Geothermal DH Potential in Europe

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All GeoDH project partners contributed.
About the GeoDH Project

Today geothermal DH technology is under developed although the potential of deep geothermal is significant. The objectives of GeoDH are therefore to:

- Propose the removal of regulatory barriers in order to promote the best circumstances and to simplify the procedures for operators and policy makers.
- Develop innovative financial models for geoDH in order to overcome the current financial crisis which is hampering the financing of geothermal projects which are capital intensive.
- Train technicians and decision-makers of regional and local authorities in order to provide the technical background necessary to approve and support projects.

In Europe, there are over 5,000 district heating systems, including some 250 geoDH systems in operation in 2014. The market share of district heating technology is about 10% of the heating market. The crucial challenge is to promote geothermal district heating (geoDH) in Europe and to facilitate its penetration to the market.

There are several Eastern and Central European countries, such as Hungary, Poland, Slovakia, Slovenia, Czech Republic, and Romania with geothermal DH systems installed. However, the potential is much larger. In the other Eastern and Central Europe countries - Bulgaria, Czech Republic, Slovenia, there is both the need to convince decision makers and to adopt the right regulatory framework but also to establish the market conditions for a development of the geoDH market.

Several Western European countries have 2020 targets for geothermal DH of which Germany, France and Italy are the most ambitious. In order to reach these targets, simplification of procedures is needed and more financing required.

A third group of EU countries includes those Member States currently developing their first geothermal DH systems, such as the Netherlands, UK, Ireland and Denmark. There is no tradition of geoDH so there is a need to establish the market conditions for its development.

The GeoDH consortium has been working on these 3 different groups of countries, thus with juvenile, in transition and mature markets, in 14 countries in total, in order to achieve results replicable across the EU28.

Visit www.geodh.eu for more information.
Executive Summary

Geothermal district heating is a technology that can make a valuable contribution to the achievement of the EU 20-20-20 energy and climate targets to for a European energy security strategy. However, in the framework of the implementation of Directive 2009/28/EC many National Renewable Energy Action Plans (NREAPs) did not present any targets and measures for geothermal DH for 2020.

The objective of this report is to demonstrate the potential to decision-makers in particular by presenting an assessment of the potential for geothermal DH in the 14 countries covered by the project GeoDH, i.e. Italy, France, Germany, Hungary, Ireland, the United Kingdom, The Netherlands, Denmark, Poland, Slovakia, the Czech Republic, Slovenia, Romania, and Bulgaria. Figures emerging from preliminary work (see methodology below for more details) are compared with the NREAPs targets for deep geothermal.

Over 25% of the EU population lives in areas directly suitable for Geothermal District Heating. Geothermal district heating is a valuable and immediate option for the alleviation of Europe’s energy dependency.

There is large potential in Central and Eastern Europe, with geoDH systems in operation in Hungary, Poland, Slovakia, Slovenia, the Czech Republic, and Romania. Existing heat networks are well developed in these countries.

Geothermal electricity and heat generation has its roots in Europe. In the case of heat, there are some 180 geothermal district heating systems in the EU, with a total installed capacity of ca.1.1 GWth, producing about 4250 GWh of thermal power.

The main benefits of geothermal heating and cooling are provision of local, baseload and flexible renewable energy, diversification of the energy mix, and protection against volatile and rising fossil fuels prices. Using geothermal resources can provide economic development opportunities for countries in the form of taxes, royalties, technology export, and jobs.

The geothermal potential is recognised by some EU Member States in their National Renewable Energy Action Plans. However, the actual potential is significantly larger. In order to increase awareness, the GeoDH consortium has assessed the potential which is presented in this report and on an interactive web map.

From the GeoDH project map we can note that:

- geoDH can be developed in all 28 EU countries;
- Geothermal energy can be installed with existing DH systems during extension or renovation, replacing fossil fuels;
- New geoDH systems can be built in many regions of Europe at competitive costs;
- The Pannonian basin is of particular interest when looking at potential development in Central and Eastern Europe;
• The extensive European Lowlands (covering significant areas in several countries: Denmark, Germany, Poland) offer good conditions to develop geoDH systems in many localities;

According to Eurostat, about one third of the EU’s total crude oil (34.5%) and natural gas (31.5%) imports in 2010 originated from Russia. Of this, 75% of the gas is used for heating (2/3 in households and 1/3 in the industry). Geothermal DH technology has the potential to replace a significant part of that fuel. In order to enable such a development the specific proposals from the GeoDH consortium are to:

• Simplify the administrative procedures in order to create market conditions which would facilitate development;
• Develop innovative financial models for geoDH, including a risk insurance scheme, and the intensive use of structural funds;
• Establish a level playing field, by liberalising the gas price and taxing GHG emissions in the heat sector appropriately;
• Train technicians and decision-makers from regional and local authorities in order to provide the technical background necessary to approve and support projects.

Map of geoDH and DH systems in operation in Europe.

**Methodology**

The objective of this report is to present the potential for the development of geoDH systems in selected regions of Europe (of the 14 countries covered by GeoDH project). The areas with best potential from the resource side are those with hot sedimentary aquifers or other types of potential reservoirs.
The report is based on the information provided by the GeoDH web-map viewer. This interactive map presents a European scale overview on the deep geothermal potential of the partner countries combined with the existing heat demand in an interactive way, thus showing best potential areas for future geo-DH developments.

The viewer is available at: loczy.mfgi.hu/flexviewer/geo_DH

Information on geological potential has been matched with heat demand, in order to highlight the regions with significant potential for developing geothermal DH with both a demand side and a supply side approach.

The potential is presented in terms of the percentage of the population living in areas suitable for the uses of geoDH in a given country.

The 14 GeoDH countries are divided in NUTS3\(^1\) regions. In these regions, we have looked at the percentage of areas with geothermal DH potential; this was then multiplied by the number of inhabitants in the area. The result was the number of people living in areas suitable to geoDH in a region. This data was added together to give the number of inhabitants living in areas suitable to geoDH at national level.

It was decided to present the potential in relative terms in order to integrate a percentage error. So this number was divided by the total population of whole country to express the potential in percentage. Below the general formula used:

\[
\% \text{ population living in areas suitable to geoDH in a country} = \frac{\text{Sum at national level of the (} \% \text{ of the NUTS3 area with a geoDH potential}) \times \text{Number of inhabitants in this NUTS3 regions}}{\text{Total population in the country}}
\]

Lastly, the results of this exercise were compared with the NREAPs targets for deep geothermal. From this comparison, the GeoDH project presents an analysis of the national targets and policies regarding deep geothermal heat in the 14 EU countries covered by the project and, when necessary puts forward key recommendations for policy-makers.

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\(^1\) The NUTS classification (Nomenclature of territorial units for statistics) is a hierarchical system for dividing up the economic territory of the EU for the purpose of: a) The collection, development and harmonisation of EU regional statistics; and b) Socio-economic analyses of the regions.

Overview

a) Geothermal DH sector in Europe: state of play

There are ca. 240 geothermal district heating plants (including cogeneration systems) in Europe representing a total installed capacity of more than 4.3 GWth and a production of 4250 GWh or ca.370 ktoe.

More than 180 geothermal DH plants are located in the European Union. The total installed capacity in the EU-28 now amounts to around 1.1 GWth.

![Figure 1 Geothermal DH capacity installed in Europe, per country in 2013 (MWth). Source: EGEC Geothermal Market Report 2013/2014.](image)

According to the around 200 planned projects, capacity is estimated to grow from 4350 megawatts (MWth) installed in 2013 to at least 6500 MWth in 2016.

The main geoDH markets are in France (41 systems), Iceland (32), Germany (25) and Hungary (19).

b) Comparison with NREAPs

The graphs (figure 2 and table 1) below show the deployment projection for deep geothermal heat (geoDH, direct uses etc.) until 2020 as stated in the NREAPs compared to the actual production in 2012. It is easy to note how already in 2012 Europe is lagging behind the expected trajectory. The European Commission, which has highlighted how the transposition of the Renewable Energy Directive has been slower than expected, has urged Member States to finalise their transposition into national law as soon as possible and to increase their efforts in addressing barriers to the uptake of renewable energy.
Figure 2: Actual Geothermal DH production towards the 2020 targets (ktoe) Source: EGEC Geothermal Market Report 2013/2014.
Denmark has not provided information about the projected deep geothermal production. Instead, in the NREAP all geothermal projects were reported under heat pumps.

<table>
<thead>
<tr>
<th>COUNTRIES</th>
<th>2010 NREAPs</th>
<th>Actual share in 2012 according to the countries’ progress reports</th>
<th>2012 NREAPs</th>
<th>2020 target NREAPs</th>
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<tr>
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<td>195</td>
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<td>Germany</td>
<td>34</td>
<td>25(^2)</td>
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<td>686</td>
</tr>
</tbody>
</table>

Table 1 Geothermal heat consumption towards the 2020 targets in the 14 GeoDH countries (ktoe)
Source: NREAPs and Country Progress Reports

In a Staff Working Document accompanying the Renewable energy progress report - SWD (2013) 102 final) - European Commission 2013), the Commission provided a more detailed overview and

\(^2\) This is the actual share for 2011. At the time of finalising this report (1\(^{st}\) July 2014) the country progress report for Germany was not available.
stressed the lack of measures and incentives for geothermal, particularly in the heating sector: "Mid-to large-scale geothermal heating systems may all require additional initiatives in order to let them play their role in meeting the 2020 targets". Geothermal energy is indeed expected to have the greatest shortfall in 2012 (-32.1%).

c) Overall potential

Based on Europe’s geothermal potential, geothermal energy could contribute much more significantly to the decarbonisation of the DH sector. A considerable expansion of the district heating sector is expected in the EU28 until 2050.

Around 25% of the EU population are located in regions with hot sedimentary aquifers or other types of potential reservoirs, so are suitable for geothermal heating and cooling exploitation.

It is crucial to target areas with medium enthalpy (>60°C) at low depth (<3 Km) and with an urban density which ensures the economic sustainability of the project.

The GeoDH project provides also an interactive web-map viewer that shows areas with good geothermal potential for district heating.

The web-map indicates the existing DH systems, including geoDH systems, in Europe. Moreover, regions with temperature distribution higher than 50°C at 1000 m deep, and higher than 90°C at 2000 m deep can be visualised.

Finally, the online tool provides information on the areas with potential for geoDH and the heat-flow density.

Figure 3: Map of geothermal potential of European Union
From the map we can note that:

- GeoDH can be developed in all EU-28 countries
- The potential for GeoDH development by 2020 is much higher than the forecasts of Member States in their NREAPs (see below)
- Geothermal can be installed with existing DH systems during extension or renovation, replacing fossil fuels
- New GeoDH systems can be built in many regions of Europe at competitive costs
- The Paris and Munich basins are the two main regions today in terms of number of GeoDH systems in operation.
- The Pannonian basin is of particular interest when looking at potential development in Central and Eastern Europe countries.
- The extensive European Lowlands (covering significant areas in several countries: Denmark, Germany, Poland) offer good conditions to develop GeoDH systems in many localities;
- In southern Europe, the option of District Cooling should be considered
- The enthalpy (temperature) is not the only selection criteria; other key factors are heat flow on the supply side, and the heat users (urban density) on the demand side.
1. Bulgaria

1. Introduction

In Bulgaria today thermal waters with temperatures of up to 98°C are used in direct applications, e.g. for heating of buildings and greenhouses, balneology, etc. Balneology is the most developed application and the main cities with geothermal applications are: Sandanski, Velingrad, Hisarya, Pavel banya and Varna.

Higher temperatures of about 150°C are expected to be found in the deeper seated sedimentary water bearing layers of Devonian and Triassic age in the Moesian plate, particularly in the Velingrad and Sapareva Banya geothermal fields. Geothermal activity is mainly concentrated in the southern part of the country due to the higher water temperature there and a low water salinity (TDS), mostly below 1g/l.

At the moment the use of a geothermal energy for heating is rather limited, but as shown below a potential exists for deep geothermal.

2. State of play for district heating

No geothermal district heating system has been built in the country so far, and the Bulgarian District Heating market is not very dynamic. According to Euroheat & Power (EHP, 2013) the market has mainly developed in Sofia, where there has been a recent growth of 1-2 % per year in the number of apartments connected to District Heating systems while in other cities growth has been episodic.

In 2011 there were only 15 district heating systems in operation in the country; the primary energy source used in Bulgaria is natural gas, especially from Russia. Natural gas was the source of around 70% of district heat, while 4% came from burning coal and coal products. (2011) (EHP, 2013).

3. Potential identified for geothermal district heating

As shown in the map overleaf, the DH infrastructure in Bulgaria is not well developed (there are only 15 district heating systems none of them is geothermal). No geoDH systems are planned. However, in Bulgaria there is a huge geothermal potential in most of the territory.

With the total population of about 7.2 mio inhabitants, the proportion of Bulgarian population that can be reached with geothermal district heating (with geothermal heat at 1000m 60°C to 100°C), is around 50%. The regions which can be fully supplied by geothermal DH are Pleven, Shumen, Targpvishte, Blagoevgrad and Smolyan.

Furthermore, in the Vidin and Montana districts temperatures above 100°C can be found at 2000m.

Bulgaria is committed to reach a share of renewable energy sources (RES) of 16% by 2020. To achieve this, the Ministry of Economy, Energy and Tourism (MEET) has developed a National Action Plan for Renewable Energy in accordance with Directive 2009/28.

The 16% share of renewable energy in gross final energy consumption in 2020 target includes a 23.8% share for renewable heating and cooling, representing around $1,103$ kilotons of oil equivalent (ktoe).

For deep geothermal H&C, the proposal in the NREAP is a low increase from 1 to 9 ktoe; no support measures are planned to accompany this development. According to the second national report on Bulgarian’s progress in the promotion and use of energy from Renewables (2013) there are already 33 ktoe produced from space heating-greenhouses-bathing etc. The 2020 target must be revised.

<table>
<thead>
<tr>
<th></th>
<th>2010 NREAPs</th>
<th>2012 actual share from Progress report</th>
<th>2012 NREAPs</th>
<th>2020 target NREAPs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulgaria</td>
<td>1</td>
<td>33</td>
<td>2.4</td>
<td>9</td>
</tr>
</tbody>
</table>

Table 2 Geothermal heat consumption towards the 2020 targets (ktoe)

5. Recommendations for policy-makers

Bulgarian gas prices rose sharply between 2008-2012, by 42.2% for domestic consumers and by 49.2% for industrial users. The Russian/Ukrainian gas crisis has made the security of supply a key issue for Bulgaria.

There are still many barriers hampering the development of geothermal district heating in Bulgaria; thus, our main recommendations are the following:

a) **Refurbish existing DH network**, to improve production efficiency, lower grid losses and to avoid environmental problems. According to the Bulgarian Heating Association’s estimation the annual heat losses are 1.5 TWh. New indirect technological systems have not been built. One of the key obstacles was the high royalties paid for the water used for production of geothermal energy.

b) **Earmark funds for geothermal energy**, in particular DHs, which can have a significant positive impact on the purchasing power and decreasing the heat prices at a regional level; however the gas prices are regulated and most of the District Heating and Cooling systems are dependent on the public gas supplier- the market must be liberalised. Public and private financial institutions must bring more capital for investments in geoDH and repayable grants to mitigate the geological risk.

c) **Increase the level of awareness and expertise** by setting up promotional campaigns on the benefits of using geothermal district heating and training local authorities.

d) **Launch a resource assessment/exploration campaign**, investigation for a characterization of the deep geothermal energy resources.
2. Czech Republic

1. Introduction

The Bohemian Massif and the Carpathian System are the two main tectonic units in the Czech territory.

Although there are several sites favourable for development of geothermal district heating systems in the Czech Republic, the only example is in Decin (Hurter, S. and Haenel, R., 2002; Jirakova H., Stibitz, M., Frydrych, V., 2013).

2. State of play for district heating

There is a strong district heating tradition (DH) in the Czech Republic. According to Euroheat & Power (EHP, 2013) some 37% of all households are connected to DH. DH systems are operational in all cities with a population of over 50,000 inhabitants. In these urban areas DH accounted for 73% of the market share.

The primary energy sources used are nearly entirely fossil fuels, with the very limited exception of biomass. About 67% of the heat supplied was produced by burning coal and coal products, while natural gas accounted for 26% of the heat supplied through DH systems in 2011. (EHP, 2013).

There is one GeoDH project, in Děčín, Northern Bohemia. There are a few sites under consideration for cogeneration. Geothermal energy has the potential to be integrated to existing networks thereby contributing to the decarbonisation of the heat sector in the country.

3. Potential identified for geothermal district heating

As shown in the map overleaf, in particular Nord-West and Eastern part of Czech Republic is suitable to geothermal district heating. With a total population of about 10.5 million inhabitants, the proportion of Czech population that can be reached with a geothermal district heating (at geothermal heat at 2000m 60 °C to 100°C) is around 10%. Most favourable areas include nuts 3 regions such as Ústecký kraj and Karlovarský kraj, Jihomoravský kraj, Moravskoslezský kraj, Stredoceský kraj, Pardubický kraj and Olomoucký kraj.

According to the Report on progress in the promotion and use of energy from renewable sources in the Czech Republic (2013), the actual share in consumption of deep geothermal H&C is 0 and the forecast is to have only 15 ktoe in 2020. However, for many years several installations were running, such as the spas in Karlovy Vary & Marianske Lazne; producing 2.15 ktoe in 2010. There is geothermal potential, if the first installations are deemed successful, more plants will be installed.

Table 3: Geothermal heat consumption towards the 2020 targets (ktoe)

<table>
<thead>
<tr>
<th></th>
<th>2010 NREAPs</th>
<th>2012 share</th>
<th>2012 NREAPs</th>
<th>2020 NREAPs</th>
<th>target</th>
</tr>
</thead>
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<tr>
<td><strong>Czech Republic</strong></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>15</td>
<td></td>
</tr>
</tbody>
</table>

5. Recommendations for policy-makers

In the Czech Republic, the need for expanded resource exploration has been recognised and numerous geothermal projects including all types of technologies are either under development or under investigation. In line with development our major recommendations are as follows:

a) **Regulate the use of geothermal resources.** In the Czech Republic there is no relevant legal regulation and guidance focusing on the delineation of protection zones related to geothermal resources. So far, protection zones are determined on the basis of analogy with reserved mineral deposit protection zones. However, problems still persist, e.g. the issue of the spatial extent of this protection zone.

b) **Phase out regulated prices.** Heat prices are regulated by the Czech Republic energy regulatory authority. The State supervises heat prices which include relevant costs and profits of the heat suppliers and taxes. System costs and externalities are not included.

c) **Simplify administrative procedures.** Deep geothermal regulations are rather complex and not complete. There is currently no single legal or technical regulation which would deal with geothermal energy resources and their use in a comprehensive manner. A Geothermal act is required.

d) **Earmark funds for geothermal energy.** In an emerging market such as the Czech Republic, geothermal projects need some financial support from the public sector, especially to cover the geological risk, and cooperation of public and private bodies is required. There is some support for district heating & cooling from RES, but they are either unstable or limited to grants.

e) **Increase the level of certainty of future energy and climate policy at European level.** Establish long term energy strategy 2020-2030
3. Denmark

1. Introduction

The deeper geothermal resources in Denmark are mainly located in to two deep, low-enthalpy sedimentary basins, the Norwegian-Danish Basin and the North German Basin. Comprehensive research based on seismic and well data primarily from previous hydrocarbon exploration campaigns have shown that the fill of the Norwegian-Danish Basin contains several lithostratigraphical formations with sandstones of sufficient quality and temperature to serve as geothermal reservoirs. Pronounced temperature anomalies are however absent in the country (Mahler, A. and Røgen, B. and Ditlefsen, C. and Nielsen, L.H. and Vangkilde-Pedersen, T., 2013).

2. State of play for district heating

District heating is a dominant heating solution for households, accounting for a 62.5% share of the market. It has been observed that the number of household heated using DH has grown by 4.1% over the period form 2008 and 2012. (EHP, 2013).

The primary energy sources used in district heating in Denmark are renewables, which account for more than 40%. The amount of waste incineration remained stable for the last five years. While coal is still the dominant fuel in large scale CHP plants, the amount of coal used for district heating fell to 16.4% in 2011. Around 32% of the heat supply came from natural gas (EHP, 2013).

There were around 400 district heating systems installed as of 2011. In Denmark there are three geothermal heat plants supplying DH networks: in Copenhagen Margetheholm, Thisted and the most recent in Sønderborg. More than 10 GeoDH plants are planned to be built including an installation in Greater Copenhagen with expected capacity of 65 MWth.

The annual heat extracted in 2012 from geothermal water and used for district heating is at about 300 TJ. Around €110 million, approximately 90% of which is private, has been invested in the use of geothermal heat for district heating.

3. Potential identified for geothermal district heating

As shown in the map overleaf, most of the Danish territory is suitable for geothermal district heating. Another aspect presented is that the existing infrastructure is well developed. Huge geothermal resources are documented in the subsurface below most Danish cities.

With the total population of 5.6 million inhabitants the proportion of Danish population that can be served by geothermal district heating (with temperatures between 60 °C to 100°C at 2000m deep) is around 75%. This area includes regions that can be fully supplied with geothermal installations such as Københavns omegn, Nordsjælland, Østsjælland, Østjylland and Vest- og Sydsjælland.

A legal framework exists in Denmark for deep geothermal (Legislative Decree No. 889 of 4 July 2007 with subsequent amendments). In their NREAP, they declare that: “In Denmark, geothermal energy is used to produce heat that can be used in district heating systems... there are many watery
sandstones places in Denmark with water conductive properties of such a nature that geothermal heat is possible…”

Although 3 geothermal DH systems are running, 0 Mtoe production of heating and cooling from deep geothermal is declared in the NREAP. According to the Danish report under Directive 2009/28/EC concerning progress in the use and promotion of energy from renewable sources (2013), the total actual share in consumption of deep geothermal H&C for 2012 is 3.4 ktoe. Furthermore, the total production in 2010 of deep geothermal H&C is 19.12 ktoe, according to the EGEC Market report 2013/2014. A collection of recent data must be made to update these figures.

**Table 4: Geothermal heat consumption towards the 2020 targets (ktoe)**

<table>
<thead>
<tr>
<th></th>
<th>2010 NREAPs</th>
<th>2012 share</th>
<th>2012 NREAPs</th>
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### 5. Recommendations for policy-makers

Assessment of the geothermal resources in Denmark indicates a great potential in large parts of the country. It has been proved possible to produce geothermal heat for district heating from deep Danish geothermal aquifers. Besides, the Danish legal framework is in place and there is an increasing interest in geothermal energy among district heating companies and municipalities. However, the following recommendations are given:

a) **Simplify the permission procedures.** The procedure for gaining permission is demanding, mainly because during the process there are 3 stages of approval by the Danish energy agency. Besides, an applicant wishing to exploit geothermal resources must collect a consortium consisting of people with major experience within the field of geothermal in order to be considered. The applicant must have a solid financial foundation and must have a major focus on the process and a willingness to explore the actual geothermal potential.

b) **Phase out unnecessary environmental screening:** All three GeoDH projects were thoroughly screened and it was found that there are no environmental issues in any of the plants. The screenings and the findings of the screenings were useful in communication with the municipality and the local community.

c) **Establish a risk insurance scheme.** The geothermal risk must be managed and mitigated by the establishment of a national fund like those in France and the Netherlands.
4. France

1. Introduction

France has been developing its geothermal resources for energy purposes since the two oil crises in the 1970s.

Low-enthalpy resources, developed for thermal applications, are primarily located in the two major existing sedimentary basins: the Paris Basin and the Aquitaine Basin in southwest France. The Paris Basin has five large aquifers, including the Dogger which has the largest number of low-energy geothermal operations in the world, with 36 operations currently recorded, which are used for collective heating applications. The Dogger covers an area of over 150,000 km² 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 1,800m). However, the regional geology of Aquitaine is quite complicated and the aquifers used are made of sands and sandstones interbedded with clays, so that the drilling of reinjection wells is not easy. In addition, the temperature is lower than in the Paris basin which makes the profitability of a doublet harder to achieve. Nowadays, secondary uses of the resource, as irrigation, are investigated.

In addition, several works have been conducted in the last years by BRGM (the French Geological Survey), with the cooperation of ADEME (French Energy Agency) to update the assessment of French geothermal resources (Boissier, F. and Vernier, R. and Laplaige, P., 2013)

2. State of play for district heating

According to Euroheat & Power (EHP, 2013) in France there were 548 district heating systems in 2011 corresponding to a market share of approximately 7%. The development of fuel used for district heating has been moving over the last 10 years towards using more renewable and waste energy. However, the most used primary energy source is still natural gas (43%), followed by waste (24%). 3.1% of the heat supplied was produced by geothermal.

The first GeoDH systems were installed in France in the 1960s in the Paris basin, pioneering the doublet well concept of heat farming. An interesting element in the French GeoDH market is the technological progression aiming at bringing the longevity of the initial DH doublet up to 50 years; The concept is the following: after 25 years, the two wells of the doublet are lined and rebuilt as reinjection wells in combination with a newly drilled production well.

Today there are already more than 40 geothermal district heating plants supplying the local DH network such as in Chevilly Larue/L’Hayles-Roses-Ile de France (19.2 MWth) and in Meaux Beauval-Ile de France (13.7 MWth). Many projects are currently being developed including in Paray-Vieille-Poste with expected capacity installed of 32.75 MWth, in Rittershoffen (24 MWth) and some smaller projects with expected installed capacity between 8 and 12 MWth.
3. Potential identified for geothermal district heating

As shown in the map overleaf, basically two regions in France are more suitable to geothermal district heating. One is related to the exploitation of the deep Dogger reservoir in the Paris area, where the infrastructure is very well developed, and the second one in Aquitaine, with around 10 single production wells, which were mostly developed in the 1980s.

Besides this, numerous GeoDH systems are already designed and have received their drilling permits. A significant number of old existing plants are going also to be refitted with casing of existing wells with smaller diameters (triplet systems) or with the drilling of new doublets in bigger diameters in order to allow a possible life time of 50 to 60 years. Geothermal heat production is expected to increase by a factor of 5 between 2006 and 2020, whereas the objective for RES heat in general is an increase by a factor of 2.

With the total population of 65,588,117 the proportion of French population that can be reached with a geothermal district heating (at geothermal heat at 1000m 60 °C to 100°C) is around 37%. This area includes Ile de France and Nuts 3 regions like Marne, Aisne, Loir-et-Cher, Loiret, and Meuse that can be fully covered with geothermal installations.

Furthermore, the corresponding proportion for temperatures above 100°C at 2000 m is around 6.2%. The area that can be covered partially by the geothermal installations include inter alia: Indre-et-Loire, Loir-et-Cher and Ain.


For geothermal direct uses, support measures are consistent to allow an important increase from 155 ktoe to 500 ktoe in 2020. However, the data from the report on progress in the promotion and use of energy from renewable sources (2013) show that the established targets have not been achieved in 2012 and the total actual share in consumption of deep geothermal H&C for 2012 is only 94 ktoe. More support is needed for reaching the 2020 objectives.
Figure 7: Map of geothermal potential of France

Table 5: Geothermal heat consumption towards the 2020 targets ( ktoe)

<table>
<thead>
<tr>
<th>Localisation</th>
<th>Capacity (MWth)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chevilly-Larue/L’Haÿ-les-Roses-Ile de France</td>
<td>19.2</td>
</tr>
<tr>
<td>Maison Alfort 1-2-Ile de France</td>
<td>14.1</td>
</tr>
<tr>
<td>Meaux Beauval-Ile de France</td>
<td>13.7</td>
</tr>
<tr>
<td>Villeneuve Saint Georges-Ile de France</td>
<td>12.6</td>
</tr>
<tr>
<td>Cachen Nord-Sud</td>
<td>11.5</td>
</tr>
</tbody>
</table>
5. Recommendations for policy-makers

The use of geothermal for H&C has doubled in the last 6 years. Nevertheless the estimation calculated by AFPG for 2020 indicates that without the continuation of strong incentives the target will not be attained. The intention of State to support the geothermal industry is obvious, and there are ambivalent results. The main recommendations are as follows:

a) **Continue the “Fonds Chaleur” and the Risk insurance scheme.** This is key.

b) **Rewrite the Mining Code.** This would favour the development of numerous projects

c) **Improve and simplify the regulatory process:** The administrative simplification for small operations (less than 30 KWth) is also of paramount importance to achieve the targets. The main problem is the time consuming process to obtain the drilling permit, which, depending on the region ranges between 6 and 18 months.

d) **Open the heat market.** A level playing field with gas sector is not ensured, as gas prices are regulated. Moreover, a large part of heat is provided by electricity with low efficiency.
5. Germany

1. Introduction

The most important regions for hydrogeothermal exploitation in Germany are the North German Basin (part of the large North European Basin), the Upper Rhine Graben, and the South German Molasse Basin.

The Mesozoic deposits of the North German Basin are made up of sandstones, clay and carbonates, with evaporite intercalations. Six Cretaceous, Jurassic and Triassic sandstone aquifers are of interest for direct use of geothermal energy: Valendis-Sandstein, Bentheimer Sandstein, Aalen, Lias and Rhät, Schilfsandstein, and Buntsandstein. Because of the salt tectonics, great variations of depth and thickness, exceeding locally 1000m, occur along short distances.

The Molasse Basin in southern Germany is an asymmetrical foreland basin associated with the uplift of the Alps. It extends over more than 300km from Switzerland in the southwest to Austria in the east. The basin is made up mainly by Tertiary, Upper Jurassic (Malm) and Triassic sediments. Eight aquifers of these sedimentary layers are of interest for direct use of geothermal energy: Burdigal-Sande, Aquitan-Sande, Chatt-Sande, Baustein-Schichten, Ampfinger Schichten, Gault/Cenoman-Sandsteine, Malm and Upper Muschelkalk. The Malm (karstic limestone aquifer of the Upper Jurassic) is one of the most important hydro-geothermal energy reservoirs in Central Europe because the aquifer is highly productive and present throughout almost the whole Molasse Basin. The Malm aquifer dips from north to south to increasing depths and temperatures.

The Upper Rhine Graben belongs to a large rift system which crosses the north-western European plate (e.g. Villemin et al. 1986). Between 30 and 40 km wide, the graben runs from Basel, Switzerland, to Frankfurt, Germany. The structure was formed in the Tertiary at about 45-60 Ma by up-doming of the crust-mantle boundary due to magmatic intrusions in 80-100 km depth. The induced thermo-mechanical stress results in extensional tectonics with a maximum vertical offset of 4.8 km. Six aquifers (Tertiary, Jurassic, Triassic and Permian) are of interest for direct use of geothermal energy: Hydrobien-Schichten, Grafenberg-Schicht, Hauptrogenstein, Upper Muschelkalk, Buntsandstein and Rotliegend (Ganz, B. and Schellschmidt, R. and Schulz, R. and Sanner, B., 2013).

2. State of play for district heating

District heating has a market share of 13.2% of all occupied accommodation, a big difference in market share between the West (around 8%) and East Germany (around 31%) (EHP, 2013).

The main fuel used for District Heating is natural gas (44%) and coal and coal products (42%) (EHP, 2013).

In Germany, there are 3,390 district heating plants and around 26 GeoDH plants including three newly installed: in Sauerlach with installed capacity of 40 MWth, in Waldkraiburg (10 MWth) and in
Traunreut (12 MWth). More than 60 geoDH plants are under consideration, of which two are in the development phase i.e. in Taufkirchen (40 MWth) and Kirchweidach (5, 5 MWth).

3. Potential identified for geothermal district heating

The most widespread utilizations of deep geothermal heat are thermal spas. However, the number of larger district heating plants is growing continuously. They presently account for about half of the deep geothermal heat production, with an upward tendency.

As shown on the map some parts of German territories are suitable for deep geothermal production. The heat network infrastructures are well developed with more than 3.300 district heating systems.

With a total population of 82 million inhabitants, nearly half of German population can be reached with a geothermal district heating (38 % with temperature between 60°C and 100°C at 1000m depth, and the rest with temperatures above 100°C at 2000 m). This number includes many areas that can be fully and partially served by geothermal installations. Almost all regions on the nuts 3 level in Mecklenburg-Vorpommern, in Niedersachsen and Schleswig-Holstein are suitable. Some other potential locations are in the regions of Baden Württemberg, Brandenburg and Sachsen-Anhalt.

Areas where heat needs can be fully covered by geothermal installations include inter alia Mannheim, Stadtkreis, Konstanz, Ulm, Stadtkreis, Ingolstadt, Kreisfreie Stadt, Passau, Kreisfreie Stadt, Neu-Ulm, Main-Taunus-Kreis and Worms, and Kreisfreie Stadt.
Figure 8: Map of geothermal potential of Germany

<table>
<thead>
<tr>
<th>Cities with geothermal DH (with highest installed capacity)</th>
<th>Capacity (MWth)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sauerlach</td>
<td>40</td>
</tr>
<tr>
<td>Unterhaching</td>
<td>37</td>
</tr>
<tr>
<td>Oberhaching</td>
<td>11</td>
</tr>
<tr>
<td>Erdig</td>
<td>10.2</td>
</tr>
<tr>
<td>Waldkraiburg</td>
<td>10</td>
</tr>
</tbody>
</table>

For geothermal direct uses, Germany adopts also interesting support measures. The increase forecasted will lead Germany to be top of European countries for geothermal H&C production.

The scenario is to grow from 34 ktoe to 686 ktoe in 2020. However, in order to reach this target a large action plan must be adopted. Unfortunately, the country progress report has not been published, and the total actual share in consumption of deep geothermal H&C for 2012 is unknown. Only available data comes from the progress report from 2011 and indicates that the total share in consumption of deep geothermal H&C for 2011 is 25 ktoe, which means that the share is lower than expected.

Table 6: Geothermal heat consumption towards the 2020 targets (ktoe)

<table>
<thead>
<tr>
<th></th>
<th>2010 NREAPs</th>
<th>2012 actual share</th>
<th>2012 NREAPs</th>
<th>2020 NREAPs target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Germany</td>
<td>34</td>
<td>?</td>
<td>114</td>
<td>686</td>
</tr>
</tbody>
</table>


5. Recommendations for policy-makers

One problem to be outlined is that the German NREAP lists existing programs and regulations, without giving a further perspective. In general, the sector of support for RES heat is heavily under-developed in Germany, and significant measures need to be taken to fully realise the possible contribution of RES. Thus, our recommendations are as follows:

a) Financing: as Geothermal DH systems are capital intensive, it is needed to have a Public/Private fund for financing new geothermal projects in existing DH or in newly constructed DH. A Public risk insurance scheme must accompany this fund.

b) Open the heat market. The level playing field with gas sector is not ensured, as the problem of regulated prices for gas is persistent.

c) The regulatory framework regarding geothermal in the different German landers must be better streamlined.
6. Hungary

1. Introduction

Hungary lies on a characteristic positive geothermal anomaly, with heat flow density ranging from 50 to 130 mW/m² with a mean value of 90-100 mW/m² and geothermal gradient of about 45 °C/km. This increased heat flux is related to the Early-Middle Miocene formation of the Pannonian Basin, when the lithosphere stretched and thinned and the hot asthenosphere got closer to the surface (Horváth and Royden 1981).

During the continuing subsidence a large depression formed, leading to the formation of the Pannonia Lake, a shallow inland sea, in which three to four kilometres of sediments were deposited, transported by rivers. With a depth interval of ca. 700-1800m in the interior parts of the basin, where the temperature ranges from 60 to 90 °C, the main porous sandstone reservoirs with bulk porosity of 20-30% and a permeability of 500-1500 mD, and with an almost uniform hydrostatic pressure are widely used for direct heat purposes as well as for balneology.

In the basin floor built up mostly of carbonate and metamorphic rocks, temperatures can exceed 100-120 °C at the average depth of 2000 metres or more, and may provide favourable conditions for development of medium enthalpy geothermal systems (including CHP plants). A high-enthalpy reservoir is also proven (pressure of 360 bars and 189 °C of the well-head) at a depth of 4200 m in Fábiánsebestyén (Nádor, A. and Tóth, A. and Kujbus, A. and Ádám, B.)

2. State of play for district heating

Heating and warm water is supplied by district heating to 655,000 households in Hungary (15.2% of all households). The majority of installations were built in the 1960’s and 1970’s in the large housing estates (panel blocks) of the socialist era. In some cases, individual measuring systems were installed, in others, costs were shared in a building dependent on apartment size (amongst other parameters).

The National Energy Strategy which runs until 2030 in Hungary, forecasts a fall in the share of heat consumption from DH in the residential and tertiary sector from 12 % to 10 % by 2020. Last years the DH in the residential sector experienced some fluctuations in recent years and the situation lead to stagnation within the market (decrease of number of heated dwellings, of total heat sales, decrease of industrial, residential consumption and of consumption of tertiary sector)(EHP, 2013).

Natural gas is the main fuel for heating in Hungary; in 2009 accounting for 92.3%. Only 2.8% of the heat supplied was produced by combustible renewables and 1.6% by geothermal (EHP, 2013). There are 19 geothermal heat plants in Hungary, of which four are new: in Makó, Szolnok, Szeged and Miskolc, the latest with the highest installed geothermal capacity of 55 MWth. Additionally, more than 16 new projects are under development and are expected to be realised in the next 3-4 years.
3. Potential identified for geothermal district heating

As shown in the map overleaf, most of the Hungarian territory is suitable for geothermal district heating, corresponding to areas where around 72% of the population lives.

The existing infrastructure is well developed (there are 95 district heating systems installed in 2011). Therefore geothermal can be more easily integrated into existing networks (with refurbishment) and replace gas and fossil fuels at lower costs.

In Hungary municipalities should have a general ‘Development plan’ which includes all aspects of development (roads, transport, public buildings, etc.) and if the municipality has plans to use renewable energy, then a ‘renewable energy concept’ is included in this general development plan.

However, not all municipalities with a geothermal potential have included this source yet, meaning there is large potential for increased deployment of the technology in the country.

With the total population of nearly 10 million inhabitants, the proportion of Hungarian population that can be reached with geothermal district heating (where geothermal heat, at 1000m or at 2000m, has a temperature higher than 60 °C) is around 90%. The areas where heating needs can be 60-90% covered with geothermal installations includes Csongrád and Békés.

There are about 950 thermal wells operating in Hungary, out of which 274 provide thermal water warmer than 60 °C, i.e. would be theoretically suitable for GeoDH.

Primary developments should focus on those areas where the good geothermal potential meets the already existing district heating infrastructure. These areas are the following: Békéscsaba, Berettyóújfalu, Bonyhád, Budapest, Cegléd, Csorna, Debrecen, Győr, Hajdúböszörmény, Hajdúnánás, Hajdúszoboszló, Kaposvár, Kapuvár, Komárom, Mosonmagyaróvár, Tiszaujváros, Sárvár. If the 45-60 °C temperature interval is also considered (which requires heat pumps and renovation of buildings in order to increase energy efficiency for ‘low temperature DH’) another 11 areas with existing DH systems should also be included: (Dombóvár, Eger, Kecskemét, Kiskunfélegyháza, Kiskunhalas, Mátészalka, Nagykőrös, Nyíregyháza, Nyírbátor, Püspökladány, Tiszavasvári). Thus altogether there are 28 areas with good geothermal potential and existing DH infrastructure in Hungary, where geothermal energy could replace gas or significantly contribute to DH, thus decrease the energy dependency of Hungary even on a short and medium term.

The second priority area for GeoDH development involves 17 areas (Algyő, Ács, Balmazújváros, Gyomaendrőd, Gyula, Hajdúdorog, Karcag, Kiskunmajsa, Lenti, Mezőkövesd, Mezőtúr, Orosháza, Tiszaöldvár, Tiszakécske, Törökzentmiklós, Tura, Túrkeve) which have good geothermal potential and existing heat demand, however they do not have established DH infrastructure yet. In these areas the installation of new pipelines are represents major investment costs. There is good potential in communal buildings (e.g. hospital, school, municipality buildings) could also decrease the amount of the used fossil fuels.

The third priority area of development is represented by those settlements, where thermal spas already exist, but the water is used only for balneological purposes. In those 18 areas cascade use and the use of heat pumps would make local heating systems possible.

Finally, there are another 47 areas where geothermal potential is good (i.e. there are thermal wells producing water with outflow temperature above 60 °C), however no concentrated heat demand exists. These are mainly rural areas where additional use of geothermal energy in the agricultural sector could contribute to diminishing the use of Russian imported gas in the heating sector.

The Hungarian NREAP gives targets only for deep geothermal, and within that does not differentiate between types of use.

Hungary has a target of 14.65% RES by 2020 with a geothermal share of 9% to 17%. The share of RES in national heating and cooling is expected to grow from 9% (2010) to 18.9% (2020) and the direct use of geothermal from 4.23 to 16.43 PJ (however this includes geothermal heating in agriculture, which is significant (27% of installed capacity and 20% of annual use).
Table 7: Geothermal heat consumption towards the 2020 targets (ktoe)

<table>
<thead>
<tr>
<th></th>
<th>2010 NREAPs</th>
<th>2012 share</th>
<th>2012 NREAPs</th>
<th>2020 NREAPs target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hungary</td>
<td>101</td>
<td>107</td>
<td>120</td>
<td>357</td>
</tr>
</tbody>
</table>


5. Recommendations for policy-makers

The intention of the State to support the geothermal industry is obvious, but there are mixed results. There are still some main barriers hampering further investments in the country, therefore some key recommendations are proposed, namely:

a) **Earmark structural (and other) funds for geothermal projects**

b) **Improve and simplify the regulatory process.** The legal framework for geothermal energy use is rather complicated and needs to be simplified; the mining, energy, environmental protection and water management authorities share competences regarding regulations and licensing procedures. Legal contradictions and time-consuming licensing procedures are still in place.

c) **Phase-out social tariffs and regulated price for gas:** In Hungary the official price for heat seems to be an important barrier. The Price of district heating (between heat supplier and end-user) in Hungary is determined by the Ministry of National Development and is ‘frozen’ at the level of March 31, 2011. At the same time, the low gas prices for residential consumers and public institutions do not make alternative (renewable) sources economic.

d) **Refurbishment of existing DH networks:** The refurbishment of existing DH networks should be done in a way that facilitates the integration of heat at lower temperatures. Additionally, it is important to combine these networks with appropriate measures on energy efficiency, e.g. well-insulated fabric and underfloor and in-wall heating.
7. Ireland

1. Introduction

Ireland’s geological setting is such that geothermal resources are classified as low enthalpy with lower than average geothermal gradients of approximately 10°C/km recorded in the south to higher gradients in the north east and in Northern Ireland where values of up to 35°C/km are observed.

Many of the areas in Ireland which have greatest potential are where hot fluids have migrated a relatively short distance from a deep geothermal heat source and are trapped in Mesozoic and Carboniferous reservoirs overlain by an insulating cover of low conductivity rock types. These areas include Mesozoic Basins in Northern Ireland (Rathlin, Lough Neagh and Larne) and 18 Carboniferous Basins and Sub-basins of the midlands, east, west and south west of Ireland (East Dublin Basin, Portarlington Trough, Dangan Trough, Clare Basin, Limerick Basin, North Cork Mallow Basin, Carrick-on-Suir Syncline, West Leinster Basin). (Pasquali, R., and Jones, G. L. and Allen, A. and Burgess, J. and Williams, T. H., 2013)

2. State of play for district heating

Deployment of deep geothermal energy resources in Ireland has been slow to date. In Ireland there are no deep geothermal installations and there is no plan to build any so far. There are only two district heating systems in whole country, in Dublin and in Cork.

However, since the completion of geothermal exploration wells in 2009 by GT Energy in Newcastle, South County Dublin, the potential for harnessing deep geothermal resources from the margin of the Dublin Basin has been further explored.

3. Potential identified for geothermal district heating

As shown on the map overleaf, some parts of Ireland are suitable for geothermal district heating. Indeed the potential exists, however, the infrastructure is not well developed (there are only 2 district heating systems installed). With the total population of 4.5 million inhabitants the proportion of Irish population that can be reached with geothermal district heating (where geothermal heat at 1000m is 60°C to 100°C) is around 35%.

These areas include cities like Dublin, where the heating requirements can be fully covered with geothermal installations and other nuts 3 regions such as the Mid-East, which can be covered in 45%.

<table>
<thead>
<tr>
<th></th>
<th>2010 NREAPs</th>
<th>2012 share</th>
<th>actual 2012</th>
<th>2012 NREAPs</th>
<th>2020 target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ireland</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 8: Geothermal heat consumption towards the 2020 targets (ktoe)

Ireland does not put any figures on deep geothermal heating and cooling, and does not propose any support measures. However, in 2010 there is 0.5 ktoe of direct use (air conditioning-cooling: 6622 MWth and bathing: 1452 MWth) and a potential for further development exists.

Geothermal legislation is under preparation and soon a new bill will be published. It should clarify the situation, especially for deep geothermal, by simplifying the licensing procedure, establishing support measures and presenting a development roadmap.
5. Recommendations for policy-makers

Ireland has neither district heating (DH) nor a deep geothermal tradition. To facilitate the development and to increase the market penetration of geothermal district heating systems. The main recommendations are the following:

a) **Set up specific legislation**, which would allow developers to obtain licenses for resource exploration and development. The Draft Geothermal Development Bill has been drafted and reviewed by the attorney general. However further progress on the legislation and subsequent regulation has not advanced since 2011.

b) **Earmark funds for geothermal energy**. A support mechanism that was in place for the installation of domestic geothermal heating systems was withdrawn. The unforeseen immediate cessation of this financial support resulted in a marked decrease of domestic system installations and unfortunate closure of many geothermal energy installation businesses. Developing innovative financial models, and especially a risk insurance scheme, could be helpful by promoting the use of geothermal energy and deployment of deep geothermal heat.

d) **Increase the level of public awareness and information**, the lack of information on the potential and on benefits of district heating has been identified as a significant barrier to development.

e) **Launch a public exploration campaign**: studies and research that aimed at assessing the nature and energy production capacity of geothermal systems.
8. Italy

1. Introduction

The geological structure of the country is extremely complex and the available geothermal information differs widely from region to region. During the Alpine orogeny (starting in the Cretaceous) period the collision between the African and European plates gave rise to the formation of the Alpine and Apennine chain. In the Late Miocene period the compressional front shifted east to the outer margin of the Apennine chain, resulting in the formation of the Foredepth basins along the Eastern margin of Italy. The inner West Apennines were affected by extension lasting up to the Pleistocene. This led to the opening of the Tyrrenihen basin, and to a significant crustal thinning associated with uplift of the mantle along most of the west Italian sector. Intensive intrusive and effusive magmatic activity occurred (Miocene - Quaternary) along the peri-Tyrrhenian area, in the Tyrrhenian Sea itself, in Ischia island, in Sicily (including the Aeolian and Pantelleria islands) and in Sardinia (Campidano graben). (Hurter, and Haenel, 2002)

2. State of play for district heating

Italy is not a traditional district heating country, notably due to the extensive gas network developed across the country, as well as to the general mild climate conditions of the central and southern parts of the country. In 2011 DH served 133 urban centres, representing 3.6% of the total heat demand. According to EHP (2013) the main fuel used for DH systems is natural gas, which accounts for 76% of the total supply. Around 13% of the heat supplied was produced by waste and only around 1 % by geothermal energy.

There are 18 geothermal heat plants supplying the local DH network such as in Pomarance (Tuscany) with the highest installed capacity (21.5 MWth), Santa Fiora (17.2 MWth, Tuscany) and in Ferrara (14 MWth). Additionally, 15 GeoDH are planned to be built, including the extension of the system in Milan with an expected capacity of 70 MWth, including from other sources.

3. Potential identified for geothermal district heating

Geothermal still has a large untapped potential in Italy. In addition, the infrastructure seems to be well developed (there are 133 district heating systems installed).

With the total population of 59, 685,227 the proportion of Italian population that can be reached with geothermal district heating (when geothermal heat at 1000m is 60 °C to 100°C) is around 50%. The areas that can be fully covered with geothermal installations include the regions including: Cremona, Mantua, Monza and Brianza, Padua, Rovigo and cities such as Venice, Milan, and Pisa.

Furthermore, the corresponding proportion for temperatures above 100°C at 2000 m is around 6%. This potential includes some regions with heat requirements that can be partially covered with geothermal DH such as Pisa, Siena, Livorno, and Padua.
Geothermal DH Potential in Europe

Cities with geothermal district heating

Figure 11: Map of geothermal potential of Italy

<table>
<thead>
<tr>
<th>Localisation</th>
<th>Capacity (MWth)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pomarance</td>
<td>21.5</td>
</tr>
<tr>
<td>Santa Fiora</td>
<td>17.2</td>
</tr>
<tr>
<td>Ferrara</td>
<td>14</td>
</tr>
<tr>
<td>Castelnuovo di Val di Cecina</td>
<td>7.3</td>
</tr>
<tr>
<td>Monteverdi Marittimo-Pisa</td>
<td>6</td>
</tr>
</tbody>
</table>

Italy has the most important potential for deep geothermal. It is rather strange that the NREAP does not propose more development of this technology and it focuses on other RES technologies and on import RES from non-EU countries.

It seems there is confusion between deep and shallow geothermal categories for heating and cooling in Table 9. For deep geothermal, Italy proposes a growth from 226 ktoe in 2010 to 300 ktoe by 2020. According to data from Italy’s Second Progress Report under Directive 2009/28/EC the improvements are lower than expected with a total actual share in consumption of deep geothermal H&C of 134 ktoe in 2012. By developing its deep geothermal potential, Italy could avoid the importation of RES and could prevent a significant amount of expenditure.

Table 9: Geothermal heat consumption towards the 2020 targets (ktoe)

<table>
<thead>
<tr>
<th>Region</th>
<th>2010 NREAPs</th>
<th>2012 actual share</th>
<th>2012 NREAPs</th>
<th>2020 target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Italy</td>
<td>226</td>
<td>134</td>
<td>239</td>
<td>300</td>
</tr>
</tbody>
</table>


5. Recommendations for policy-makers

For geothermal DH it is important to develop heat supply chains. Italy has high geothermal potential, both low and high temperature. In addition, in Italy most of the plants use efficient District Heating. However, some people still think that district heating is an old technology. Thus, the main recommendations are as follows:

a) **Increase the level of geothermal knowledge, expertise and setting guidelines.** Regions have been left with all the responsibilities to achieve the goals, but without tools, guidelines and often with no technical expertise required to assess and manage instances. National guidelines for the exploration and production of geothermal resources are required.

b) **Improve and simplify the regulatory process.** There is a lack of specific legislation on DH network and the situation needs to be improved. Too many laws, decrees, resolutions, circulars and procedures (often overlapping) cause confusion in the DH sector.

c) **Lower costs for drilling, construction and management.** High drilling costs are experienced in the whole country. As a matter of fact only two other geoDH systems use deep geothermal heat: Ferrara and Vicenza (which uses an old oil exploration well), while the remaining Italian GeoDH systems use low temperature shallow resources.
9. Netherlands

1. Introduction

The geological structure of the Netherlands is characterised by three basins - the Western Netherlands, the Central Netherlands and the Broad Fourteens Basin which are limited in the south by the strongly folded Paleozoic of the Brabant massif.

The area around Amsterdam is of interest, where Cretaceous sands suitable for geothermal utilisation exist. These are marine sandstones structured cyclically by alternating regressions and transgressions. They are characterised, partly, by outstanding reservoir properties and occur at a depth of about 2,000m with minimal deformation. The knowledge of individual reservoir horizons from wells differs. Because of hydrocarbon exploration, a significant number of wells have been drilled in the Slochteren formation, in the North of the Netherlands and around the Ijsselmeer. Considerably less drilling has been done in the Southern part of the country (European Commission, 1999).

2. State of play for district heating

In the Netherlands, the supply of heat from District Heating schemes accounts for small proportion of total heat consumption. About 4.4% of all dwellings in the country have a District Heating connection. However, the share of DH has been slowly increasing and, there is definitely potential for further increases.

The primary energy resource used is nearly entirely natural gas, which accounts for 92%. Around 1% of the heat supplied was produced by waste and 7% by others fuels.

In the Netherlands, there are already 8 geothermal heat plans supplying the local DH network with installed capacity below 11 MWth. The new plants are planned to be located in Agriport A7, in Heemskerk, in Venio/Grubbenvorst and in Brielle, with expected capacity of 17.4 MWth.

3. Potential identified for geothermal district heating

As shown in the map overleaf, many parts of the territory in the Netherlands are suitable for geothermal district heating and the infrastructure seems to be well developed.

With the total population of 16,779,575 inhabitants, the proportion of Dutch population that can be reached with geothermal district heating (where geothermal heat at 1000m is 60 °C to 100°C) is around 30%. The area that can be fully covered with geothermal installations includes nuts 3 regions like Overig Gronigen, Nord Frisland, Zuidoost-Drenthe, Agglomeratie’s, Delft en Westland, Zuidoost-Zuid Holland
Furthermore, the corresponding proportion for temperatures above 100°C at 2000 m is around 33%. This potential includes many regions that can be covered in around 95% with geothermal DH such as Delfzijl en omgeving, Overig Groningen and Achterhoek.

**Figure 12: Map of geothermal potential of Netherlands**

<table>
<thead>
<tr>
<th>Cities with geothermal DH (with highest installed capacity)</th>
<th>Capacity (MWth)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GreenWell Westland</td>
<td>11</td>
</tr>
<tr>
<td>Bleiswijk</td>
<td>8.1</td>
</tr>
<tr>
<td>Pijnacker Duijvestijn</td>
<td>7.1</td>
</tr>
<tr>
<td>Lansingerland</td>
<td>6.9</td>
</tr>
<tr>
<td>The Hague/Aardwarmnt Den Haag Vof</td>
<td>6.6</td>
</tr>
</tbody>
</table>

For deep geothermal, the Netherlands proposes a growth from 39 ktoe in 2010 to 259 ktoe by 2020. However, according to the data from the progress report on Energy from renewable sources in the Netherlands 2011-2012 the improvements are lower than expected which the total actual share in consumption of deep geothermal H&C of 12 ktoe in 2012.

Deep Geothermal Energy (Direct Use applications) is expected to contribute 0.26 Mtoe (11 PJ) in 2020.

Most of the deep geothermal applications will be Greenhouses and District Heating - which will require new infrastructures.

However, all statistical data for geothermal H&C (deep and GHP) in the Netherlands should be clarified and the 2020 targets and support measures adapted accordingly.

| Table 10: Geothermal heat consumption towards the 2020 targets (ktoe) |
|---------------------------------|----|----|----|----|
|                                | 2010 NREAPs | 2012 actual share | 2012 NREAPs | 2020 target NREAPs |
| **Netherlands**                | 39       | 12           | 75        | 259            |


4. Recommendations for policy-makers

Gas prices are rising sharply and public interest in carbon light energy options has increased. Renewed interest in deep geothermal energy in the 00’s led to the implementation of the first deep projects, mostly for the heat demand of greenhouses. Policies followed later and are still struggling to keep pace with practical developments. Thus, the major recommendations are as follows:

a) **Establish a local Heat Plan.** In the Netherlands, the regulations relating to Geothermal District Heating relate to several disparate pieces of legislation. For example, rates are covered by the heat act whereas the forced connection to heating and cooling infrastructure is covered by the Building act. A heat plan would designate areas for district heating and make clear the environmental criteria on which building permits will be granted or refused.

b) **Phase out the obligation to have a natural gas connection.** The Building Act in the Netherlands prescribes that, to receive a building permit it is obligatory to have a natural gas connection. This is an obligation to connect but no obligation to purchase and use natural gas. However in most cases, installation companies are used to this way of working and advice persons to use natural gas. Since there is a lot of natural gas available in the Netherlands, the industry of conversion technology is strongly embedded. Both the gas and conversion industry have an interest in the sale of natural gas and boilers. It should be noted that the Netherlands produces significant amounts of natural gas and in the past CO2 emissions were not perceived to be as important as they are today.
c) **Earmark funds for geothermal energy.** The last signals are not positive for the geothermal sector. The proposal is that there will be a reduction of 40% for large projects. Furthermore there will be increased safety focus which will affect smaller projects.

d) **Focus on energy saving measures.** The Dutch government did not force the use of the label. But with respect to the content, for new buildings, district heating is evaluated in the energy efficiency calculations of buildings under the Building Act (energy performance coefficient). For existing buildings, however, the energy label ignores (fossil) energy saving measures like district heating.
10. Poland

1. Introduction

Poland extends over parts of four major tectonic provinces: the East European Platform in the North East, the Mid-European Platform in the South West, the Variscan fold belt in the West, and a fragment of the Alpine belt, i.e. the Carpathians and Carpathian Foredeep in the South. The most important geothermal reservoirs for heating purposes lie in the Central and North Western Poland (the Polish Lowlands) and are mostly connected with the Mesozoic formations of the so-called Polish Trough (filled with Permian-Mesozoic sediments creating a cover of older formations).

In general, the aquifers hosted by Early Cretaceous, Early Jurassic and some Early Triassic formations have the greatest geothermal potential in the Permian-Mesozoic cover of the Polish Lowlands. Good conditions are found also in the Podhale region (part of the Inner Carpathians also in Slovakia) and, locally, in some areas of the Outer Carpathians and Carpathian Foredeep. In recent years (2006 – 2013) geothermal potential for prevailing area of the country was presented in a series of regional atlases (Górecki, Hajto et al., 2006, 2011, 2013: Górecki, Sowizdzal et al., 2012 Barbacki et al., 2006; Solik-Heliasz, 2009). These works extended and updated the knowledge given, among others, several years earlier in Geothermal Atlas of Europe (Hurter, S. and Haenel, R., 2002).

2. State of play for district heating

Euroheat and Power (2013) shows that in Poland there has been a significant increase in natural gas consumption in the preceding ten year period. However, due to new installations in DH and CHP an increase in the use of renewable fuels, in particular biomass is expected.

Coal is the main fuel in Poland. Around 76% of the heat supplied was produced by coal and coal products, while natural gas accounted for 6.77% and oil and petroleum products for 6.18%. Deep geothermal has almost the lowest share (0.09%) followed by geothermal heat pumps (0.02%) (EHP, 2013).

There were around 500 District Heating Systems installed in Poland as of 2011. Currently (2014) there are 6 geoDH plants; among them in Podhale Region with the highest installed geothermal capacity of 40.7 MWth (total ca. 81 MWth) and Pyrzyce, with installed geothermal capacity of 35.2 MWth (total ca. 48 MWth).

3. Potential identified for geothermal district heating

There are many DH systems in Poland Geothermal district heating is usually implemented by retrofitting pre-existing systems However, the systems are not initially designed and implemented to use geothermal energy. Polish reservoir conditions give geothermal water temperatures of up to ~85°C while the large district heating systems are often designed for the typical inlet water temperature of 130 or 110°C with a return temperature of 90°C (sometimes 70°C). Whilst heating systems in older buildings are designed for parameters 90/70°C, while new buildings are increasingly designed to operate heating installations at 75/60°C. Because of this, the majority of geothermal
heating plants operate in hybrid systems with peak sources (gas, biomass). In such systems geothermal water at 40–86°C is successfully used for heating purposes. Recently some geoDH plants have started to supply lower temperature systems, which has resulted in more efficient heat extraction from geothermal water, even at relatively low temperature (using compressor heat pumps).

Some parts of the country’s territory, in particular Central and North Western Poland (within the Polish Lowlands) are suitable for geothermal district heating (Fig. 13). The most promising geothermal reservoirs for heating are related to the Early Cretaceous and Early Jurassic formations (locally also Early Triassic). In general, the extensive Polish Lowlands area (continuation of North European Lowlands to the East) may be considered to have potential for geothermal uses, including heating sector in many cases.

Taking into account the Early Cretaceous reservoir (Fig. 13) at the depths up to ca. 2000m, and the total population of ca. 38.6 mln, the proportion of Polish population that could be reached with geoDH where geothermal heat at 2000m is about 60°C (or higher) is around 10%. This area includes major cities as, for example Szczecin and Lodz and Nuts3 regions such as Lodzki, Koninski, Szczecinski and Warszawski Zachodni.

However, it should be noted that a significant part of geothermal potential for geoDH is also connected with Early Jurassic (locally Early Triassic) reservoirs at depths 2000–3000m. Their temperatures are in the range of 60–100°C which creates good prospects for geoDH. Given this potential it is assumed that for significant number of localities in the Polish Lowlands, the construction of geoDH systems, particularly where DH grids already exist can be considered. The proportion of Polish population that could be reached with geoDH where geothermal heat at 3000m is about 60-80°C and somewhat higher is around 50%.

The Podhale region in the South (Inner Carpathians) is another area with suitable conditions for heating purposes. The large geoDH system (accompanied by bathing and recreation) has been operating there for over 20 years. Some geoDH prospects are ascribed also to particular areas within the Outer Carpathians and the Carpathian Foredeep (Fig. 13).

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1 only in a case of Poland and Slovakia the content of the maps was amended, where relevant, by information on reservoirs at a country-scale, like from national geothermal atlases, country update reports, etc.)
Figure 13: Map of geothermal potential for geoDH in Poland. Based on Górecki, Hajto et al. (2006, 2011, 2013), Barbacki et al. (2006), Górecki, Sowiżdżał et al. (2012)

Remarks: for Central and North Western part of the country (Polish Lowlands) a total extent of the Mesozoic formations prospective for geoDH - Early Triassic, Early Jurassic and Early Cretaceous is shown (while their maximum geological extent is greater). Lighter colour inside shows the range of Early Cretaceous formations suitable for geoDH. Some geoDH prospects (not marked) may be connected with particular localities in South West (the Sudetes region)

<table>
<thead>
<tr>
<th>Cities with geothermal DH</th>
<th>Capacity (MWth)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Podhale Region</td>
<td>40.7</td>
</tr>
<tr>
<td>Pyrzyce</td>
<td>35.2</td>
</tr>
<tr>
<td>Stargard Szczeciński</td>
<td>12.6</td>
</tr>
<tr>
<td>Mszczonów</td>
<td>6.4</td>
</tr>
<tr>
<td>Poddębice</td>
<td>3.8</td>
</tr>
<tr>
<td>Uniejów</td>
<td>3.5</td>
</tr>
</tbody>
</table>

Note: geoDH systems in Mszczonow, Uniejów and Poddebie cities are based on Early Cretaceous geothermal reservoirs, in Pyrzyce and Stargard Szczeciński - on Early Jurassic reservoirs, in the Podhale Region - on Middle Triassic reservoir

An important development of deep geothermal H&C is expected, with a growth from 23 ktoe in 2010 to 178 in 2020, and especially between 2019 and 2020 (+71 ktoe in 1 year) according to NREAPs.

However, according to the recently published Interim Report on progress on the promotion and use of energy from renewable sources in Poland (2013) in 2011–2012, the growth is lower than expected, around 16 ktoe in 2012. This is only 55% of the established targets for 2012. This data shows that it would be very difficult to achieve targets of 178 ktoe in 2020, even with forecasted annual growth of 71 ktoe between 2019 and 2020.

Table 11: Geothermal heat consumption towards the 2020 targets (ktoe)

<table>
<thead>
<tr>
<th>Poland</th>
<th>2010 NREAPs</th>
<th>2012 share actual</th>
<th>2012 NREAPs</th>
<th>2020 target NREAPs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>23</td>
<td>15.8</td>
<td>29</td>
<td>178</td>
</tr>
</tbody>
</table>


5. Recommendations for policy-makers

In Poland, there are circumstances conducive to the deployment of geothermal energy; there are resources, a market and commitment from the scientific community. However, policy makers should create substantially better conditions for RES heat deployment. Thus, the recommendations are as follows:

a) **Create awareness amongst the public and decision makers about geothermal energy resources:** More public and political support to promote, consider and initiate geoDH systems is needed, as is deepen knowledge and awareness among decision makers and politicians of various levels, local/regional administrations, DH designers and district heating companies. Some relevant activities have taken place conducted in the country but they should be done at more regular and wider basis

b) **Implement EU- and national legislation** to increase the RES use and follow sustainable energy development. There is a lack of adequate national policy concerning geoDH (as part of the RES heat sector) expressed by, among other things, a lack of a comprehensive set of state regulatory acts related to the RES sector (of which geothermal energy is a part), especially RES Law, which should create the proper long-term environment for geothermal projects’ planning and development.

c) **Earmark funds for the incentives for investment phase and production/sales stages:** such as support schemes, fiscal measures. Since 2013 there are no dedicated support schemes on national level for geothermal resources’ exploration drilling and subsurface parts of geoDH in Poland.
d) Establish Drilling/Insurance Fund

e) Phase out the regulated tariff for heat. The Tariff for heat and electricity must to be agreed with the Energy Regulatory Office; therefore it is not possible to make high profits from heat.

f) Refurbishment of existing DH network: Geothermal installations operating in Poland often supply heat to the already existing district heating systems in the consumer’s buildings which were not initially designed to use geothermal energy.
11. Romania

1. Introduction

Romania extends over a variety of tectonic units. The Pannonian Basin is bounded to the West by the Western Carpathians and to the South by the Southern Carpathians.

In the South and East, the Getic and Pericarpathian Fordeeps separate the Southern and Eastern Carpathians from the Moesian and Moldavian platforms, respectively.

The search for geothermal resources for energy purposes in the country began in the early 1960’s based on a detailed geological programme for hydrocarbon resources. There are over 250 wells drilled at depths between 800 and 3,500m, showing the existence of low enthalpy geothermal resources between 40 and 120°C. Geothermal installations are preferentially situated in the NW of the country, the Pannonian Basin. A few have been installed in the Getic ForedEEP and the Moesian Platform. (Hurter, S. and Haenel, R., 2002; (Rosca, M. and Bendea, C. and Cucueteanu, D., 2013)

2. State of play for district heating

In the last two years District Heating market has shrunk in size by approximately 10% due to population’s reduced purchasing power, an increase in the price of fuels, unreliable support from local administrations, high network losses, and lack of investment. However, improvement has been observed in some cities, proper insulation has been installed in 3% of the buildings already (EHP, 2013).

Over the last 10 years the use of coal has decreased, which is being replaced by natural gas and renewables. The main fuel used for District Heating in natural gas (71%), while coal and coal products accounted for 26% and renewables only for 1.2% of the heat supplied through DH systems in 2011 (EHP, 2013).

In Romania there are 84 District Heating systems installed. There are more than 10 GeoDH plants such as that in Moara Vlasiei with highest installed capacity of 29.9MWth, and that in Beius with installed capacity of 21 MWth. It is expected that 5 existing GeoDH plants will be extended; moreover, two plants are in a negotiation phase.

3. Potential identified for geothermal district heating

As shown in the map overleaf, Western and Southern Romania are particularly suitable for geothermal district heating.

With the total population of 20,095,996 the proportion of Romanian population that can be reached with geothermal district heating (where geothermal heat at 2000m is 60 °C to 100°C) is around 20%.
The area includes city Bucharest that can be fully supplied with GeoDH system and nuts3 regions such as Satu Mare and Ilfov where 90% of the needs can be met. In addition, almost 50% of the Bihor region is also suitable for geothermal installations.

Furthermore, the proportion of the country’s population that can be reached with GeoDH where the temperature at 2000m is above 100°C is around 10.0%. This potential includes nuts 3 regions such as Arad, Timis, Bihor and Satu Mare that can covered in around 50% with the geothermal installations.

Figure 14: Map of geothermal potential of Romania

<table>
<thead>
<tr>
<th>Cities with geothermal DH (with the highest capacity)</th>
<th>Localisation</th>
<th>Capacity (MWth)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moara Vlasiei</td>
<td>29.9</td>
<td></td>
</tr>
<tr>
<td>Beius</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>Oradea-losia Nord</td>
<td>19.0</td>
<td></td>
</tr>
<tr>
<td>Calimenesi</td>
<td>10.7</td>
<td></td>
</tr>
<tr>
<td>Otopeni</td>
<td>10.6</td>
<td></td>
</tr>
</tbody>
</table>

Cities with geothermal district heating
Cities with district heating
Other reservoir potential fill
Hot sedimentary aquifer fill

Romania has more than 100 deep wells for geothermal energy. The potential for heating and cooling is huge. Some measures are proposed for the further development of deep geothermal.

The target is to reach 80 ktoe by 2020 for deep geothermal heating & cooling, so to multiply by 3.7 the current production of 21.6 ktoe, which is very low and less ambitious than expected.

Table 12: Geothermal heat consumption towards the 2020 targets (ktoe)

<table>
<thead>
<tr>
<th></th>
<th>2010 NREAPs</th>
<th>2012 actual share</th>
<th>2012 NREAPs</th>
<th>2020 NREAPs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Romania</td>
<td>25</td>
<td>21.6</td>
<td>35</td>
<td>80</td>
</tr>
</tbody>
</table>


4. Recommendations for policy-makers

In Romania the district heating sector is defined and regulated. However, this market is not expanding. The focus should be on maintaining the valuable assets of existing district heating. The major recommendations are as follows:

a) **Improve competitiveness.** There are no public utilities actually operating geothermal systems. Geothermal district heating systems are operated only by one of two companies. In addition, the distribution network is public property, according to the Romanian legislation.

b) **Simplify administrative procedures.** For deep geothermal the regulations are complex and the procedures for licensing must be simplified.

c) **Phase out the regulated price.** The price of thermal energy produced in DH systems (using natural gases) is partially covered by local authorities – in Bucharest by 50%. In this case, even if the price for population is high, it is yet affordable. The future does not seem to be a serious preoccupation for local and national authorities.

d) **Earmark funds for geothermal energy.** There are no dedicated and predictable economic tools to support geoDHS. For instance there is a lack of funds for pre-feasibility studies which could in turn help to obtain more knowledge about the geothermal potential and increase awareness. Existing support schemes are not reliable and a risk insurance scheme must be established.

e) **Improve buildings codes and urban policy.** Current policy does not in favour of district heating, and is not supported by politicians. Measures in favour of DH are insufficient, and in the end consumers choose other heating solutions.
12. Slovakia

1. Introduction

Two main geographic regions define the Slovakian landscape: the Carpathian Mountains and the Pannonian Basin. The distribution of aquifers with geothermal waters and the thermal manifestation of geothermal fields in Slovakia have made it possible to define a significant number prospective areas and structures with potentially exploitable geothermal energy sources. These include mainly Tertiary and intramontane depressions situated in the Inner West Carpathians (south of the Klippen Belt).

The highest temperatures, geothermal gradient and heat flow density indicate that, with regard to the geothermal properties, the Eastern Slovakian basin is the most active region in Slovakia. (European Commission, 1999)

2. State of play for geothermal district heating

According to the Euroheat and Power (2013), the main trend has been towards switching the fuel used in DH from coal or natural gas to biomass. However, the primary energy source is still natural gas, which accounts for 61%, while 28% of the heat supplied was produced by burning coal and coal products and 7% by biomass.

There are 2,361 district heating systems in Slovakia and 4 GeoDH plants: in Galanta -2 and 3, in Sala and Sered with installed capacity between 1.4 and 5.8 MWth. Around 10 geothermal plants are planned to be build, among them are 5 in the negotiation phase, and one is preparing for building permission (in Velky Meder).

3. Potential identified for geothermal district heating

With a total population of 5,410,836, the proportion of the Slovak population that can be reached with geothermal district heating (where geothermal heat at 2000m is 60 °C to 100°C) is around 50%. This area includes nuts3 regions such as Nitriansky kraj, Trnavský kraj, and Presovský kraj.

Furthermore, the proportion of the country’s population that can be reached with geoDHS with temperature above 100°C at 2000m is around 20%. This potential includes mostly nuts3 regions such as Nitriansky kraj and Kosický kraj.

However, part of the potential might be not covered by the map. Only in a case of Poland and Slovakia the content of the maps was amended, where relevant by information on reservoirs at a country-scale, like from national geothermal atlases country update reports, etc.
Figure 15: Map of geothermal potential of Slovakia

Cities with geothermal DH

<table>
<thead>
<tr>
<th>Localisation</th>
<th>Capacity (MWth)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Galanta-3</td>
<td>5.8</td>
</tr>
<tr>
<td>Galanta-2</td>
<td>5.1</td>
</tr>
<tr>
<td>Šaľa</td>
<td>1.9</td>
</tr>
<tr>
<td>Sereď</td>
<td>1.4</td>
</tr>
</tbody>
</table>


Slovakia wishes to develop geothermal direct uses, and is planning to increase the production from 3 ktoe (calculated by Slovakian authorities and reported in the NREAP in 2010) in 2010 to 90 ktoe by 2020, with a forecasted growth from 2013 of +10 ktoe each year.

Table 13: Geothermal heat consumption towards the 2020 targets (ktoe)

<table>
<thead>
<tr>
<th></th>
<th>2010 NREAPs</th>
<th>2012 share</th>
<th>2012 NREAPs</th>
<th>2020 NREAPs</th>
<th>target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slovakia</td>
<td>3</td>
<td>6</td>
<td>3</td>
<td>90</td>
<td></td>
</tr>
</tbody>
</table>


However there is a big problem with the statistical data of the NREAP 2010. The geothermal industry reports a figure of 73 ktoe produced in 2010 for Slovakia! Geothermal water is utilised for direct use in:
5. Recommendations for policy-makers

The Slovakia’s ambitious plan to develop geothermal direct uses and to increase it by 300% required a lot of effort. In addition, according to Euroheat and Power (2013) a fall in sales has been observed due to measures taken by costumers to save energy (building insulation, hydraulic and thermo regulations of systems. Thus, our main recommendations are as follows:

a) **Refurbish of existing DH networks and build the new ones** to meet the NREAP’s goals and to easily integrate geothermal into well-developed existing infrastructure, replacing gas and fossil fuels at lower costs.

b) **Improve and simplify administrative procedures**, which are rather complex and with significant obstacles. In addition, the regulatory framework for emission trading and the additional cost might cause a fall in number of district heating systems

c) **Earmark funds for geothermal energy.** There are no specific support measures for geothermal (some incentives mentioned in the NREAPs plan are not detailed) and a scheme to mitigate the geological risk must be established.

d) **Develop multipurpose uses** (combined heat&power, agro-industry, H&C of buildings etc.)
13. Slovenia

1. Introduction

Several tectonic units with different hydrogeological properties and geothermal conditions compose the territory below Slovenia. In the northeast, the Mura-Zala basin (the south-western part of the Pannonian basin) and the Eastern Alps (incl. magmatic rock complex) are parts of the European plate. Predominately carbonate Southern Alps, External and Internal Dinarides and Adriatic foreland represent parts of the Adriatic microplate.

The geothermal energy potential is concentrated in the eastern part of the country. (Rajver, D. and Prestor, J. and Lapanje, A. and Rman, N., 2013)

2. State of play for district heating

In Slovenia the number of households using district heating increased by 1.8% in 2011 in comparison with 2009. In general in 2011 heat production fell slightly, if we compare it with 2010 (0.8% down) but increased by 7.3% by comparison with 2009.

The primary energy sources in Slovenia are coal and coal products (71%). Around 13% of the heat supplied was produced by natural gas, while combustible renewables accounted for 11% of heat supplied through DH systems in 2011.

There are 54 district heating systems in Slovenia in 2011. There are only three Geothermal heat plants supplying the local DH network: in Benedict, Lendava and in Murska Sobota. Two in Turnisce and Ormoz are under negotiation. In addition, it is planned to extend existing plants in Murska Sobota and Benedict.

3. Potential identified for geothermal district heating

In Slovenia some suitable areas for exploitation and energetic use were identified, in particular in eastern part of the country. With the total population of 2,058,821, the proportion of Slovenian population that can be reached with a geothermal district heating (where geothermal heat at 2000m is 60 °C to 100°C) is around 50%. This area includes nuts3 regions such as Podravska, Savinjska, Spodniejposavska, Jugozhodna Slovenija and Osrednjeslovenska.

Furthermore, the proportion of the country’s population that can be reached with geoDHS where temperatures above 100°C were found at 2000m is around 6.5%. This potential includes only Podravska region, which can coved in 40% with the geothermal installations.

The NREAP provides substantial information about measures for developing geothermal energy in Slovenia. It is indeed true there is a huge potential. In the NREAP Slovenia proposes just a small increase from 18 ktoe in 2010 to 20 ktoe in 2020, so 2 ktoe more in 10 years! However, according to the progress Report for Slovenia under Directive 2009/28/EC (2014) and the published data the improvements are higher than expected, almost double. The total actual share in consumption of deep geothermal H&C is 31 ktoe in 2012.
Table 14: Geothermal heat consumption towards the 2020 targets (ktoe)

<table>
<thead>
<tr>
<th></th>
<th>2010 NREAPs</th>
<th>2012 actual share</th>
<th>2012 NREAPs</th>
<th>2020 target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slovenia</td>
<td>18</td>
<td>31</td>
<td>18</td>
<td>20</td>
</tr>
</tbody>
</table>


5. Recommendations for policy-makers

There are several support measures for geothermal heating and cooling in Slovenia. In addition, Slovenia aims to promote systems of district heating using geothermal energy. An important element is the current proposal for an obligatory share of RES in DH systems and the establishment of spatial planning rules which prioritise district heating systems, and the establishment of spatial planning rules which prioritise district heating and CHP. However some recommendations are as follows:

a) Improving and simplifying the regulatory process. The regulations for deep geothermal with concessions are more complex

b) Phasing out regulated prices - The regulated prices above 1 MW have to be based on actual costs. Systems below 1 MW can operate freely on the market.

c) Earmarking funds for geothermal energy, there is a lack of enough free financial resources - state, municipal and private and of financial supports (such as grants, subsidies, drilling risks insurances etc.). However, grants and low-interest loans can be acquired.

d) More friendly and open market for investors, there is a lack of possibilities for new companies to enter the market and high bureaucracy and decision making based on political reasons and not techno-economic reasons.
14. UK

1. Introduction

The geological and tectonic setting precludes the evolution of high enthalpy resources close to the surface and only low to moderate temperature fluids have been accessed by drilling in sedimentary basins in the south and northeast of England. Elevated temperature gradients and high heat flows have been measured in and above some granitic intrusions, particularly in southwest England. More recent work in northeast England also suggests higher than anticipated temperature gradients and hence increased focus on the possible application of geothermal heat in the region (Curtis, R. and Ledingham, P. and Law, R. and Bennett, T.)

2. State of play for district heating

The district heating in UK is underdeveloped. Currently only 4% of building are connected to heat networks despite the economic potential for DH to provide for around 20% of heat demand. Currently, DH provide for around 1-2% of the UK’s demand.

The most important fuel source used in CHP installations is natural gas, which accounts for 71%.

In the United Kingdom, there is only one small GeoDH system, in Southampton, with an installed capacity of 2.8 MWth. Few projects are currently being developed including one in Redruth (West Cornwall) with high expected capacity installed of 55 MWth.

3. Potential identified for geothermal district heating

The exploitation of geothermal resources in the UK continues to be minimal. As shown in the map overleaf, the south west, Yorkshire and the Humber, and southern and north eastern Scotland, are particularly suitable to geothermal district heating.

With the total population of 63,256,142 the proportion of British population that can be reached with geothermal district heating (with geothermal heat at 2000m 60 °C to 100°C) is around 20%. The area includes nuts 3 regions such as Clackmannanshire and Fife, Falkirk, West Lothian that can be fully covered with GeoDH system. Other nuts 3 regions like Cheshire East, Dorset, East Lothian and Midlothian can be covered partially at 80-90%.
Figure 17: Map of geothermal potential of Romania

<table>
<thead>
<tr>
<th>Cities with geothermal DH</th>
<th>Localisation</th>
<th>Capacity (MWth)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Southampton</td>
<td>2.8</td>
</tr>
</tbody>
</table>

The UK does not propose measures on geothermal direct uses and does not give any data on 2010 production or the target for 2020. According to the Second Progress Report on the Promotion and Use of Energy from Renewable Sources for the United Kingdom (2013), the actual share of energy from deep geothermal in heating and cooling sector is only 0.8 ktoe. The current deep geothermal production in the UK is:

- A geothermal district heating system in Southampton started operation in 1987. It has been expanded to 2.8 MWth producing 1.73 ktoe.
- A spa in Bath: 0.379 ktoe
- Some heating systems for greenhouses: 0.189 ktoe

<table>
<thead>
<tr>
<th></th>
<th>2010 NREAPs</th>
<th>2012 share</th>
<th>2012 NREAPs</th>
<th>2020 NREAPs</th>
</tr>
</thead>
<tbody>
<tr>
<td>UK</td>
<td>n/a</td>
<td>0.8</td>
<td>n/a</td>
<td>n/a</td>
</tr>
</tbody>
</table>


5. Recommendations for policy-makers

In the UK there has been a revival of interest in geothermal energy in the UK due to increasing pressure to develop secure, low carbon, sustainable energy sources. The next five years will prove to be critical for geothermal developments in the UK. Thus, the major recommendations are as follows:

a) **Establish and improve regulations.** Scattered pieces of legislation seem to be enough for the moment as few projects are currently developed. However, a licensing scheme is needed to facilitate investment, decrease project development risk, and facilitate the administrative process.

b) **Simplify procedures for drilling access** is needed. However, the UK Government recently completed a consultation on the simplification of procedures for drilling access.

c) **Earmark funds for geothermal energy.** District heating does not receive enough financial support from the government, only in Scotland are loans provided. A risk insurance system is needed.

d) **Regulate the use of geothermal resources.** Legislation has defined public ownership of geothermal resources and developers pay royalties for using them. However, project developers are not protected against external interference.
15. Recommendations

Based on the results of this report, the following recommendations are put forward in order to seize the geothermal DH potential in Europe:

- Create conditions to increase awareness about the advantages of this technology and its potential. National Committees on Geothermal promoting the technology to decision-makers and engaging the civil society to favour social acceptance should be established.

- Contribute to the economic competitiveness of Europe by providing affordable and reliable heating and cooling. In order to help geoDH to develop, a better regulatory framework must be established in many countries.

- Establish the economic and financial conditions for geothermal development: a risk insurance fund in Europe is an innovative option tailored to the specificities of geothermal to mitigate the cost of the geological risk and is a complementary tool to operational support, still needed to compensate for the long-standing lack of a level-playing field.

- Enhance the education and training process, since multidisciplinary expertise and interaction of several disciplines are necessary. Create Networks for Geothermal Energy Education and Training involving industrial platforms, Universities and Research Centres developing a workforce for future geothermal development.

- Contribute to the development of the local economy. Create local jobs and establish a geothermal industry in Europe which will be able, by 2030, to employ more than 100,000 people (exploration, drilling, construction and manufacturing).
List of main abbreviations and acronyms used

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>CHP</td>
<td>Combined Heat and Power</td>
</tr>
<tr>
<td>DH</td>
<td>District Heating</td>
</tr>
<tr>
<td>geoDH</td>
<td>Geothermal district heating</td>
</tr>
<tr>
<td>GWh</td>
<td>Gigawatt hour</td>
</tr>
<tr>
<td>GWth</td>
<td>Gigawatt thermal</td>
</tr>
<tr>
<td>Ktoe</td>
<td>Thousand tonnes oil equivalent</td>
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<tr>
<td>NREAP</td>
<td>National Renewable Energy Action Plan</td>
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<tr>
<td>RES Directive</td>
<td>Directive 2009/28/EC on the promotion of the use of energy from renewable sources</td>
</tr>
<tr>
<td>SEAP</td>
<td>Sustainable energy action plan</td>
</tr>
</tbody>
</table>
References


GeoDH: D2.2 Geothermal DH Potential in Europe


Other official sources:
