geothermal reservoir suitable for district-heating. For a simple approach only 2 parameters were considered: temperature of fluid (thermal groundwater) > 50 °C, and high yield (normally several thousand l/min). Due to the great variety of thermal aquifers at a European scale, it was not possible to quantify exactly yield limits values, therefore those geological situations were considered, where such permeable reservoirs may exist: i.e. (1) basins with thick porous sedimentary sequence infill and (2) large, preferably active tectonic zones, where enhanced permeability may exist in deep-lying carbonate / crystalline rocks.

2.2. Data collection and input

As the aim of the project is to give a uniform evaluation for all Geo-DH countries, only those datasets have been used for evaluation at a first stage, which contain harmonized data for all targeted countries. These are typically pan-European maps at a scale of 1: 1 000 0000 to 1 : 5 000 000 scales, showing the geology as well as hydrogeological and geothermal conditions. The most important maps and models used for interpretations, also partly incorporated into the web-map viewer as base-maps were the following:

The *Geological Map of Europe and Adjacent Areas* (Asch 2003) shows the main geological units (sedimentary, igneous and metamorphic) by a color code and abbreviation indicating the geochronological age of the rocks, as well as the main tectonic elements (different types of faults, thrusts). It made possible to outline the contours of the large Neogene sedimentary basins, major tectonic zones, where natural faults and fractures as preferential pathways for deep convective hydrogeothermal systems may exist, as well as young volcanoes.

The sediment thickness / depth of the sedimentary basins were further amended on the basis of the models of Tesauro et al. (2008) and Laske and Masters (1997).

Areas with actively deforming basins and critically stressed basement areas with extensional and strike-slip settings, potential sites for enhanced permeability due to the formation of natural fracture networks were further adjusted after the world stress map (Heidbach et al. 2008) and maps showing the major tectonic faults zones of Europe (Cloetingh et al. 2010, Artemieva et al. 2006)

The *International Hydrogeological Map of Europe* (BGR 2008) provides a categorization of rocks according to their hydrogeological properties being classified to porous and fissured aquifers (with highly and moderately productive sub-classes), as well as insignificant aquifers. It made possible to outline areas where hydrogeothermal applications can be excluded (insignificant aquifers), as well as those regions which may serve as major recharge areas for deep-seated porous or fissured aquifers, potential hydrogeothermal reservoirs.

Knowledge of temperature at a drillable depth is a prerequisite for geothermal exploration. The maps showing the *temperature distribution at depth of 1000 m and 2000 m* (Hurter and Haenel, 2002), made it possible to outline areas where temperature is higher than 50-60 °C at a depth of 1000 m, and above 90-100 °C at a depth of 2000 m. A more detailed and up-to-date modeled subsurface temperature distribution for Europe was prepared by the Geoelec project (Limberger and van Wees 2013) showing temperature variation down to a depth of 5 km, which was also considered during interpretations, especially at bigger depths.

The map of *terrestrial heat-flow density* (Hurter and Haenel, 2002) was also incorporated and amended where relevant after Cloetingh et al. (2010). It made possible to outline areas with high heat-flux, i.e. where heat-flow density exceeds 90-100 mW/m^2.

In the second stage, the general European-scale picture was regionally improved, where more detailed information was available at country-scale. These data were collected based on a questionnaire that has been sent out to Geo-DH partners, EGEC national contact points, IGA country update authors, Geological Surveys national contact points and members of the GeoEnergy Expert Group of the EuroGeoSurveys, as well as assessment of literature data.

2.3. Establishing the web-map viewer (WMV)

The Geo-DH WMV is currently available at: http://loczy.mfgi.hu/flexviewer/geo_dh (running on the web-map server of the Geological and Geophysical Institute of Hungary). After its finalization it will be directly linked to the Geo-DH project website (www.geo-dh.eu).

The viewer, established under ArcGIS first offers a short introduction on the project, geothermal district heating and a manual how it works (Fig. 1).

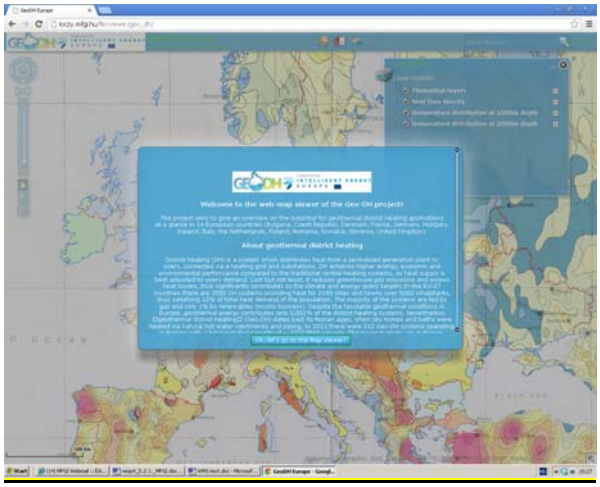


Figure 1: Welcome page of Geo-DH-WMV

At the top right corner there is a list of layers which shows the currently available thematics, which can be activated/de-activated, also with a short description of each map. One can zoom in and out by the scroller at the left-side of the screen, and the picture can be moved using the pan.

Based on the combined interpretation of the various base-maps (geology, hydrogeology, geothermal conditions – see chapter 2.1.) it was possible to outline at a European scale 2 major types of reservoirs prosperous for Geo-DH developments: (1) Neogene basins with thick porous sedimentary sequence infill where temperature exceeds 50 °C at a depth of 1000 m, it is above 90 °C at a depth of 2000 m, and heat-flow density exceeds 90 mW/m^2 (Fig. 2) and (2) large, preferably active tectonic zones where enhanced permeability may exist in deep-lying basement rocks under favourable temperature conditions.

Other deep sedimentary or fractured reservoirs (e.g. Permo-Traissic sandstones in the UK, Triassic and Eocene carbonates, Jurassic and Creatceous sandstones in Poland) were identified based on individual country assessments.



Figure 2: Outline of Neogene basins (yellow), marking areas where temperature is above 50 °C at a depth of 1000 m, above 90 °C at a depth of 2000 m, and heat-flow density is above 90 mW/m^2 (orange colors)

The currently existing Geo-DH plants (EGEC 2012) were also incorporated in the web-map viewer: by clicking on the site, a small information window pops-up with basic data of the plant (Fig. 3).

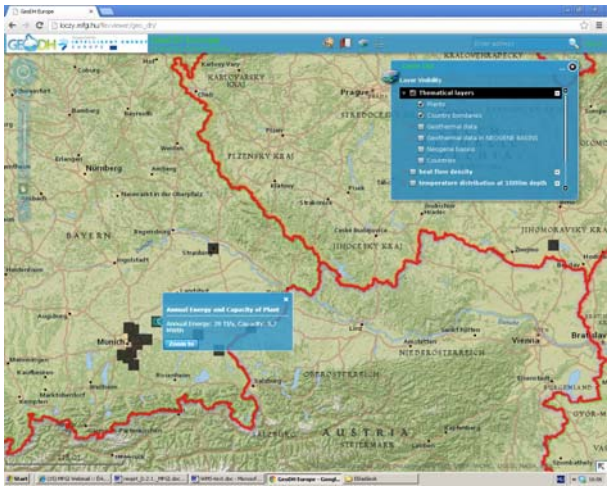


Figure 3: Information on operating Geo-DH plants (based on EGEC 2012)

3. GEOTHERMAL POTENTIAL FOR DISTRICT HEATING – A EUROPEAN-SCALE OVERVIEW BASED ON GEOLOGICAL CONSIDERATIONS

Understanding the geological evolution of Europe contributes to get a large-scale picture on the areas with good geothermal potential.

From a geological point of view Europe can be divided into 2 main parts, being in contact along the Trans-European Suture Zone (Artemiva et al. 2006). The eastern, Precambrian part of Europe (Ukranian shield, East European Platform Baltic shield) has not been tectonically re-activated after its formation. These large areas are in thermally steady state and are

characterized by low heat flow values, therefore cannot be considered as areas with good geothermal potential.

Majority of the Geo-DH project countries lie in the western and central part of Europe, where the Phaneorozoic lithosphere was profoundly affected by the tectonic events of the Caledonian (500-400 Ma) and Variscian (430-400 Ma) orogenesis. Surface heat-flow in western and central Europe varies generally between 50 and 80 mW/m^2 indicating a thinner thermal lithosphere, compared to the adjoining Precambrian terrains to the north. Within this regime those areas are characterized locally by higher surface heat-flow, where the upper crust is hosting granitic rocks enriched in U and Th, thus having the capacity of high heat production (SW England, W-ern France, Massive Central, Erzegebirge) (Cloetingh et al. 2010). These are prosperous areas for the exploitation of geothermal energy.

The Palaeozoic Variscian orogens of Europe have been significantly reworked during the Cenozoic orogeny, when the Alps and Dinarids formed as a result of the collision of the Eurasian and African plates. Coeval with the continental collision, several smaller back-arc basins (Tyrrhenian, Aegean and Pannonian basins) formed having a thin crust (20-30 km) and lithosphere, characterized by high heat-flow density. West and north of the Alps the Cenozoic European Central Rift (ECRIS) is associated with magmatic events and is also characterized by high heat-flow density.

The best potential fractured reservoirs in Europe are linked to those active fault zones, where preferably extensional deformation is still ongoing, as these fractures are more likely to stay open. Such faults are related to the presently still active ECRIS, which extends from the Dutch North Sea to the western Mediterranean (Dézes et al. 2004). The marginal faults of the associated grabens (Limagne and Bresse grabens superimposed on the Massive Central and its eastern flank, Upper Rhine graben which bifurcates into the NW trending Roer Valley graben and the NE trending Hessian graben transecting the Rhenish Massif, as well as the NE striking Eger graben transecting the Bohemian massif) are all potential sites for an enhanced fractured porosity formation in the depth. The volcanic activity during the Miocene and Plio-Pleistocene times, which associated the development of the ECRIS contributed to the good geothermal potential of these areas. Such active fault zones are also abundant in the entire circum-Mediterranean region, which is tectonically the most active area in Europe, shown by the great number of earthquakes.

Major Cenozoic sedimentary basins with considerable sediment thickness encompass significant area of Europe (Paris basin, Aquitainian basin, Molasse basin in the northern foreland of the Alps; Pannonian basin and Transylvanian basin in Central Europe; Po basin, Tuscany and other smaller Neogene basins along the eastern cost of Italy; the large foreland basin of the Eastern and Southern Carpathians in Romania; and the extensive basin system covering Poland-North Germany and Denmark). These basins have thick sedimentary succession which comprises important aquifers. However favorable geothermal conditions (i.e. elevated subsurface temperatures and heat-flow density) are restricted mostly to the Pannonian Basin, and some smaller parts of at other areas (Fig. 2).

4. GEOTHERMAL POTENTIAL FOR DISTRICT HEATING – SOME COUNTRY EXAMPLES

In this chapter we provide some examples about the geothermal district-heating potential and current DH utilization of some selected countries of the Geo-DH project having juvenile, transitional and mature markets, and also representing different geotectonic settings and reservoir types.

4.1. Pannonian Basin, transitional Geo-DH market examples of Hungary, Slovenia and Slovakia

The geothermal potential of the Pannonian basin is outstanding in Europe, as it lies on a characteristic positive geothermal anomaly, with heat flow density ranging from 50 to 130 mW/m^2 with a mean value of 90-100 mW/m^2 and geothermal gradient of about 45 °C/km (Dövényi and Horváth 1988). This increased heat flux is related to the Early-Middle Miocene formation of the Pannonian Basin, when the lithosphere stretched and thinned (thus the crust is "only" 22-26 km thick) and the hot astenosphere got closer to the surface (Horváth and Royden 1981).

The two main types of reservoirs are the several thousand meter thick multi-layered porous sediments (Upper Miocene-Pliocene "Pannonian sequene") that fill in the Neogene Pannonian basin; and the karstified zones of the Palaeozoic-Mesozoic carbonates, as well as fractured zones in the crystalline rocks in the basement. Both reservoir types supply existing geo-DH system and are potential for future developments, however overexploitation in several areas (especially due to wide-spread balneological utilization and insufficient re-injection in the energetic-schemes) may be a restricting factor. Moreover in the transboundary regions, where extended reservoirs are cut by political borders, cross-country effects of exploitation (e.g. drop in temperature, yield) have to be considered.

In *Hungary* there are 111 settlements where district heating systems now exist, but there are only 9, where geothermal energy contributes to the district heating (operated otherwise by gas) and thermal water is supplied to the already existing systems. There are 3 towns where the share of geothermal is high in the district heating systems: Szentes (97,4%), Csongrád (90%) and Hódmezővásárhely (80,4%). These systems in SE-Hungary are all fed by the thermal water stored in the porous Pannoninan aquifers at a depth range between 1200 and 1800 m. In the rest of the towns the contribution of geothermal energy is only about 10-

30%. The only exception is Szentlőrinc, targeting a basement reservoir, which is completely based on geothermal.

In Hungary, there are another 10 so called "geothermal-based town heating systems" with another 3 projects under construction. In these systems the gas-based heating of some public buildings (town hall, library, school, hospital, etc) is replaced by geothermal and other nearby buildings (private houses) may join the newly established thermal water pipelines. Due to the limitations of heat and yield, these systems cannot 100% fulfill the energy demand of the consumers; nevertheless they are significant in regional development. These systems are spread around the country in various geological settings, however most of them are on the Great Hungarian Plain targeting the porous Pannonian reservoirs.

The NE-ern part of *Slovenia* belongs to the Pannonian basin in geological terms, and has very good geothermal potential. However, there are only two geothermal district heating systems operating at Murska Sobota where about 300 flats are heated by thermal water and at Lendava where several buildings (e.g. school, kindergarten, few houses) are supplied from the porous Upper Miocene-Pliocene ("Pannonian sequene") aquifers. At Benedikt a system is in a test phase, which is supplied by a deep metamorphic crystalline reservoir at the basement (Rajver et al. 2010).

The geothermal conditions of NE-Slovenia are prosperous, also for the establishments of new DH systems, here rather the lack of heat demand (major towns) can be a restricting factor for future developments.

Sharing the N-ern part of the Pannoninan basin, *Slovakia* has also good potential for low-enthalpy resources. The geothermal atlas of Slovakia (Franko et al. 1995) identified 27 hydrogeothermal areas, or structures in various geological settings. Geothermal based district heating exists at Galanta, Sala and Sered (~70-80 °C) and individual heating systems are at many other locations. A major new development site is at Kosice with 260 000 inhabitants. The city has one of the most widespread existing DH systems (pipeline) in Central Europe. The geothermal potential of the Kosice basin is estimated to be as high as 1200 MW_t with having thermal water of 130 °C only 15 km from the city (Hováth 2013). Thus this location is perfect example of matching the supply and the demand.

4.2. NW Europe juvenile Geo-DH market examples of UK and The Netherlands

The overall geothermal potential of the *UK* is not outstanding: the average heat-flow is around 52 mW/m^2, areas of increased heat flow are associated with the radiogenic granites in SW-England and the buried granites of N-England. Within the UK the only sedimentary aquifers that lie at sufficient depths and have suitable hydrogeological properties for low enthalpy geothermal applications are the Permo-Triassic sandstones. These are found in four deep sedimentary basins in England and Wales (Wessex, Chesire, East England and Worcester), as well as two reservoirs in North Ireland. Temperatures within the sandstones are generally 40-60 °C with a maximum of 100 °C occurring within the Cheshire Basin, where Permian sandstones are found at depths greater than 3.5 km (Busby 2010). The only geothermal district-heating system has been operating in Southampton since 1987 and this has evolved and expanded to become the largest commercially developed CHP/district energy scheme in the UK supplying 3,000 homes, 10 schools and numerous commercial buildings (Smith 2012). The aquifer feeding the system contains 76 °C fluid and is found at appr. 1800 metres deep in the Wessex Basin.

Another promising site is Cornwall, SE England, which is underlain by high heat production granites with measured heat flows of 100 mW/m^2 and temperature gradients in the range 30 to 40 °C/km. The area has been a site for a HDR-CHP project for several years; nevertheless the pending support from the government recently halted it.

UK is an example, where the demand (densely populated counties with large cities) overcomes the geothermal potential of the country, therefore future developments may be rather restricted from the resource-side, although new important markets are emerging.

Dutch interest and activities in deep geothermal energy evolved during the last few years, the number of licence applications for deep drillings increased substantially. Aquifers that are developed and/or investigated for heating purposes occur at depths of a few meters to roughly 4.000 m in Permian, Lower Triassic and Lower Cretaceous sandstones and in Tertiary sand units, but for Geo-DH purposes aquifers in the range of 1500 – 3500 meter are the most prosperous (van Heekeren and Koenders 2010). The theoretical potential for deep geothermal energy (direct use) is substantial in The Netherlands; nevertheless at the moment only two systems are operating.

The Hague is the first city that is using deep geothermal heat for providing residential areas with heating. In the coming years approximately 4,000 homes and some companies will be connected to geothermal heat. The other site at Heerlen uses heat energy stored in old mineshafts for the heating and cooling of buildings, therefore is not a classical "deep-geothermal district-heating project", on the other hand a nice example on effective utilization of low-enthalpy resources. Since the abandonment of mining in 1976, the former mineshafts have been filled with geothermally heated groundwater. A new district heating grid uses water at a constant temperature of 22 °C from the mines, used water is pumped back into the mineshafts. The water runs through an embedded hydraulic piping system under the floor of the

Heerlerheide Centrum, a new multifunctional complex for residential use, which also contains a library, a supermarket, a conference room and a café.

The good potential of deep geothermal in the Netherlands forecasts a rapid growth, also for new Geo-DH sites, as the heat demand is also significant in the densely populated country. Nevertheless as the main geothermal aquifers are at depths which are common to normal oil and gas producing operations, potential conflicts and interactions with hydrocarbon industry should be considered.

4.3. Mature Geo-DH market examples of Germany, and France: good practice of reinforcing favourable geothermal potentials by regulatory and financial supporting schemes

In *Germany* the first geothermal doublet for DH was established in 1984 in Waren/Müritz. In 2012 there were 24 systems operating representing a total installed capacity of 196,05 MW_{th} and annual use of 835,4 TJ/y (EGEC 2012), spread around the three areas with good geothermal potential: the N-ern German Basin, the Molasse Basin in S-ern Germany (Munich region), and along the Upper Rhine Graben where HDR/CHP plants are commissioned (e.g. Landau, Bruschal).

The sediment thickness of the North German Basin ranges from 2 - 10 km. The Mesozoic deposits are made up of sandstones, clay and carbonates, with evaporate intercalations. Six Cretaceous, Jurassic and Triassic sandstone aquifers are potential for Geo-DH, however great variations of depth and thickness, exceeding locally 1000 m may occur along short distances due to salt tectonics of the basin. Therefore, the temperature and energy content of the geothermal resources vary strongly on a regional scale and requires thoughtful exploration strategies (Schellschmidt et al. 2010).

The Molasse Basin in southern Germany is an asymmetrical foreland basin associated with the uplift of the Alps. The basin is made up mainly by Tertiary, Upper Jurassic (Malm) and Triassic sediments. Eight aquifers of these sedimentary layers are of interest for Geo-DH. The most prosperous is the highly productive Malm karstic limestone aquifer, extending throughout almost the whole Molasse Basin, dipping from north to south with increasing temperatures (Schellschmidt et al. 2010). This aquifer has been intensively used both by Austria and Germany (also for balneological purposes) which led to a pressure decrease in the range of 30 meters with a downward trend in the central part of the reservoir. In 1987 an international contract between Germany, Austria and the European Community was signed which regulates the cooperation of the German and Austrian water management authorities, also concerning the thermal aquifer in the Bavarian-Upper Austrian border region. As a follow up, based on a detailed numerical hydrogeological modelling the TAT project (Goldbrunner 2007) phrased recommendations for the enhanced and sustainable utilization of thermal water resources of this region, which are also worthwhile to consider in future Geo-DH developments.

The 30-40 km wide Upper Rhine graben belongs to the Cenozoic European Central Rift (ECRIS) formed in the Tertiary at about 45-60 Ma ago due to magmatic intrusions in 80-100 km depth. The thermomechanical stress resulted in extensional tectonics providing favourable conditions for secondary porosity formation. Within the Upper Rhine graben six aquifers (Tertiary, Jurassic, Triassic and Permian) are of interest for direct use of geothermal energy (Schellschmidt et al. 2010).

Germany is likely to have the highest number of operating Geo-DH systems by 2015, thus becoming the leader in EU in this sector. This high ambition is not only underlain by the good geothermal potential of the country, but by the favorable regulatory and financial environment supporting RES. The German Renewable Energy Sources Act (EEG) provides encouraging feed-in tariff, while the Renewable Energy Heat Act (EEWarmeG) obliges building developers to source a minimum percentage of the energy requirement for heating and hot water from renewable energy sources in new buildings. As part of the German Government's integrated energy and climate programme, the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) has adopted new funding guidelines for the so called Market Incentive Programme, which offers subsidies for installation of a power or heating plant, deep boreholes and heat extraction. In collaboration with the "KfW Bankengruppe" (group of banks) the BMU has established a risk mitigation instrument, too (Schellschmidt et al. 2010).

In *France* there were 42 Geo-DH systems operating in 2012 representing a total installed capacity of 273,7 MW_{th} and annual use of 4444,6 TJ/y (EGEC 2012). This provided heating to approximately 200,000 dwellings, with the majority situated in the Paris basin, where the first wells were drilled in the 1960's exploiting the deep-seated Dogger carbonate reservoir. Since then the Paris basin Geo-DH system operating now with many doublets became the most often cited examples as the world's largest concentration of low-energy geothermal applications in operation, exploiting the same aquifer (Ungemach 2010). The Paris basin has five large aquifers, including the Dogger covering an area of over 150,000 km^2 with the temperature measured directly below the Paris region varying between 56 °C and 85 °C according to the depth of the reservoir (between 1,600 and 1,800 m). In addition to the favorable geological conditions, the Paris basin offers a strong link between the geothermal resources and the demand for heating, as numerous conurbations are situated directly above continuous aquifers.

The other prosperous area is the Aquitaine basin in SW-France, where all of the sites operate without reinjection. Other French regions also have high

potential for low-enthalpy resources, but the geological structures are more complex and the fields much more localized (Alsace, Hainault, Bresse, Limagne, etc.) (Boissier et al. 2010). Furthermore France also shares the high-enthalpy geothermal potential of the Rhine Graben with Germany.

Similarly to Germany, the mature geothermal market in France is not only due to the favourable geological setting, but benefit a lot from the advantageous financial incentives. The insurance system that covers the geological risk, and provides financial aid for the implementation of projects is managed by ADEME and SAF Environnement. This has allowed the execution of several dozen geothermal heat installation systems in France, mainly in the Paris and Aquitaine regions. The Renewable Heat Fund (Fonds Chaleur Renouvelable) managed by ADEME with a budget of 1.2 billion euros for the 2009-2013 period, is dedicated to the funding of projects using renewable heat to be economically competitive in relation to installations that cover the same energy needs using conventional energy sources. In addition to the aid granted by the Renewable Heat Fund, heat networks exploiting more than 50% of renewable and recovered energy sources, including geothermal energy, benefit from a reduced VAT rate (5.5%) applied to the heat that they distribute.

5. CONCLUSIONS

The contribution of geothermal energy to the district heating of Europe is not significant; however the geothermal potential would allow a substantial growth in many countries. The Geo-DH project aims to increase the share of geothermal-based district heating systems in 14 countries of Europe by removing regulatory and financial barriers, as well as providing a decision-support tool in the form of a web-map viewer that gives an overview on the geothermal potential for district-heating, to be coupled with areas of heat demand. Based on the integrated interpretation of pan-European maps showing the geology and geothermal conditions in a uniform system, and the detailed evaluation of the Geo-DH potential of the targeted countries, the most important geothermal reservoirs have been outlined and visualized in an interactive format. Some country examples representing various geological settings and market conditions underline the future development potentials and also raise attention that the most advanced Geo-DH markets had grown not only due to favorable geothermal potentials, but as a result of exhaustive financial and regulatory supporting schemes.

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