Summary of EGC 2013 Country Update Reports on Geothermal Energy in Europe

Miklos Antics[1], Ruggero Bertani[2], Burkhard Sanner[3]

[1] GPC IP, Paris Nord 2, Bat. 4A, 165 Rue de la Belle Etoile, BP 55030, 95946 Roissy CDG cedex, France

[2] Enel Green Power SpA, Via Andrea Pisano 120, 56122 Pisa, Italy

[3] European Geothermal Energy Council EGEC, 63-65 Rue d´Arlon, 1040 Brussels, Belgium

m.antics@geoproduction.fr , ruggero.bertani@enel.it , b.sanner@egec.org

Keywords: geothermal potential, geothermal power, geothermal direct use, geothermal heat pumps, policy, country update.

ABSTRACT

The European status of geothermal energy use by the year 2012 is presented. The situation varies from country to country according to the geothermal technology that best suits the available natural resource. The spectrum includes power generation from high enthalpy resources (Iceland, Italy, Greece, Turkey), direct use of hydrothermal resources in sedimentary basins (France, Germany, Poland, Italy, Hungary, Romania, and others). Shallow geothermal is available everywhere and is mostly harnessed by ground source heat pump installations.

Geothermal power generation in Europe currently stands at about 1850 MW_{el} installed capacity. The installed capacity of geothermal heating from medium to low temperature sources exceeds 8000 MW_{th}, of which almost half is used in district heating.

Concerning shallow geothermal energy (ground source heat pumps – GSHP and Underground Thermal Energy Storage – UTES), the installation growth rate is even more spectacular, and a capacity of at least 17’000 MW_{th} was achieved by the end of 2012, distributed over more than 1.3 Mio GSHP installations.

Summing up, geothermal energy scored well in Europe and has an enormous potential. For the heating sector, the deep and shallow energy production combined has meanwhile exceeded even the ambitious target of 15’000 MW_{th} set forth in the Ferrara Declaration for 2010 (table 1 and figure 1; EGEC, 1999).

1. INTRODUCTION

A tradition for IGA World Geothermal Congresses is the quinquennial activity of geothermal country update reports, taking a snapshot of the world-wide development in geothermal energy. For EGC 2007 in Unterhaching, Germany, country update reports were prepared for the first time for a European Geothermal Congress, and now the second such activity took place on the European level.

Table 1: Geothermal development as forecast in the Ferrara Declaration of 1998 (excerpt, installed capacity).

	1998	2010	2020
Heat* [MW_{th}]	5200	15000	48000
Electricity** [MW_{el}]	940	2000	3000

* Deep and shallow resources

** incl. EGS

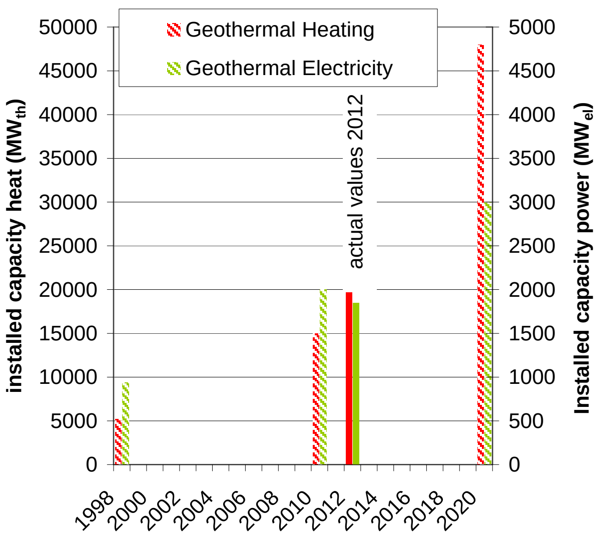

Figure 1: Comparison of installed capacity after Ferrara Declaration of 1998, and reported values for 2012

Contacts in 39 European countries had been asked to prepare a country update report, presenting the status of geothermal energy at the end of 2012 and some outlook to 2015. Reports were received from 33 countries (see table in “references”) and are included in the EGC 2013 proceedings. This paper gives an overview of these reports, and a synoptic evaluation of geothermal energy in Europe today. For calculating totals and for some tables, in few cases values from WGC 2010 have been taken as a stand-in for missing entries; those are marked and were taken from Bertani (2010), Lund at al. (2010) and individual country update reports of WGC 2010 not cited separately here.

In December 2012, EGEC had published for the second time a market report for geothermal energy (EGEC, 2012). It should be noted that the country update reports and the EGEC market report cannot be compared directly, as they serve different purposes and their way of preparation is different. The EGEC market report collects exact data from power plants and geothermal district heating and evaluates the market tendencies, based upon information from EGEC members and data solicited directly by EGEC staff. For the country update reports, invitations have been extended by the authors of this paper to relevant persons or groups in the individual countries, and the reports have been prepared inside the countries and under full responsibility of the respective person or group. This paper just summarises and evaluates the national reports.

A further note should be given concerning the European statistics. In Antics and Sanner (2007) we had suggested a classification which comprises the following geothermal categories:

- Geothermal Power
- Deep Geothermal Resources (direst use)
- Shallow geothermal (mainly heat pumps)

Two years later, in Directive 2009/28/EU exactly these categories can be found for geothermal energy. Eurostat and the national statistical offices now have to provide their data in this form, as this will be the basis for checking the fulfilment of the renewable energy targets set forth in the directive for the individual EU member states. Non-member states in Europe will probably adapt their statistics in a similar way.

For the first time, clear rules on how to calculate the renewable heat from heat pumps have been devised by Eurostat and published in March 2013 in the Commission Decision 2013/114/EU (more in chapter 4). In geothermal direct uses, there is still some discrepancy in counting. Often only district heating is considered, leaving agriculture and balneology aside; for EGC 2013 the two latter categories have been taken into account explicitely.

In the following chapters, first some statistical evaluation for the three geothermal sectors in all of Europe is presented, and then short summaries of the development in the individual countries are given. Summary tables for the different sectors are given at the end of the paper.

2. GEOTHERMAL POWER PRODUCTION

A situation for geothermal power in Europe at the end of 2012 is listed in table 2 at the end of this paper. Nine countries have geothermal power plants, with the ones in Russia and in France (overseas departments) not geographically located in Europe.

The geothermal electricity in Europe is growing, continuously, both in the traditional areas and in the low-medium temperature resources through the extensive utilization of binary plants technologies. Fig. 2 shows the development as reported at the various WGC and EGC events since 1995, and the forecast to 2020. In electricity, the minimum target of the Ferrara declaration for the year 2020 (table 1) might be exceeded also. The load factor is increasing on average, having achieved values around 75 %. Single plants report values of almost 100 %. In table 2 the values per country are listed. The rather poor load factors in Austria and Germany can be, beside being a result of teething problems in new binary plants, attributed to the fact that most of these plants are part of district heating schemes and need to share the geothermal resource with the heat supply.

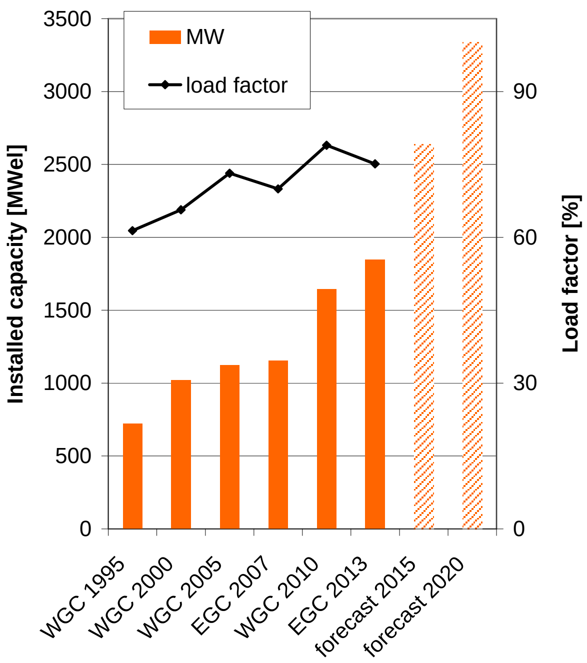

Figure 2: Installed capacity and average load factor for geothermal electricity in Europe as reported at various events, and forecast of installed capacity to 2015 (EGC 2013 country update reports) and 2020 (Bertani).

Figure 3 shows the installed capacity for the different countries as to end of 2009 (WGC 2010, for 2012 and 2015 /EGC 2013). Iceland had the highest increase in the last 3 years with 90 MW_{el} installed new, and Turkey follows closely with about 85 MW_{el}. The next years are expected to bring a real boost in particular for Turkey, where about 150 MW_{el} are under construction now and more than tripling of the installed electric power from 2012-2015 is expected in the country update report.

In figure 4 a comparison is presented between the values from EGC 2013 and from the EGEC Market Report 2012. Despite the different methodology, the values show a good match in most cases. In general it can be said that the statistics for geothermal energy are easiest in the field of electricity, as these plants deliver a commodity that is counted and billed regularly.

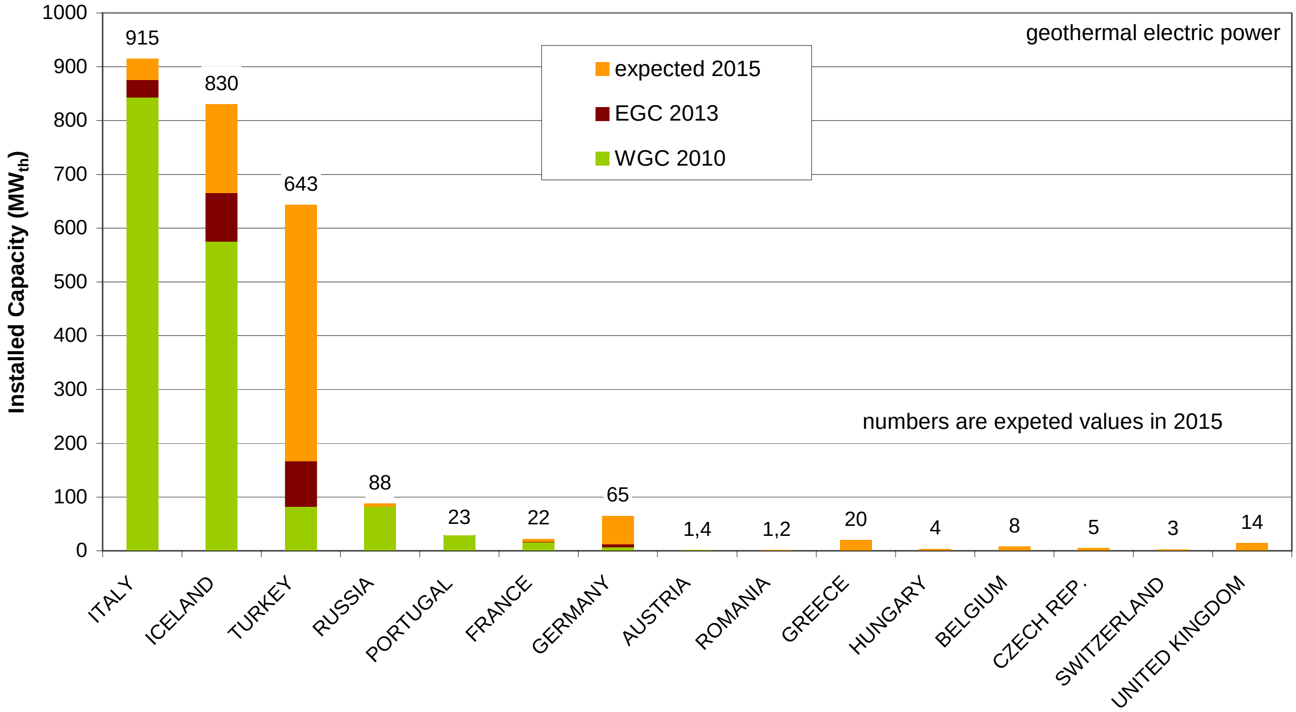

Figure 3: Installed geothermal power in Europe 2010-2015, after WGC 2010 and EGEC 2013

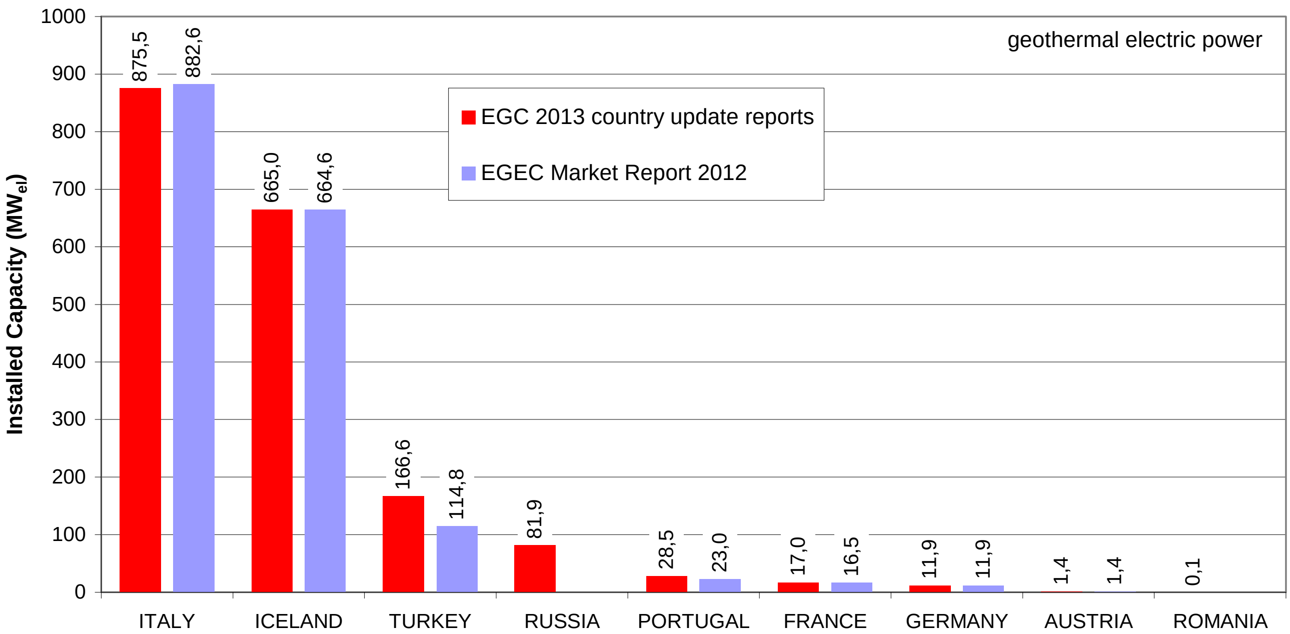

Figure 4: Installed geothermal power in Europe 2012, after EGC 2013 country update reports and EGEC Market Report 2012

3. GEOTHERMAL DIRECT USES

In the past, the reported geothermal energy used as heat (or cold) was mainly the share used in district heating and in some of the agricultural uses. In particular the amount used in spas and balneology is difficult to determine and was often not reported. In recent years new attempts were made to better quantify this sector, e.g. in Italy. The values for 2012 for each country are listed in table 3 at the end of this paper. Figure 5 shows the total values for each country and the share of geothermal district heating thereof, while in figure 6 again a comparison is made between the EGC 2013 values for installed capacity (district heating only) and the values from the EGEC Market Report 2012. Figure 7 is a synopsis of, the values reported at WGC 2010, the EGC 2013 values for 2012, and the EGC 2013 forecast for 2015.

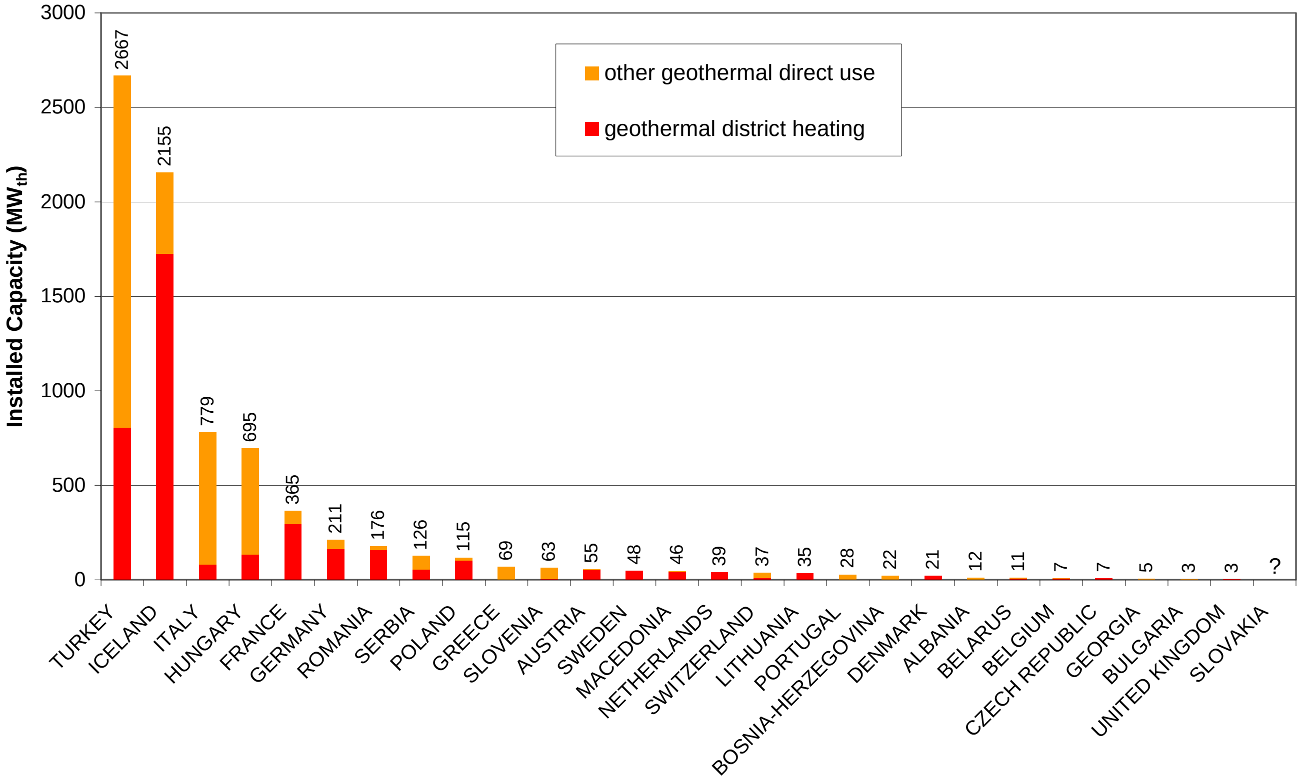

Figure 5: Installed capacity in geothermal direct use in Europe 2012 and share of geothermal district heating, after EGC 2013 country update reports

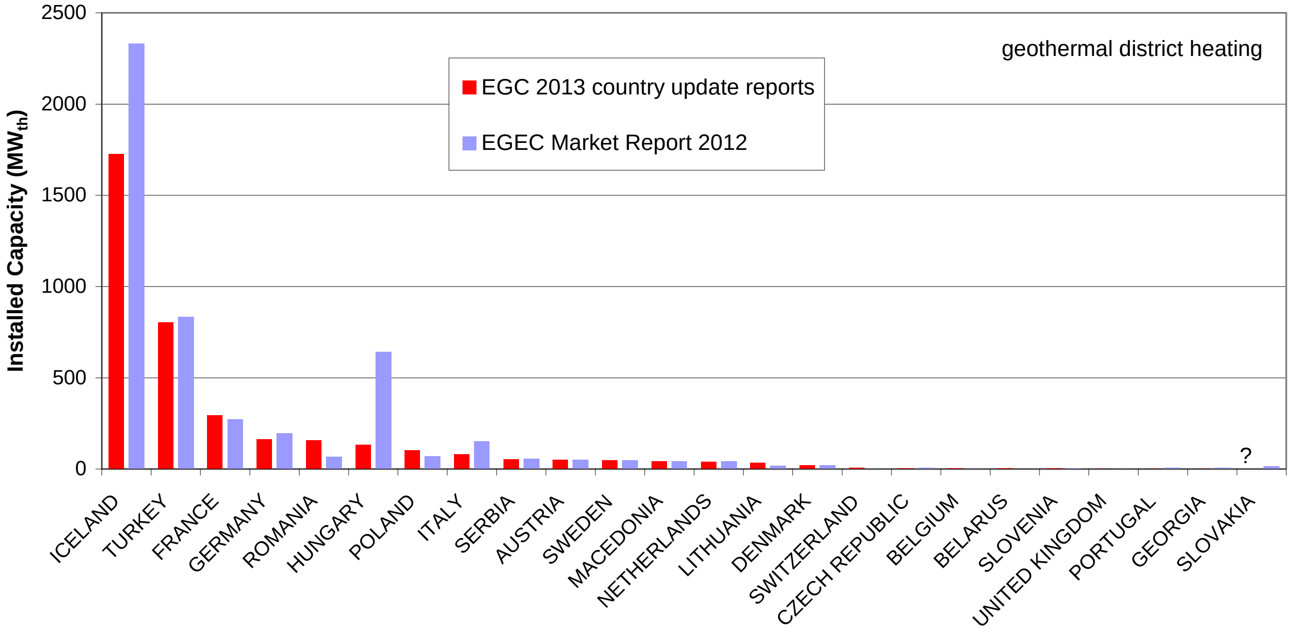

Figure 6: Comparison of installed capacity in geothermal district heating in Europe 2012, after EGC 2013 country update reports and EGEC Market Report 2012

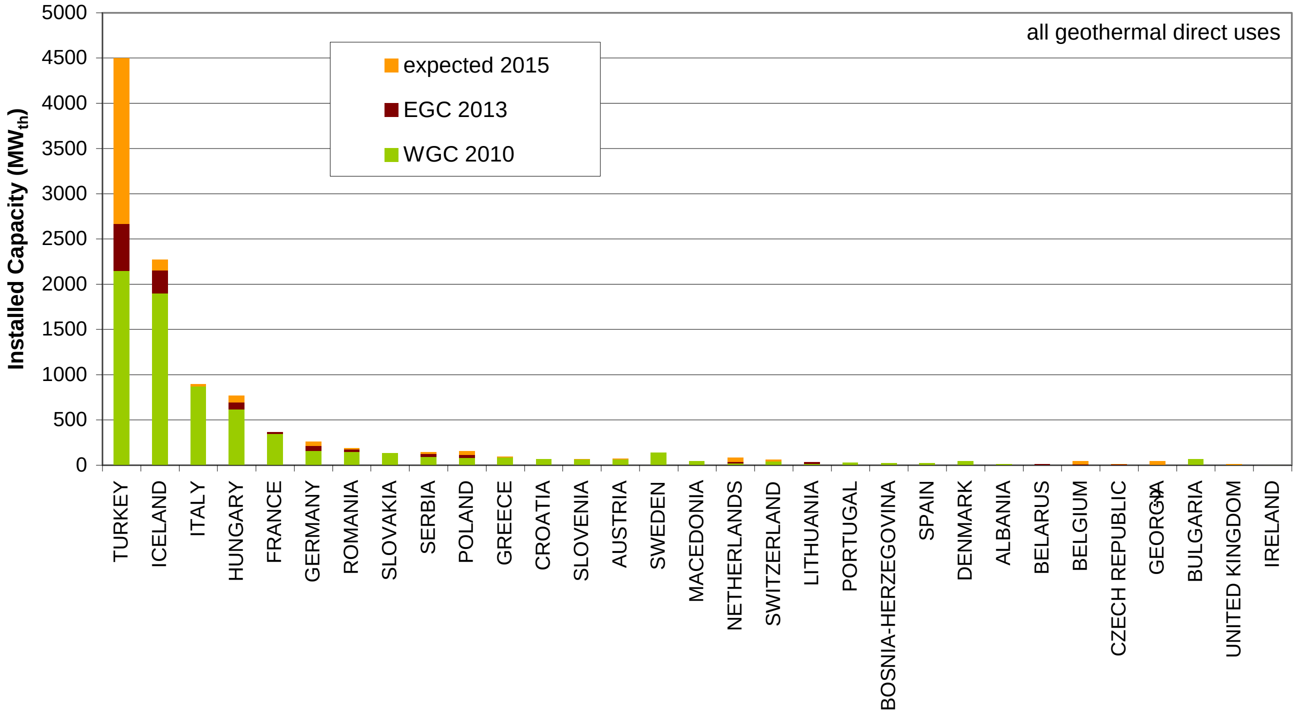

Figure 7: Installed geothermal direct use in Europe 2010-2015, after WGC 2010 and EGEC 2013

From figure 5 it can be seen that in particular Turkey, Italy and Hungary have huge shares of geothermal direct use outside district heating. Figure 8 gives details for these three countries, of which in Italy district heating only accounts for 10 % of all geothermal direct use!

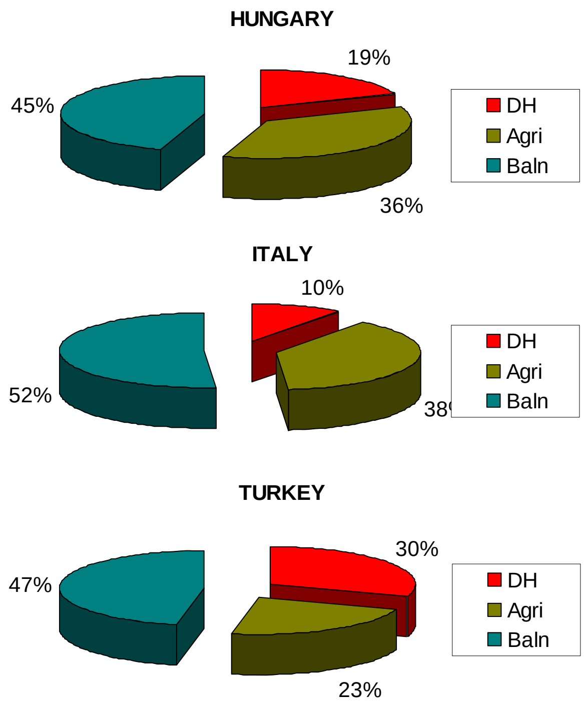

Figure 8: Share of installed capacity in district heating, agricultural uses and balneology in geothermal direct use as of 2012 in Hungary, Italy and Turkey

The changes in accounting for geothermal direct use over the last years (i.e. reporting more of the heat used in other applications than district heating) leads to some inconsistencies. So might the differences in figure 6 between the values for Turkey, Iceland and Italy after EGC 2013 and after EGEC Market Report 2012 be due to different delineation of district heating and agricultural uses. This also renders a growth curve over two decades (cf. figure 2 for geothermal power) inadequate. Only a comparison over shorter time periods makes sense, as is done in figure 7 for 2010-2015. Here Turkey again shows the biggest increase, with an expected doubling (almost) of installed capacity over the next few years!

4. SHALLOW GEOTHERMAL APPLICATIONS

In terms of number of installations, installed capacity and energy produced this is by far the largest sector of geothermal energy use in Europe (figure 9). It enjoys the widest deployment among European countries; the data for 2012 from the individual countries are summarised in table 4 at the end of this paper.

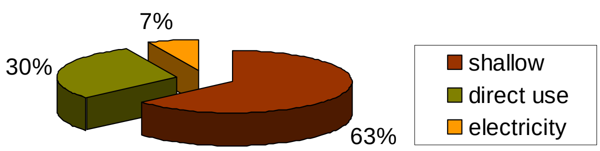

Figure 9: Share of installed capacity in the three geothermal sub-sectors in Europe as of 2012

The countries with the highest amount of geothermal heat pumps are Sweden, Germany, France and Switzerland (figure 10). These four countries alone account for ca 64 % of all installed capacity for shallow geothermal energy in Europe.

Seen over the time period from 2010-2015 (figure 11), the four "big ones" are most probably also seeing the highest numbers of increase until 2015. In relative terms, Italy, Poland and the Czech Republic are among the countries with the highest growth rate.

Statistics for shallow geothermal energy were to a large extent based upon counting of heat pumps, estimations and calculation. This sector is dominated by a large number of small installations that cannot be listed or monitored individually. In figure 12, values from different sources are compared; WGC 2010, EurObserv´ER 2011 (for 2010 data), and EGC 2013. Beside the higher numbers for EGC 2013 in many countries (as these data include two more years of construction), the values are in the same order of magnitude.

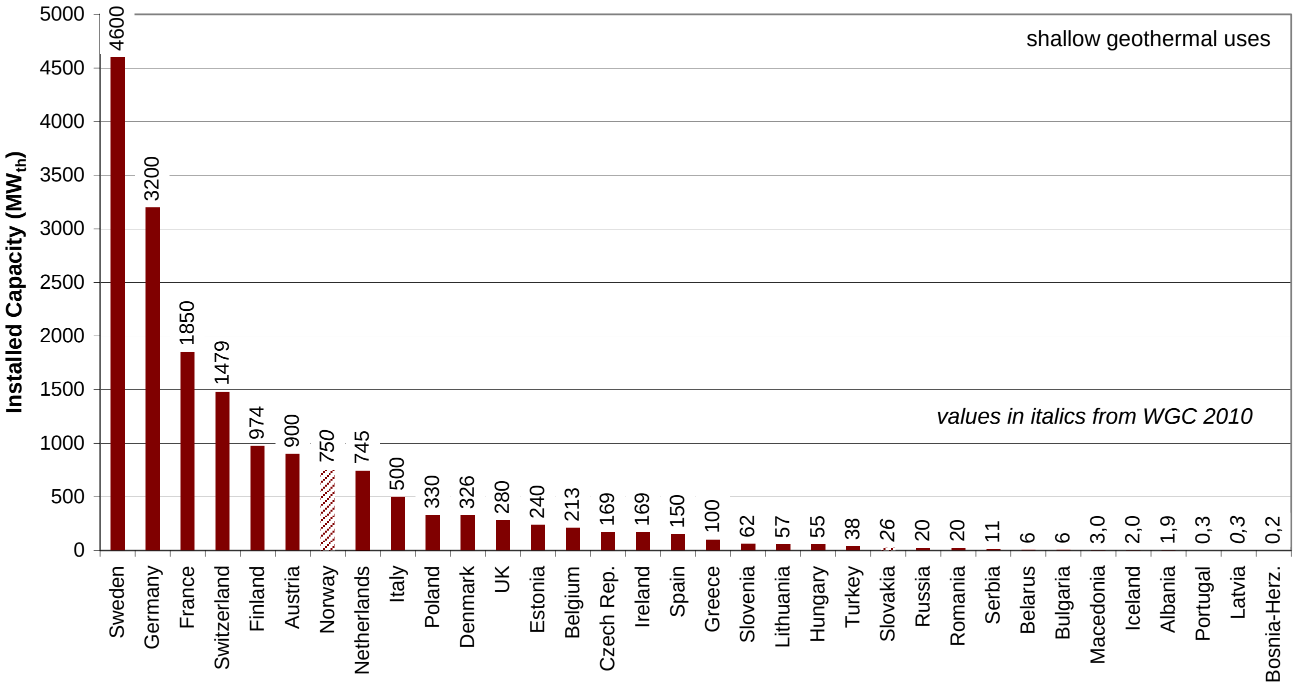

Figure 10: Shallow geothermal installed capacity in Europe 2012, after EGC 2013 country update reports.

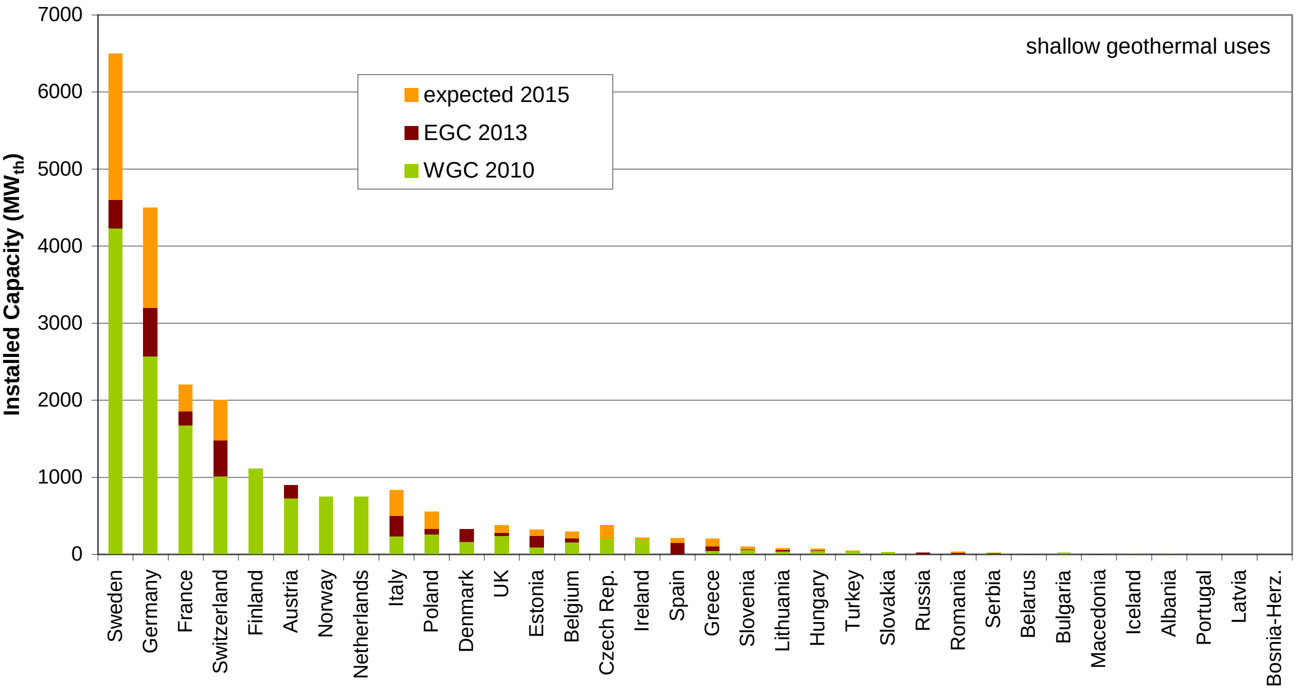

Figure 11: Installed capacity for shallow geothermal systems in Europe 2010-2015, after WGC 2010 and EGEC 2013

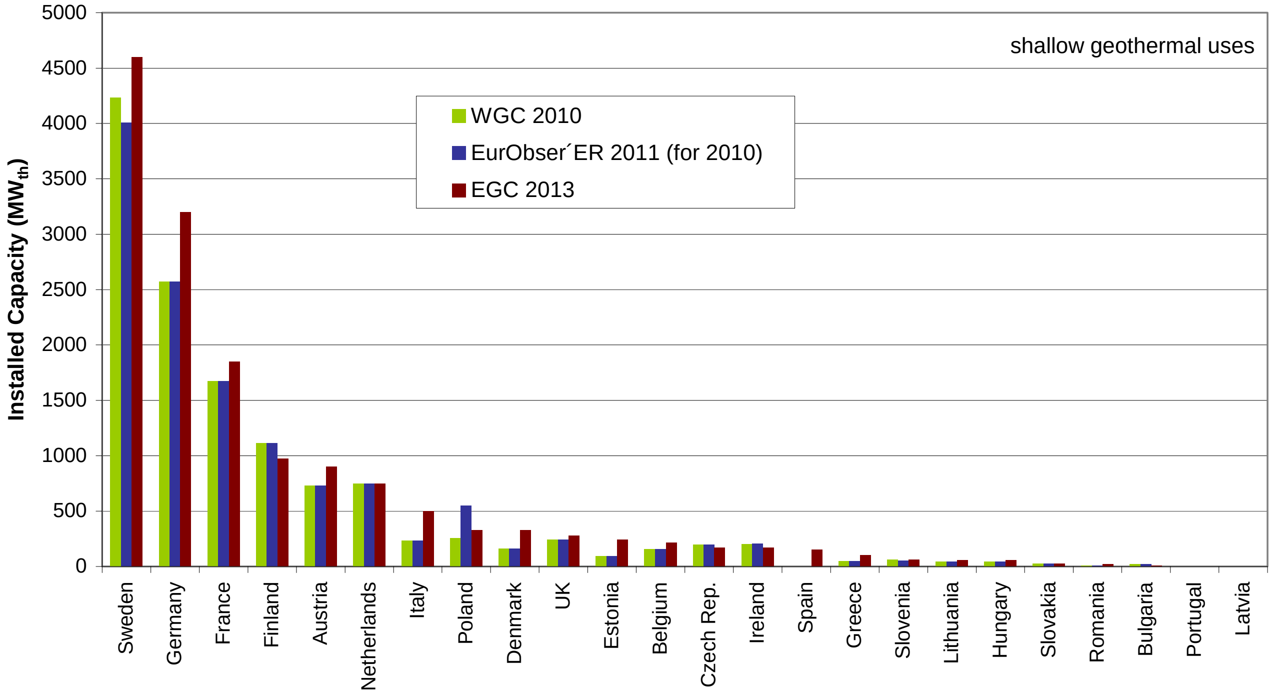

Figure 12: Installed capacity for shallow geothermal systems in Europe for 2010 and 2012, after different sources

For EU statistical purposes, the renewable (geothermal) contribution of geothermal heat pumps to the heat produced from now on should be calculated according to the EU Directive 2009/28/EC "Renewable Energy", Annex VII, by the equation:

$$E_{RES} = Q_{usable} * (1 - 1/SPF)$$

E_{RES}	*renewable energy (in GWh)*
Q_{usable}	*estimated total usable heat (in GWh)*
SPF	*seasonal performance factor*

In March 2013, the EC has issued the necessary rules for applying this formula, prepared by Eurostat (Decision 2013/114/EU). As a default (i.e. if no better data from actual measurements are available), Q_{usable} shall be calculated as:

$$Q_{usable} = H_{HP} * P_{rated}$$

Q_{usable}	*estimated total usable heat (in GWh)*
H_{HP}	*full-load hours of operation*
P_{rated}:	*capacity of heat pumps installed*

Also default values for H_{HP} and SPF are given in 2013/114/EU. These values are given for three different climate zones (cold, average and warm). As example, for Germany, located in the "average climate" zone, H_{HP} is considered as 2070 h/year (a rather high value), and SPF for Ground-Water and Water-Water heat pumps as 3.5 (this value is more on the low side for Germany). Then the full calculation is:

Q_{usable} = 3200 MW * 2070 h/yr = 6'624 GWh/yr

E_{RES} = 6'624 GWh/yr * (1 – 1 / 3.5) = 4731 GWh/yr

The pure geothermal contribution from ground source heat pump systems in Germany thus can be estimated to be 4.73 TWh_{th} in 2012, according to the new EU calculation rule. This is considerably higher than the 2012 value of 4,170 GWh reported following the methods used by now, mainly due to the high defaulte number of full-load hours. In future, geothermal statistics will become easier inside the EU, with the national statistical offices and Eurostat providing the data as to Directive 2009/28/EC.

5. MARKET SITUATION

Investment in geothermal energy was at least 5.3 billion € in 2012. The relevant tables were only filled for 21 of 33 countries, with some major players like Italy missing, and Germany only giving an overall number (no breakdown according to sub-sector). This also might contribute to the high investment (in relative terms) in the shallow sector, as this is dominated by Sweden with some 2500 Mio € alone! Based on the same 21 countries, the extrapolation to 2015 amounts to ca 6.9 billion, an increase of almost 30 %.

For employment, we can state that at least 32'000 persons work in the geothermal sector. The relevant tables were only filled for 19 of 33 countries, with some major players like Italy missing, and Germany only giving an overall number (no breakdown according to sub-sector). This also might contribute to the high amount of deep geothermal workers in the breakdown, as this is dominated by Turkey with 7000 persons alone! Based on the same 19 countries, the extrapolation to 2015 amounts to ca 41'000 persons, an increase of about 28 %.

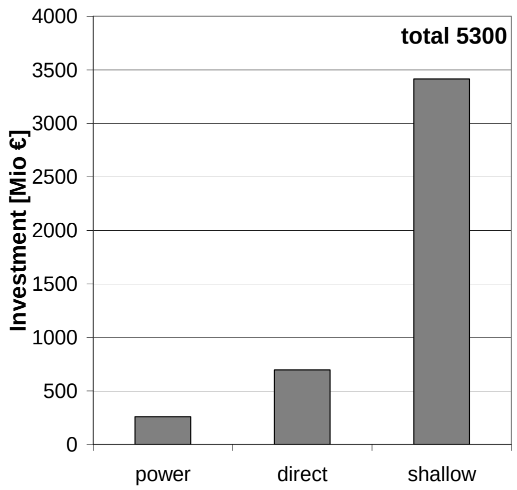

Figure 13: Investment in the different fields of the geothermal sector (only 21 of 33 countries; Germany with 960 Mio € is considered in the total, but not in the sectorial breakdown)

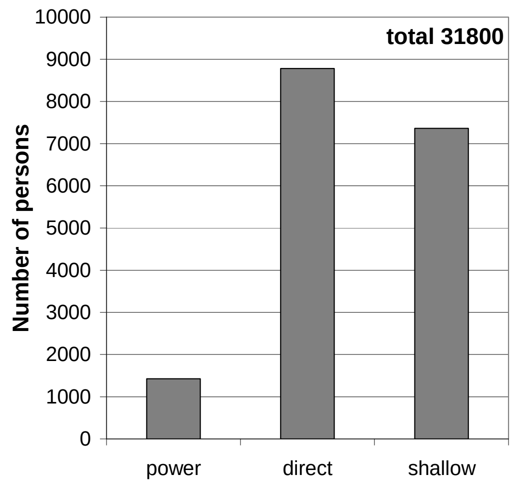

Figure 14: Number of persons working in the different fields of the geothermal sector (only 19 of 33 countries; Germany with 14200 is considered in the total, but not in the sectorial breakdown)

The tables concerning financial incentives show that support for R&D is available in most countries, while incentives for installation and/or operation are less frequent.. The reported measures, divided by sector, are:

Power: Direct investment support was reported in 4 countries, risk coverage in 2. In 7 countries the operation is supported by feed-in tariffs, in 1 by feed-in premium, and in 3 by Green Certificates.

Direct use: 17 countries report support for investment, mainly as direct financial support or low-interest .loans Risk coverage is available in 4 countries. For operation, only 8 countries have schemes of various types for geothermal direct use.

Shallow geothermal: Investment support for shallow geothermal is given in 20 countries, mainly as direct investment support, but also in the form of low-interest loans or tax reductions. Support for operation was, not surprisingly, only reported in 5 countries.

The most reports for information to the public as well as education and training were in the shallow geothermal sector. Geological information for shallow geology is provided in 24 countries! For power and direct use, the availability is much dependent upon the potential in the respective countries.

6. COUNTRY SUMMARIES

Albania

The geothermal energy resources of Albania are mainly natural springs and deep wells with temperatures up to 65.5°C. The construction of space-heating systems based on direct use of shallow ground heat, by using borehole heat exchanger (BHE) and heat pumps, represents a priority in future geothermal development.

Austria

In general Austria exhibits moderate to favourable conditions for hydrogeothermal use considering several basin areas with either widespread aquifers or enhanced geothermal conditions. In this context utilization of natural thermal water has long-term tradition in Austria. Geothermal energy supply has commenced in the late 1970s and was boosted in the time period between 1985 and 2005. Since then hydrogeothermal development has been on a modest level. The main barriers of a further geothermal development in Austria are given by a very moderate federal funding scheme.

There are 8 District Heating networks, with 51,5 MW_{th} of installed capacity and a production of 158,8 GWh_{th}; in addition, 4,4 MWth are used for other utiliazations (25,2 GWh_{th}). Only three small geothermal combined heat and power projects are operative:

- Altheim, commissioned in 2002 with 1 MW_e electrical unit, providing 28 GWh_{th} of heat and approximately 1 GWh_e of electricity;
- Bad Blumau, commissioned in 2001, with a very small 250 KW_e unit, achieving an appreciable production of 1,2 GWh_e of electricity
- Simbach Braunau, commissioned in 2009, also with a small turbine, currently not operating, but providing 46 GWh_{th} of heat to the district heating network.

The country total is 1,5 MW_e and 2,2 GWh_e; there are no on going projects for further electrical development.

Belgium

Today, only one deep geothermal energy system (since 1985, in Saint-Gislain) is still in operation. All other systems, developed in the 80's in Flanders, are closed. After many decades of very limited activity on deep geothermal energy development, nowadays different initiatives are deployed for both power and thermal energy production.

Shallow geothermal energy installation numbers are growing steadily, but far behind the neighbouring countries. Main reason is the rather high investment with long payback times at residential housing. Medium to big size systems are becoming important, certainly when providing heating and cooling. These systems can benefit also from better support measures.

Bosnia and Herzegovina

Geothermal energy was used from hydrogeothermal systems only. Direct use of geothermal energy is mainly attributed to bathing and swimming (including balneology), space heating, less for geothermal heat pumps, greenhouses and industrial use.

There are 22 thermal and thermomineral spas and recreations centers where swimming pools are heated by geothermal water directly or indirectly through heat exchangers and GHPs. Thermal spas and recreations centers are predominant thermal localities for direct heat use. No district heating network are present; the total installed capacity for other uses is 21,5 MW_{th}, producing 70,6 $GWh_{th.}$

Belarus

There is no direct utilization of geothermal resources in Belarus. All existing geothermal installations use heat pumps to extract low-enthalpy geothermal resources. Until now there is no utilization of geothermal energy for generation of electricity in the country. There are dozens of deep abandoned oil wells that can be good candidates for power generation.

Bulgaria

Thermal waters are widely used for water supply mainly in the region of the north-eastern Bulgaria, due to low mineral content. In many instances this is the only alternative sources in the region. Bottling of mineral water and soft drinks preparation takes third place in terms of the utilized water amount. This is encouraged by low water usage fees.

Geothermal water for heating and cooling of individual buildings and greenhouses has currently a very limited application. No district heating system has been built in the country so far. In the last 10-12 years, the geothermal energy use has been continuously decreasing due to closure of outdated simple direct heating systems. New technologies have not been implemented either. More intensive space heating utilization is expected with the new amendments made in the Water Act. These amendments address significant fee reduction and granting the concession of state-owned deposits to the local municipalities. Major barriers that emerge at the current stage are the lack of local investments and expertise of the municipalities in managing the geothermal resource. Systems operating on shallow geothermal energy are attractive to private consumers due to high fossil fuel prices.

Czech Republic

The geothermal energy use in the Czech Republic has been constantly increasing in spite of the high upfront investments, especially in the initial phases.

Besides heat extraction from hydrothermal resources, the importance of geothermal drilling using different technological approaches is under development. Several research studies show that there possibilities of geothermal electricity generation from wells of depth ca. 5 km. There are favourable natural and geologic conditions, as well as market conditions for geothermal energy supply. The first efforts for deep geothermal projects development are on-going however shallow geothermal energy has actually the lead.

Denmark

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 at 3 plants with a total design rate at 33 MW heat extraction from the 15-20 % saline geothermal water and a number of district heating companies are conducting exploration and are considering establishing a geothermal plant.

Shallow geothermal energy is expected to become more widespread in the future especially in areas with no district heating or natural gas supply. Most of the present ground source systems are using horizontal collectors.

Estonia

Estonian GSHP market has been developing without any direct subsidies for the past 20 years. Given that GSHP systems are economical and one of the most attractive options for energy efficient heating and cooling, new support mechanisms for further market development (to be competitive with other RES which are supported) are expected, including defining GSHP as RES according to European Union standards.

The deep geothermal market is still undeveloped due to lack of information among policy makers and lack of modern geological knowledge. However, since the establishment of EGA in 2011 this situation has started to improve. Actions within the next few years will focus on research and analysis of Estonian geothermal potential, which can pave the road to new horizons.

Finland

Geothermal energy or geoenergy (as called in Finland) has taken long jumps forward during the last five years. The HP boom started with air-coupled HPs, still prevailing, but shifting today more and more to GSHPs both in small house as well as large projects. The future seems positive and geoenergy is taking even greater share from the renewable energy palette. The governmental target to be set for the year 2020 is now 8 TWh representing about 10% of the energy needed for heating of houses. With the present trend this figure will be surpassed. Last year (2012) the total consumption for space heating in Finland was 95 TWh. Today about 30 % of the used energy is produced by renewable sources. The target set by 2020 is 38 %.

France

The increase of geothermal energy uses for heating and cooling is substantial, doubling in the last 6 years. Strong incentives are required in order to fulfil the forecast of AFPG.

The continuation of the "Fonds Chaleur" is obviously a key point, but the administrative simplification for small operations (less than 30 kWth) is also very important and the rewriting of the Mining Code in preparation could favour the development of numerous projects.

For electricity generation, the activity was stopped since 10 years and consequently the expected targets for 2012 at 80 MW installed in France are already not possible to complete, even taking into account the plant to be built in Dominica island in order to sell the production to French Caribbean islands. Nevertheless, the permits to be granted in France overseas departments will allow the development of new EGS-CHP operations.

For direct uses applications, the on-going projects in Ile de France, Aquitaine and Alsace region and the use of great power heat pumps installed on existing plants to lower the temperature of geothermal deep fluids before injection in the reservoir will permit an average increase of 50 MWth of installed power during the next 7 years.

For GSHP, the future is to use geothermal energy in more than 5% of the buildings annually built, which is a bad result if compared with leading countries such as Sweden, Switzerland and Germany. In parallel the market of GSHP in old construction to be renewed is the key for shallow geothermal resources use.

The regulation regarding energy use in buildings (RT2012) is not favourable at all for the development of the geothermal heat pump technology, in particular the green gas effect which is not taken into account to encourage this renewable technology. These regulations have to be modified in order to allow geothermal energy to attain the ambitious objectives fixed by the government.

Georgia

Owing to its geological location, Georgia has considerable resources of middle and low temperature thermal water (33 – 108 ºC). Most of the geothermal wells are middle depth and non-operating.

On the other hand the economic development of the country relies to a great extent to energy production. Geothermal potential of Georgia exhibits a promising resource that might be available for energy production. In spite of these conditions Georgia has strong ambitions in the construction of geothermal district heating systems. Shallow geothermal energy use is not reported for the country.

Germany

Due to moderate temperature gradients in most parts of Germany and a general lack of high enthalpy reservoirs, geothermal energy use in Germany is still on a comparably low level. Current project development concentrates in the southern part of Germany, where regional geologic settings provide good conditions for heat use and in part also for power generation.

The installed capacity of geothermal heat uses in Germany amounted to 3,500 MW_t in 2011, with a pure geothermal contribution of about 2,400 MW_t. 90 % of the installed capacity is attributed to geothermal heat pumps. The remaining 10 % is contributed by centralised installations using thermal waters from depths over 400 m, such as heating plants and thermal spas. The geothermal heat production in Germany amounted to 4.6 TWh in 2011 with 15 % attributed to deep geothermal utilizations. In 2012, geothermal heat production is estimated with about 5 TWh.

In 2012, four geothermal power plants or combined heat and power plants were in operation in Germany, the power-led plants of Insheim, Landau and Bruchsal in the Upper Rhine Graben, and the combined plant of Unterhaching in Bavaria. Due to the commissioning of the Insheim plant, the installed electric capacity increased to 12.1 MW_e at the end of 2012. A continuation of this positive trend can be expected in the next years. Considering projects presently under construction, 60 to 70 MW_e installed capacity seem feasible until the end of 2015 by a conservative estimate.

With the resolution of the amended Renewable Energy Sources Act (EEG) on 30 June 2011, the German Government further improved the conditions for the development of geothermal energy in Germany. The positive effect of the EEG on geothermal power development is backed up by financial support of pilot and demonstration projects by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU). In addition, a market incentive programme grants support for the installation of efficient heat pump systems in private houses and office buildings. Furthermore, repayment bonuses for geothermal heat and power plants and drill costs are granted and part of the exploration risk can be covered within a program.

Altogether, the use of geothermal energy in Germany shows a slow but continuous positive trend in the last years. In regions with favourable conditions, a vivid project development takes place, which will further increase the geothermal heat and power capacity in the next years. Governmental support provides interesting incentives for further investments in the geothermal market.

Greece

Greece is rich in geothermal resources and has a long history of bathing for therapeutic purposes. The largest application is geothermal heat pumps (more than 60% of the installed capacity), followed by bathing and swimming (including pool heating) and greenhouse heating. No district heating network are present; the total installed capacity for other uses is 69,3 MW_{th}, producing 504 $GWh_{th.}$

Currently, no geothermal electricity is produced in Greece, despite the very good potential of the country and the fact that a pilot 2 MW_{el} had been operated for about two years in the 1980s in Milos Island. However important research is ongoing on several areas, following a first tender for geothermal exploration leases, In particular, Aristino-Alexandroupolis (Thrace), Neo Erasmio (Thrace), Eratino-Chrysoupolis (Macedonia), Nigrita (Macedonia), and Chios are most promising medium-enthalpy areas, with the traditional Milos, Lesvos and Santorini. There is a solid possibility of some successfully project by 2015, with about 20 MW_{el} expected.

Hungary

Hungary's excellent geothermal potential is well known. Traditionally, the country's geothermal energy production that focuses mainly on the direct heat was used for direct-heat supply, with most of the thermal water used in spas. As yet, there is no developed ground-source heat-pump market or operational geothermal power plant in Hungary. Forecasts are ambitious both for district heating and shallow geothermal energy use generating a six fold investment increase for 2015 compared to 2012.

Ireland

Geothermal energy in Ireland is dominated by the exploitation of low temperature resources for space heating using heat pumps. The last country update in 2010 showed domestic ground source heat pumps installations for space heating and domestic hot water as the principal application primarily as a result of government support through dedicated grant schemes towards the capital investment costs of installations.

The marked rate of increase reported in the number of heat pump units installed in Ireland up to 2010 accounting for up to 164MW installed capacity from ground source alone has now declined. The currently difficult economic situation and the end of the dedicated financial support for domestic ground source heat pumps has resulted in very few systems being installed during 2011 and 2012, with the main deployment attributed to large scale open and closed loop ground source systems with individual installed capacities of up to 2MW in size.

Since the initial exploration drilling on the southern margin of the Dublin Basin, the deep geothermal energy sector has progressed very slowly. Despite encouraging results from 2D seismic reflection surveys at the Newcastle project and planning for the first deep geothermal electricity plant being granted in late 2010, the lack of subsidies for geothermal electricity generation and the holdup in the implementation of a legislative framework for licensing deep geothermal resource exploration and development have stalled the sector. Extensive research aimed at better understanding deep geothermal resources in different geological settings in Ireland is being undertaken.

A number of initiatives to stimulate a sustainable future development of the shallow geothermal energy sector in Ireland are being implemented. These are aimed at tackling some of the barriers to the future development of the geothermal sector that have been identified. Technical guideline documentation and new interactive mapping of the shallow geothermal resources and their potential for deployment in Ireland are being developed with a view to providing standards for system installation and increasing public awareness amongst users and local authorities about shallow geothermal energy potential. The structure of a national database of ground source systems is being developed with a view to improving the reporting of shallow geothermal energy installations in Ireland. New comprehensive training initiatives and certification for industry stakeholders involved in design and installation of systems are currently being undertaken.

Iceland

The country is blessed by an abundant supply of geothermal resources. The geothermal resources are utilized both for electricity generation and direct heat application. The share of geothermal energy in the nation´s primary energy supply is 69.2%. Space heating is the most important direct utilization of geothermal energy in Iceland, covering 90% of all houses in the country. Other sectors of direct use are swimming pools, snow melting, industry, greenhouses and fish farming. The count of heating networks goes to the large number of 30, with 1725 MW_{th} of installed capacity and a production of 6342 GWh_{th}; in addition, 430 MW_{th} are used for other utilizations (1893 GWh_{th}).

Generation of electricity by geothermal energy has been increasing during the past 15 years, mainly due to increased demand in the energy intensive industry. This country is one of the top leader in the continent, and among the most active in the world, both for electricity and heating, with special record in the cascade utilizations. The geothermal potential is huge, and the limitation in the growing is not from the abundance of the resource, but from the demand side, being population limited and the possibility of exporting electricity very scarce.

The following geothermal areas are active:

- Bjarnarflag, in operation since 1969 with 3,2 MW_e on installed capacity and a good production of 17,5 GWh_e

- Krafla, where two units of 30 MW_e each, commissioned in 1978 and 1997, are producing 472 GWh_e.
- Svartsengi, with a complex of two flash units 30 MW_e each, in operation since 1999 and 2005, and seven small binary plants for a total of 8,4 MW_e (1989), completed by a back pressure unit (1981) of 8 MW_e, for an aggregated capacity of 76 MW_e and a production of 507 GWh_e; the plant produces 150 MW_{th} of thermal energy, serving 20,000 customers, and also feeding the touristic attraction of the Blue Lagoon;
- Reykjanes, two units of 50 MW_e each, in operation since 2005 and 2006, producing 789 GWh_e;
- The cogeneration plant of Nesjavellir, four 30 MW_e units (1998, 2001, 2005), with an impressive electricity production of 1011 GWh_e and a thermal output of 300 MW_{th}.
- Hellisheidi, another quite complex system of four plants with 6 units of 45 MW_e and 1 of 33 MW_e (2006, 2007, 2008, 2011), for a total of 303 MW_e and 2414 GWh_e; The two last units of Hellisheidi IV represents the major recent increase in 2011 (90 MW_e). Heat distribution started in 2010.
- Finally, the small binary Kalina plant at Húsavík, commissioned in 2000, 2 MW_e experimental site.

The country total is 665 MW_e and 5210 GWh_e. There are about 170 MW_e on new project currently planned, with the target of 830 MW_e for 2015.

Italy

In Italy the electricity generation is only in Tuscany, whereas direct uses are scattered all along the country, mainly for bathing and district heating purposes. The development of direct uses in Italy is in all the five sectors of application: space heating & cooling, thermal balneology, agricultural uses, fish farming, and industrial processes. 17 heating networks are present, with 80.7 MW_{th} of installed capacity and a production of 168 GWh_{th}; in addition, 698 MW_{th} are used for other utilizations (3200 GWh_{th}).

This country is the top leader in the continent, with its 100-years of history in geothermal electricity production: Larderello is still alive and able to keep a sustainable production, through the deep drilling and reinjection programs. The present production is only in Tuscany, in the following traditional high temperature areas (dry steam and hot water):

- Larderello, 22 units for a total of 595 MW_e and a production of 3539 GWh_e; these plants have been commissioned from 1991 to 2005
- Travale-Radicondoli, 8 units for 200 MW_e and a production of 1181 GWh_e; the oldest started its operation in 1986, while the most recent new entries are Chiusdino 1 and Nuova Radicondoli uint 2, 2x20 MW_e, commissioned in 2011.
- Piancastagnaio, where an old plants have been dismounted and three 20 MW plants are in operation (1990, 1991, 1994), producing 353 GWh_e
- and finally Bagnore, with a 20 MW_e unit in operation since 1998, and a new small binary plant of 1 MW_e on the separated water has been commissioned in 2012, with a total producing 161 GWh_e

The country total is 875 MW_e and 5235 GWh_e. A new 2x20 MW is under construction in Bagnore. New zones have been opened to the geothermal research in Tuscany and other regions, targeting fluids suitable for electricity production through binary cycles, in the medium enthalpy levels.

Lithuania

Lithuanian geothermal anomaly is the most intensive one in the East European Platform) utilisation of geothermal energy is expedient in Lithuania. Analysis of geological setting and parameters of major geothermal aquifers (Cambrian, Lower Devonian, Middle Devonian) enables to estimate the productivity of the geothermal well doublets in middle Lithuania. The Cambrian geothermal aquifer can be considered highly promising for district heating purposes.

The geothermal modelling indicates that temperature 150 °C can be met at the depth of 4.2-5.0 km in the southern part of West Lithuania. This area is considered a prospective target for development of the EGS/HDR systems for production of electric power. The area is as large as 2,200 km^2.

In practice, there is one district heating plant, the Klaipėda geothermal demonstration plant (KGDP), and a growth of installed capacity of ground-source heat pump systems.

Macedonia

There are minimal changes in the overall geothermal status in Macedonia, which comprise: introduction of one bigger (60 l/s – 75ºC) and several small boreholes (5 – 15 l/s, 30 – 55ºC), completion of the injection system for 1/3 of effluent water, application of heat exchanger (doublet system) for indirect utilization of the geothermal water in the district heating system of Kocani; finalization of the privatization process of existing spas; reconstruction of the heating installations in Negorci Spa and reconstruction in progress in Bansko Spa. Meanwhile, no new research and exploration activities have been performed. The "Energy Development Strategy for Republic of Macedonia up to 2030" and "Strategy for Exploitation of Renewable Energy Sources in Republic of Macedonia up to 2020" do not include any foreseen geothermal development as a prospective energy source for Macedonia. Nevertheless, it could be observed increased interest of small investors for the renovation of existing projects and development of new projects.

Netherlands

The period 2009 up to mid-2013 witnessed the emergence of several new projects bringing the total number of deep geothermal installations to nine (of which two were in the process of start-up). Two new projects started drilling in March and April 2013 and it is expected that construction of some more wells will start in 2013. Total capacity at the end of 2012 was 40 MW_{th} and the yearly production is roughly 200 GWh (heat).

All wells except the first Minewater project are Direct Use applications. The temperatures of the nine current deep wells vary between 60 ^{0}C (1.600 meter) and 87 ^{0}C (2.900 meter). The well temperatures confirm the expected average temperature gradient of 3,1 ^{0}C per 100 meter. Production volumes vary roughly between 100 and 200 m^3 per hour. All wells - except the Minewater project - are aquifer based systems and the only product is heat (no cooling or electricity).

The Shallow Geothermal Energy market in the Netherlands is a national market. Designers, installers and consultants are, besides a few exceptions, all Dutch. It is expected that more than 200 companies are involved in thia market. There are no numbers present of the exact amount. The total turnover is estimated to be about € 45 to 55 million per year.

Prevalent in underground thermal energy storage are open systems (groundwater wells, called aquifer thermal energy storage, ATES), while closed-loop systems can mainly be found in ground source heat pump plants.

Norway

In Norway, the emphasis on energy efficiency and new building codes that restrict the use of energy for heating have increased the interest for Ground Source Heat Pump (GSHP) systems. More than 90 % of the GSHP systems utilize energy from boreholes in crystalline rock. There is a trend towards deeper boreholes and Borehole Heat Exchangers (BHE), systems involving 500 m depths have been successfully delivering heat for more than two years.

Ground Source Heat Pumps (GSHP) are regarded both economically and technically as one of the best alternatives for energy efficient heating and cooling of new large and medium sized buildings, and these applications will be important in reaching national energy targets.

So far Norway has no deep geothermal installations in operation, but there are preliminary plans for utilizing deep geothermal energy in a district heating system in mainland Norway and to replace fossil fuels with geothermal energy in Ny Ålesund, an insulated settlement on Svalbard. Deep geothermal energy is set on the agenda, and research projects are emerging.

Poland

There are favourable conditions for the development geothermal energy in the country: prospective water and energy resources, potential clients of geothermal heat and water, as well as high level and scientific commitment, the Polish and European experience of servicing companies (drilling, geophysics), contractors of installations, etc.

The growth of the number of operating geothermal plants, associated environmental and social benefits alongside with the growth of investments observed in past few years, suggest that more dynamic geothermal energy development is possible. Particularly prospective is the district heating sector (space heating, DH, agriculture, aquaculture, other). In some locations the prospects exist for binary electricity and heat cogeneration (based on ca. 90-100 ºC water). The most promising sector is represented by recreation and balneotherapy (attracting especially private investors). Further GSHPs' development is expected, following the progress observed in 2011-2012.

Portugal

High temperature geothermal resources in Portugal are limited to the volcanic islands of the Azores, where they have been used for power production since 1980, at the Ribeira Grande geothermal field. On the Portuguese mainland, there are at present no direct use projects running, outside a few existing Bath Spa's. No pure geothermal district heating networks are present; the total installed capacity for other uses is 26,3 MW_{th}, producing 92.1 GWh_{th}. Geothermal heat pump plants exist, and the creation of a Shallow Geothermal Energy Platform in Portugal is due to increase their use.

This country is producing electricity only in the Azores islands, from an high enthalpy resource, from two plants:

- Ribeira Grande, where four binary units (1994, 1998) for 15 MW_e and 85 GWh_e
- the most recent installation of Pico Vermelho, 2006, where a 12 MW_e binary is currently producing approximately 100 GWh_e,

The contribution of the geothermal source represents today 22% of the power generated in the Azores archipelago. There are no further development planned for 2015, despite the discovery of a new productive field in Pico Alto geothermal area. The country total is 28 MW_e and 185 GWh_e.

Romania

Romania recorded an important step in its geothermal development: the installation of the first ORC binary plant of 50kWe. District heating has been extended on the existing localities but no new projects have been recorded. The market for ground source heat pumps GSHP practically opened in Romania only in the late 1990' and is now developing quite well. Because nowadays there are no technical norms for GSHP applications, it is still impossible to obtain data from all companies installing such systems. They are systematically avoiding openly present their applications as references. The forecast is very positive. Geothermal development will drain a fifteen fold investment increase in 2015, mainly in direct use applications.

Russia

Direct use of geothermal resources is mostly developed in Kuril-Kamchatka region, Dagestan and Krasnodar Krai, and first of all for heat supply and green houses heating. There are promising projects being at different stages of development. The geothermal electrical activity is limited to the far East region of Kamchatka and the Kuril Islands, without any substantial development in recent years. The following plants are operating:

- Pauzhetsky, two 2,5 MW_{el} units (1966) and a third of 9,5 MW_{el} (1980), with production of 59 GWh_{el}
- Verkhne-Mutnovskaya, with three 4 MW_{el} (1998, 1999, 2000), cumulating a total of 58 GWh_{el}
- Mutnovskaya, where two 25 MW_{el} are in operation (2002, 2004), producing 323 GWh_{el}
- on the Kuril island, there are two units at Iturup and one at Kunashir, 1,8 MW_{el} each, commissioned in 2007.

Additional small units are planned in Kunashir Island and Pauzhetskaya, for an increase of 5 MW_{el}. The country total is 82 MW_{el} and 441 GWh_{el}

Serbia

Geothermal investigations in Serbia began in 1974, after the first world oil crises. The country has favourable geothermal characteristics, with four geothermal provinces. The most promising are the Pannonian and Neogen magmatic activation provinces. More than eighty hydrogeothermal systems are present in Serbia.

Geothermal energy in Serbia is being utilized from hydrogeothermal drillholes for balneological purposes, in agriculture and for space heating with heat exchangers and heat pumps. A great number of 17 heating network are present, with 53.6 MW_{th} of installed capacity and a production of 231 GWh_{th}; in addition, 72.6 MW_{th} are used for other utilizations (341 GWh_{th}).

Slovenia

Geothermal energy use in Slovenia has been followed on regular basis since 1995, with a slow and constant increment of the energy contribution from direct use of thermal water. Three district heating networks are present, with 3.7 MW_{th} of installed capacity and a production of 6.3 GWh_{th}; in addition, 59.4 MW_{th} are used for other utilizations (158 GWh_{th}).

Spain

The geothermal resources of Spain are very high. Nonetheless, geothermal energy still shows a very low penetration despite its great potential. The conditions that enable the existence of high temperature geothermal resources have been confirmed in Spain only in the Canary Islands, specially in Tenerife, where an appreciable potential is present, even if its depth could be a severe limitation in the economical development of the geothermal potential. With regard to low-temperature geothermal energy, Spain's current installed capacity (built during the 80's) is associated with direct heat applications, mainly for spas and greenhouses.

Sweden

Over the last two decades the market for ground source heat pumps (GSHP) has been continuously growing in Sweden. These systems are recognized as cost effective and environmental sound ways for space heating. Up to the mid 2000 the growth was connected to small size GSHP system for single houses. In later years larger systems have become more and more popular. Furthermore, seasonal storage of natural heat and cold in the underground (UTES) have become increasingly common for combined heating and cooling of commercial and institutional buildings. After some 20 years of operational experiences UTES systems are proved to be energy efficient, technically safe and profitable.

Most part of Sweden lack the geological conditions for deep geothermal exploitation. However, there is one plant in Lund from the mid-1980: tie that is still going strong with a production of some 250 GWh of geothermal heat to the DH of Lund annually.

Switzerland

Geothermal heat pumps are continuously a success story in Switzerland, with annual growth rates of 20 %. The areal density with about 3 standard 12 kW units per km^2 is highest in the world.

Several geothermal projects for district heating or balneological usage were realised in Switzerland in the last decades, while deep geothermal power has not been produced yet.

Through the events in Fukushima and the enacted nuclear phase-out, the perspectives of deep geothermal energy have been distinctively improved and the development has accelerated. The acceptance is currently high, but the expectations related to deep geothermal energy increased simultaneously. Deep geothermal energy is of high potential in Switzerland and could play an important role in Swiss energy supply in the future, but to achieve this goal, challenges of the most different kind must be tackled. There are fast developments in all areas: cantonal and national politics, in the general awareness and among the power supply companies.

Turkey

More than 250 geothermal fields were discovered in Turkey and about 95% of them are low to medium enthalpy fields mainly suitable for direct use applications. As of today, 58 % of the proven capacity (2705 MWth) is utilized for geothermal heating, including residence heating, greenhouse heating, thermal facilities heating, balneological use and heat pump application. The good number of 16 geothermal district heating network are present; the total installed capacity for other uses is 1862 MW_{th}.

The country is experiencing an impressive development of its large potential, after a long period of inactivity after the first plant of Kizildere. due to the new incentive law and the privatization of the geothermal market, several investors entered in the geothermal electricity exploration and a massive drilling phase is on going in the most attracting areas of the country. The following projects are in operation:

- Kizildere, where the old flash plant of 20 MW_e, commissioned in 1984, has been enriched with a binary unit of 8 MWe (2008); its production was 93 GWh_e
- Germencik, where a big flash unit of 47,4 MW_e started its opration in 2009, with a production of 360 GWh_e
- Dora, two binary units of 16 MW_e in total, for a production of 37 GWh_e
- Tuzla, another 8 MW_e binary,
- Three new large binary complex, (Irem, Sinem, Deniz), commissioned in 2012, for a total capacity of 68 MW_e

In addition to the impressive increase in the installed capacity, 150 MW_e of new projects is currently under development (Kizildere, Dora, Pamukören and Gümüsköy), reaching in 2020 the target of about 650 MW_e. The present values are 167 MW_e, 490 GWh_e.

United Kingdom

The exploitation of geothermal resources in the UK continues to be minimal. There are no proven high temperature resources and limited development of low and medium enthalpy resources. However, in the reporting period 2007-2013, there has been a significant resurgence of interest in all aspects of geothermal energy in the UK. New geothermal assessments and reports have been produced, and several deep aquifer projects, minewater projects and EGS/HDR projects are at various preliminary stages.

In terms of real activity "in the ground" a new deep hole has been drilled in the centre of Newcastle, and ground source heat pump installations have continued, albeit at a lower rate of growth than had been anticipated. "Geothermal" seminars and conferences have been held, and the UK has increasingly participated in EU and international geothermal initiatives. Compared to previous updates, there has been a significant awakening of geothermal interest in Scotland.

Over this period there has been increasing recognition both at European and at UK national levels of the importance of delivering secure low carbon sources of heating.

REFERENCES

Antics, M. & Sanner, B.: Status of Geothermal Energy Use and Resources in Europe, *Proc. EGC 2007*, Unterhaching (2007), paper #082, 1-8

Bertani, R. Geothermal Power Generation in the World, 2005–2010 Update Report. *Proc. WGC 2010*, Bali (2010), paper #008, 1-41

EGEC: Ferrara Declaration / Dichiarazione di Ferrara. *EGEC Business Seminar Ferrara,* Brussels (1999), 1-2, www.egec.org

EGEC: EGEC Geothermal Market Report 2012, EGEC, Brussels (2012), 1-53

EurObserv´ER: Ground-source heat pump barometer. *Systèmes solaires*, N° 205, Paris (2011), 82-101

Lund, J.W., Freeston, D.H. and Boyd, T.L.. Direct Utilization of Geothermal Energy 2010 World-wide Review. *Proc. WGC 2010*, Bali (2010), paper #007, 1-23

Table of EGC 2013 country update reports:

Author(s)	Country
Frasheri, A.	Albania
Goldbrunner, J. and Goetzl, G.	Austria
Zui, V. and Martynova, O.	Belarus
Hoes, H., Petitclerc, E., Declercq P.-Y. and Laenen, B. Geothermal	Belgium
Miošić, N., Samardžić, N. and Hrvatović, H.	Bosnia and Herzegovina
Bojadgieva, K., Benderev, A., Berova, A. and Apostolova, I.	Bulgaria
Jirakova, H., Stibitz, M. and Frydrych, V.	Czech Republic
Mahler, A., Røgen, B., Ditlefsen, C., Nielsen, L.H., and Vangkilde-Pedersen, T.	Denmark
Soesoo, A. and Sukles, U.	Estonia
Kallio, J.	Finland
Boissavy, C., Vernier, R. and Laplaige, P.	France
Melikadze, G. and Vardigoreli, O.	Georgia
Ganz, B., Schellschmidt, R., Schulz, R. and Sanner, B.	Germany
Andritsos, N., Arvanitis, A., Dalabakis, P., Karytsas, C., Mendrinos, D. and Papachristou, M.	Greece
Nádor, A., Tóth, A.N., Kujbus, A. and Ádam, B.	Hungary
Ragnarsson, A.	Iceland
Pasquali, R., Jones, G.L., Allen, A., Burgess, J., and Hunter Williams, T.	Ireland
Bertani, R., Grassi, W., Cataldi, R., Conti, P., Montemaggi, M., Romagnoli, P.	Italy

Author(s)	Country
Zinevicius, F., Sliaupa, S., Aleksandravicius, T.A. and Mazintas, A.	Lithuania
Popovska-Vasilevska, S. and Armenski, S.	Macedonia
van Heekeren, E.V. and Bakema, G.	Netherlands
Midttømme, K., Müller, J., Skarphagen, H., Berre, I., Ramstad, R.K. and Sørheim, H.R.	Norway
Kępińska, B.	Poland
Martins Carvalho, J., Coelho, L., Nunes, J.C. and do Rosário Carvalho, M.	Portugal
Rosca, M., Bendea, C. and Cucueteanu, D.	Romania

Author(s)	Country
Svalova, V., Povarov, K.	Russia
Nuhovic, S., Djokic, I.	Serbia
Rajver, D., Prestor, J., Lapanje, A. and Rman, N.	Slovenia
Arrizabalaga, I., De Gregorio, M., García de la Noceda, C., Hidalgo, R. and Urchueguía, J.	Spain
Andersson, O. and Bjelm, L.	Sweden
Link, K., Rybach, L. and Wyss, R.	Switzerland
Parlaktuna, M., Mertoglu, O., Simsek, S., Paksoy, H. and Basarir, N.	Turkey
Curtis, R., Ledingham, P., Law, R. and Bennett, T.	United Kingdom

Table 2: Geothermal Electric Power in Europe in 2012.

	2012 installed capacity	2012 electricity produced	2012 load factor	Inst. cap. expected 2015
	]MW_{el}]	[GWh_{el}/yr]		[MW_{el}]
Austria	1,4	2,2	17,9	1,4
Belgium				8,0
Czech Republic				5,0
France	17,0	108	72,5	22,0
Germany	11,9	25	24,0	65,0
Greece				20,0
Hungary				3,5
Iceland	665,0	5212	89,5	830,0
Italy	875,5	5235	68,3	915,0
Portugal	28,5	185	74,1	23,0
Romania	0,05	0,4	91,3	1,2
Russia	81,9	441	61,4	87,6
Switzerland				2,5
Turkey	166,6	950	65,1	643,0
UK				14,0
Total / Average	1847,9	12158,3	75,1	2641,0

Table 3: Geothermal Direct Use in Europe in 2012.

	Geothermal DH Plants		Geothermal heat in agriculture and industry		Geothermal heat in balneology and other	
Country	Capacity [MW_{th}]	Production [GWh_{th}/yr]	Capacity [MW_{th}]	Production [GWh_{th}/yr]	Capacity [MW_{th}]	Production [GWh_{th}/yr]
Albania					11,73	
Austria	51,00	158,80	2,00	4,60	2,40	20,60
Belarus	5,50	2,38	2,90	12,53	2,30	9,94
Belgium	6,10	16,70	0,90	1,30		
Bosnia-Herz.	0,00	0,00	1,60	11,25	19,94	59,36
Bulgaria			3,48	15,70		
Czech Rep.	6,56	25,00				
Denmark	21,00	30,00				
France	295,00	1116,00	20,00	100,00	50,00	100,00
Georgia	1,30	4,74	2,80	10,22	0,70	2,56
Germany	163,00	349,00	0,00	0,00	48,00	380,00
Greece			27,30	274,00	42,00	230,00
Hungary	132,97	375,03	250,14	825,07	312,37	1648,74
Iceland	1725,00	6342,00	120,00	410,00	310,00	1483,00
Italy	80,70	168,00	298,00	1000,00	400,00	1200,00
Lithuania	35,00	93,90				
Macedonia	42,55	144,00	2,79	17,00	0,84	1,83
Netherlands	39,00	202,00				
Poland	101,90	148,40	2,00	1,80	11,50	36,30
Portugal	1,50	3,90	1,00	3,50	25,30	88,60
Romania	158,00	300,00	8,00	50,00	10,00	12,00
Serbia	53,65	231,25	16,96	82,88	55,60	258,41
Slovakia	*No report provided (156,3 MW_{th} total in WGC 2010)*					
Slovenia	3,72	6,27	13,96	31,61	45,48	126,42
Sweden	48,00	270,00				
Switzerland	8,40	10,30			28,90	240,00
Turkey	805,00		612,00		1250,00	
UK	2,00	14,00			0,55	3,00
Total	3786,85	10011,67	1385,83	2851,46	2627,60	5900,76

Table 4: Ground Source Heat Pump Use in Europe in 2012. *

Country	Number of GSHP	Capacity [MW_{th}]	Production [GWh_{th}/year]	kW_{th} per unit	Full-load hours per year
				Data calculated by authors of summary	
Albania	106	1,9	2,5	*18,3*	*1291*
Austria	*74531*	900,0	*1440,0*	*12,1*	*1600*
Belarus	100	5,5	2,4	*55,0*	*433*
Belgium	16158	213,0	335,1	*13,2*	*1573*
Bosnia-Herz.	3	0,2	3,7	*53,3*	*23125*
Bulgaria	8	5,5	14,7	*687,5*	*2673*
Czech Rep.	11783	169,0	328,0	*14,3*	*1941*
Denmark	27000	*326,0*	695,0	*12,1*	*2132*
Estonia	7500	240,0	660,0	*32,0*	*2750*
Finland	90000	*974,1*	3500,0	*10,8*	*3593*
France	150000	1850,0	2775,0	*12,3*	*1500*
Georgia	0	0,0	0,0	*0,0*	*0*
Germany	265000	3200,0	4200,0	*12,1*	*1313*
Greece	1200	100,0	135,0	*83,3*	*1350*
Hungary	5000	55,0	110,0	*11,0*	*2000*
Iceland	10	2,0	1,0	*200,0*	*500*
Ireland	*9657*	169,0	225,0	*17,5*	*1331*
Italy	*40541*	500,0	472,2	*12,3*	*944*
Lithuania	4387	56,6	141,3	*12,9*	*2496*
Macedonia	150	*3,0*	*4,5*	*20,0*	*1500*
Netherlands	29300	745,0	880,0	*25,4*	*1181*
Norway	No data provided (*750 MW_{th} in WGC 2010*)				
Poland	30000	330,0	470,0	*11,0*	*1424*
Portugal	13	0,3	0,5	*23,8*	*1548*
Romania	400	20,0	32,0	*50,0*	*1600*
Russia	1000	*20,0*	*50,0*	*20,0*	*2500*
Serbia	700	11,2	16,1	*16,0*	*1438*
Slovenia	6300	62,0	96,1	*9,8*	*1550*
Spain	3300	150,0	210	*45,5*	*1400*
Sweden	425000	4600,0	15200,0	*10,8*	*3304*
Switzerland	120000	1479,0	2338,0	*12,3*	*1581*
Turkey	132	38,0	*60,8*	*287,9*	*1600*
UK	16000	280,0	500	*17,5*	*1786*
Total / Average	1335279	16506,4	34898,9	*58,7*	*2418*

Data in *italics* calculated by the authors of the summary