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GEOTHERMAL ENERGY DEVELOPMENT IN EUROPE AND POLAND. CONTRIBUTION OF UNU-GTP GRADUATES.

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ABSTRACT

The paper overviews the status quo and prospects of geothermal energy uses in Europe and Poland. In several countries of the continent, a constant progress in geothermal applications has been observed in recent years. This applies also to Poland where a state support programme was introduced a few years ago. The important contribution of UNU Geothermal Training Programme to the development of this energy sector in Europe is emphasised. The role of the Programme remains important, especially as further rise in the use of geothermal energy is expected in the coming years.

1. INTRODUCTION

Europe has a significant potential and resources of geothermal energy. With an exception of a few countries, they belong to the low-temperature category. Europe is the global leader in geothermal direct uses. In 2015 and 2016, geothermal energy applications were reported from 32 countries and geothermal electricity generation took place in 8 states (Lund and Boyd, 2015; Antics et al., 2016).

The leaders of direct applications included Turkey, Iceland, Italy, Hungary, France and Germany. Further development of this energy source is needed due to many reasons (such as reduction of CO_2 and limitation of climate changes). This is determined by several factors, including, among others, increase of knowledge and raising awareness of many groups of people (decision makers, scientists, practitioners, investors, etc.) on the energy source; and providing access to good practices, proven technologies and building teams of own specialists. The UNU Geothermal Training Programme has offered significant assistance in these areas for some Central and Eastern European countries.

2. GEOTHERMAL DEVELOPMENT IN EUROPE

Geothermal energy in Europe is first and foremost used directly (L-T resources), while in some countries it is also involved in power generation (H-T resources or L-T binary schemes). This section mentions several facts according to Antics et al. (2016) and the EGEC Geothermal Market Report (2016).

Direct uses are mainly related to geothermal district heating, geoDH (Figure 1). In 2015, 280 geoDH systems were operating (against the total number of ca. 5,000 district heating networks in the EU states), while further 160 were on different stages of implementation. It corresponded to 4.8 GW_{th} installed capacity, including 1.7 GW_{th} in the EU states. One should pay attention to the average 10% annual installed thermal capacity increase in 2010–2015 in the EU states (against the 3% average for the whole

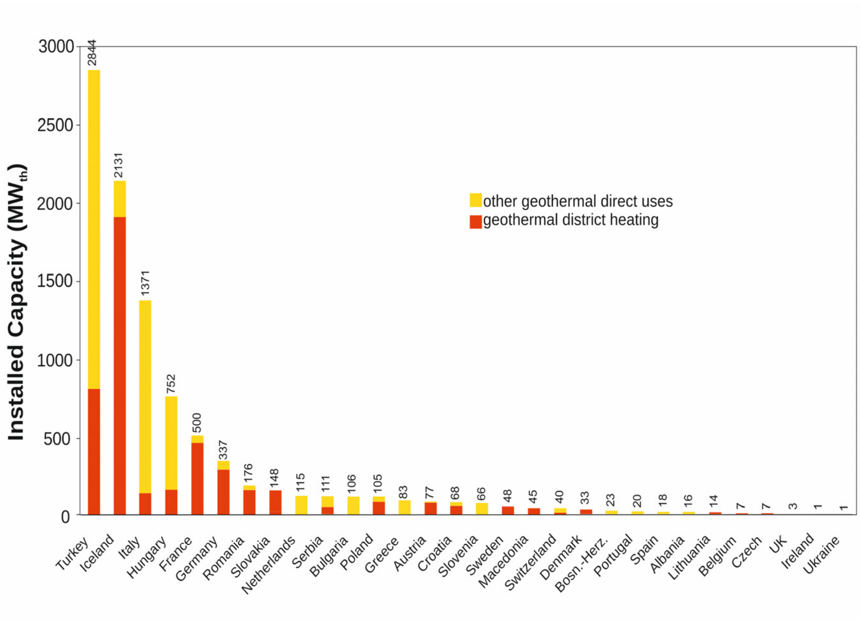

FIGURE 1: Europe – installed capacity for geothermal direct uses, 2015. The position of some home countries of UNU-GTP graduates is shown (based on Antics et al., 2016)

Europe). Of the top five countries in installed geothermal capacity for geoDH Iceland was definitely a leader, followed by Turkey, France, Germany and Romania. In terms of geothermal heat generation Iceland was also number one, while the next places were taken by France, Germany, Hungary and Austria. Other important areas of direct application include agriculture, as well as balneotherapy and recreation. Other uses are in aquaculture, industry, snow melting, etc.

Geothermal power is generated in eight European countries. In 2016 it corresponded to 2.5 GW_e installed capacity, including 1 GW_e in the EU states. The average annual capacity's increase in the EU countries was 2% between 2010 and 2015 (against the 10% average for the whole Europe where majority of increase was in Turkey: 91%). The H-T power generation takes place in Italy, Turkey, Iceland, Russia and France (in cases of Turkey and Russia – in Asian parts, and for France – the overseas area). The systems in other countries (Germany, France, Romania, Austria) are based on binary L-T schemes – this technology is still at the initial stage of development and future progress is expected.

Significant amount of shallow geothermal energy is acquired through heat pumps. In 2016, ca. 1.7 million of such installations were operating. In the countries of UNU-GTP graduates the sector is generally at the beginning of its development, but a more dynamic progress is observed in Poland.

In Europe, district heating is a sector of special importance for further development of geothermal uses due to the need to reduce GHGs' emissions and to limit climate changes. The measures to be taken should include the introduction of geothermal into the operating district heating grids. This applies also to the countries of the UNU-GTP fellows.

3. GEOTHERMAL DEVELOPMENT IN POLAND

3.1. Geothermal potential and current state of its uses

In Poland, geothermal waters are found in sedimentary formations in the Polish Lowlands, in Podhale Region – part of the Inner Carpathians (the most prospective areas) and in some locations in the Outer Carpathians, the Carpathian Foredeep and in crystalline and metamorphic rocks in the Sudetes Region. Geothermal energy has been implemented on a limited scale so far. Its practical uses involve space heating, balneotherapy, recreation, single case of fish farming, and some other minor uses (Figure 2).

The outflow water temperatures vary from ca. 20 to ~95°C (depths up to ca. 4 km). The proven water reserves amount from a few up to 150 L/s. TDS are in wide range from 0.4 to 150 g/L.

FIGURE 2: Poland – geothermal direct uses, 2017/2018 (based on Kępińska, 2016, updated).
1. District heating plants, 2. Health resorts, 3. Recreation centers, 4. Recreation centers under construction, 5. Fish farming, 6. CHP plants /early stages of investment/, 7. Heating plants under construction, 8. Geothermal exploration wells planned for drilling in 2018/2019 (funded by state support), 9. Wood drying

In the case of geothermal district heating (geoDH), six plants are operating as of 2018. In 2017 their total installed geothermal capacity was ca. 77 MW_{th} while geothermal heat sales amounted to ca. 870 TJ. In individual localities, geothermal water parameters as well as installed capacities and heat production vary considerably, e.g.: the approved water reserves amount from a few L/s, up to 150 L/s. The highest outflow water temperatures are 82-86°C while the lowest are 42°C, while TDS vary from 0.4 to 150 g/L. In particular plants the geothermal share of the total heat production ranged from 29 to 100%. It is worth mentioning that geoDH in the Podhale area is (probably) the largest geoDH system in Europe (excluding Iceland) for its geothermal capacity and annual heat sales (40.7 MW and 450 TJ/2017, respectively). That system is under constant development. All geoDHs resulted in a significant reduction of CO_2 and other pollutants (www.eeagrants.agh.edu.pl).

Ten resorts are using geothermal water for health treatment. In the last decade one can observe a kind of boom in the construction of recreation centres – at least fifteen were opened. Several new investments in recreation are at various stages of fulfilment.

An interesting case is connected with aquaculture: in fact, in one locality only geothermal water and energy is applied for such purpose. This is a large-scale Atlantic salmon farm producing at its initial stage of operation ca. 1000 tonnes of fish per year.

Other direct applications comprise a semi-technical wood drying, heating a football pitch and some other minor uses.

In recent years progress in harnessing shallow geothermal energy by heat pumps has been observed (as part of the progress in the heat pumps' branch in general). At the end of 2015 the number of such installations was estimated as ca. 45,000 units (Kępińska, 2016).

Poland belongs to the group of European countries where geothermal direct uses have been on a moderate scale till now. It is still far below its geothermal potential, real needs, ecological, economic and social interest. It is hoped that this situation will improve thanks to a wider development in the coming years, also due to a governmental support programme for geothermal energy uses introduced in 2016. It includes, inter alia, support for drilling geothermal exploration wells. So far (early 2018), five wells were granted such financial assistance (Figure 1).

One should also remember that the Polish energy sector is based mainly on coal with an increasing share coming from natural gas. Therefore, entry to the market by renewables – including geothermal – is a challenging task. On the other hand, competitive geothermal heat prices, several positive effects, as well as the new State Raw Materials' Policy, the Strategy for Responsible Development and – last but not least – present political climate, shall facilitate increase of the share of geothermal, specially for heating.

3.2. Current geothermal projects

In 2017–2018 some further geothermal investment projects are ongoing. In case of existing geoDHs they include optimisation, extension and drilling some next wells. Several further investment projects oriented for recreation and balneotherapy are in various realisation stages.

In 2018, the start of several new drillings funded by the already-mentioned state support programme is expected. This should be a long-awaited take-off of the geoDH sector – resulting in several new plants in the coming years (some planned as CHP). In all cases, together with space heating (sometimes planned as hybrid systems), different types of multi-purpose use is envisaged.

Besides the above mentioned investment projects, pre-investment works and feasibility studies on several sites and entities have been completed. One should also mention the research and R+D+I works, academic education at some universities, etc.

3.3. Future prospects

Previous use of geothermal energy in Poland, though being on a limited scale, brought positive economic, environmental and social effects. Despite the fact that the state energy sector is based on fossil fuels (mainly coal), there are prospects for geothermal development, especially in heating. Geothermal energy should be applied to a greater extent in existing district heating networks, as well as in agriculture, aquacultures, balneotherapy, and recreation, etc. Local co-generation is also possible (L-T binary schemes; several hundred kW_e to 1-2 MW_e). There are also interesting ways to apply geothermal water for production of mineral or tap water, and mineral products.

The wider scope of application will bring many important effects, including low-emission heating, improved living conditions, greater use of local energy sources, sustainable and innovative development. Geothermal can be used on its own, or as an element of hybrid systems. Furthermore, in order to improve the relatively low level of savings and efficient use of energy in Poland, a more comprehensive (holistic) approach to energy as an essential component of economic development and quality of life, together with education and promotion, is recommended (following the examples of other countries, e.g. Iceland).

4. CONTRIBUTION OF UNU GEOTHERMAL TRAINING PROGRAMME AND ITS GRADUATES TO GEOTHERMAL DEVELOPMENT IN EUROPE

By 2017 among 670 UNU Geothermal Training Programme (UNU-GTP) graduates from 60 countries, there were 75 persons from 17 European countries, namely: Albania (2 prs), Azerbaijan (1), Bulgaria (5), Georgia (1), Greece (3), Hungary (6), Latvia (1), Lithuania (2), Macedonia (1), Poland (14), Portugal (4), Romania (9), Russia (9), Serbia (3), Slovakia (2), Turkey (10) and Ukraine (2). They came to Iceland between 1986 and 2016. Their participation in the Training Programme was important for the states and institutions they represented as well as for their personal and professional development.

Their position and degree of effective use of knowledge and skills gained in Iceland varied depending on the state and was determined by the degree and rate of geothermal development in the respective country. In some countries, where more geothermal projects were implemented, many UNU-GTP graduates are actively involved in the sector. They work in universities and science institutions. Many have obtained high scientific degrees. Some became leading geothermal experts, initiate and hold important functions in various domestic and international R+D+I projects, work for geothermal plants, consulting companies, serve as consultants for decision makers. Several graduates entered geothermal business sector. A few examples of such activities are presented below.

In Turkey, among the graduates are leading university lecturers and experts involved in specialised geothermal studies and contributing to many projects ongoing in this country in recent years. In Romania among the graduates are previous rector and current vice-rector of the University of Oradea. They e.g. initiated the international geothermal studies and training centre at that University. In Poland some former UNU-GTP fellows hold academic positions of lecturers and supervisors of masters and doctoral theses. Some were involved in the project of the First Experimental Geothermal Plant in Poland, which preceded the largest European geoDH (one graduate was its CEO for many years). They have participated in different domestic and international projects, co-authored series of geothermal atlases for Poland. Several were among founders of the Polish Geothermal Society, initiated and organise the Polish Geothermal Congress, play active roles in promotion of geothermal and related topics. In the last decade some graduates, together with other representatives of Iceland and Poland (Orkustofnun, ministries from both sides) were engaged in successful efforts to introduce geothermal into the scope of the EEA Financial Mechanism for Poland, 2014–2021. In 2017, the first two bilateral geothermal projects funded by that Mechanism were completed – with several UNU-GTP teachers and graduates, experts from Orkustofnun and other entities working together *(www.eeagrants.agh.edu.pl).*

Examples of international involvement of some UNU-GTP graduates from Europe include:

- Participation and delivering many papers for the five editions of the World Geothermal Congress, WGC (1995–2015). Participation in most of them was supported by UNU-GTP fellowships;
- Involvement in the IGA ERB International Summer School on Direct Applications of Geothermal Energy (specially editions: Poland 2004, Slovakia 2009, Romania 2012);
- Participation in the BoDs of International Geothermal Association (IGA) and in IGA European Regional Branch Forum;
- Working in the Organising Committee of WGC 2005 (Turkey), IGA Steering Committees of WGC in 2010 (Indonesia) and 2015 (Australia-New Zealand);
- Cooperation on geology and geothermics in developing countries (eg. projects addressing academic centres in Nigeria funded by UNESCO (Polish Committee); projects funded by the Word Bank);
- Active participation in international high level events (eg. COP23 in Bonn, 2017).

The graduates maintain the contacts with UNU-GTP and Orkustofnun. They have attended former anniversary events and conferences in Iceland. In 2003, the author of this paper was honoured as an UNU-GTP invited lecturer. The graduates are irreplaceable "ambassadors" of geothermal, UNU-GTP and Iceland in their countries and internationally. They contribute to the cooperation of people from different countries. This helps to build bridges and establishing friendly personal and professional relations, which is the UNU mission statement, remarkably reflected by the UNU-GTP.

5. CONCLUSIONS

In a majority of European states, a growing use of geothermal energy and the related positive environmental, economic and social effects are observed. It is particularly clear when compared to the status in the previous ten years, as presented at the 30th Anniversary UNU-GTP Workshop (Kępińska, 2008; Małolepszy, 2008). One can also notice increased knowledge, awareness, social acceptance and progress in technologies. Also the politicians and decision makers are gradually getting more convinced that geothermal is among the best energy sources to reduce CO_2 emissions, alleviate climate changes, and improve energy safety. It is reflected in the policies of many countries and the European Union for the upcoming years. Geothermal energy has established its position and although it still lags behind other renewables, an increase in its share in the energy mix to the level of at least several percents can be expected in some states. It applies also to the home countries of UNU-GTP graduates from Europe since the Programme has contributed to the development of geothermal uses in these countries and to their input to international cooperation. It is hoped that this will be continued.

ACKNOWLEDGEMENTS

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