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Geothermal Direct Use - International Energy Agency Geothermal Technical Collaboration Programme

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ABSTRACT

Geothermal direct use technologies are mature and competitive with capacity and energy increasing at greater than 10% per annum across the globe. The International Energy Agency Geothermal Technology Collaboration Programme (IEA Geothermal) operates Working Group 8 which is focused on the direct use of geothermal energy. Over the last few years the group has been raising awareness and fostering uptake of direct use technologies through workshops and seminars held in several countries. The Working Group has 10 participating member countries and the European Commission working across five active tasks. Collaboration between the participants sees the sharing of research and development advances that are known to the participants. The work covers the complete spectrum from high to low temperature geothermal direct use applications, including ambient geothermal energy use in facilities heating and cooling using geothermal heat pump technology. Innovative smart thermal grids and innovative city energy systems are increasing with significant opportunities for this technology where significant reductions in carbon emissions from heating systems are achievable. Discussed in the paper are the tasks of the Working Group, highlights from recent work and a future view of the direct use of geothermal energy as the potential for new and innovative direct use applications is realised through energy systems that are focused on managing and reducing carbon emissions.

1. INTRODUCTION

Figure 1: The thermal spas of d'Ovronnaz in the Western Swiss Alps ("Les bains d'Ovronnaz").

Geothermal water has been used for millennia for various heating and bathing applications. During the last few decades the use of geothermal energy for a range of heating purposes has become more important worldwide, and this has resulted in steadily increasing uptake and use. Applications using geothermal energy include; heating buildings, raising plants in greenhouses, crop drying, aquaculture, snow melting, spas such as shown in Figure 1, bathing, therapeutic use, and industrial processes. Over the last decade, cooling using geothermal energy has become more important.

In 2013, IEA Geothermal Working Group 8, which is focused on the Direct Use of Geothermal Energy, was restructured (Link 2015) into the following tasks:

- Task A) New and Innovative Geothermal Direct Use Applications
- Task B) Communication
- Task C) Guidelines on Geothermal Energy Statistics (Closed 2017)
- Task D) Guidelines on Statistics for Geothermal Heat Pump Applications
- Task E) Design Configuration and Engineering Standards (continued)
- Task F) Costs of Geothermal Heat Pump Systems (Launched 2018).

The Working Group work includes large innovative heat pump applications such as smart thermal low temperature grids combined with underground thermal storage.

The Working Group's mission is to provide unbiased quality information, communication and knowledge transfer to mitigate the barriers to geothermal direct use in order to enhance deployment. The main objectives are to collaborate, cooperate, share knowledge, and boost awareness thereby increasing the use of existing technologies.

Current participants in Working Group 8 are France, Germany, Iceland, Japan, Mexico, New Zealand, Republic of Korea, Switzerland, United Kingdom, and United States of America. Observing guests are Australia, Norway and the European Commission.

The sections that follow discuss activity that has occurred in the 6 Tasks including a section on recent activity.

2. TASK A – NEW AND INNOVATIVE GEOTHERMAL DIRECT USE APPLICATIONS

2.1 Introduction

Task Leader: Brian Carey, GNS Science, New Zealand

Geothermal direct use technologies are, in general, mature and in many countries competitive. One aspect that is in focus is the development of innovative applications that open up new utilization possibilities, to enhance efficiency, and to reduce costs, such as "Smart cities" and "energy grids" which are being adopted in a number of European cities. There is a move towards larger geothermal heat pump systems (Ground Source Heat Pumps - GSHPs), sometimes combined with other energy sources (e.g., solar thermal energy) and usually incorporating underground energy storage. Geothermal in agriculture is increasing rapidly, such as in countries like the Netherlands where in the 10 years from 2007 to 2017 geothermal heat use in greenhouses has grown from nothing to 3PJ per annum (IRENA 2019). In many countries in the world, cooling using geothermal energy is becoming at least as important as heating.

Figure 2 Wairakei Prawn Farm uses geothermal heat to grow fresh water prawns. The energy comes from geothermal water discharged from 14MWe Wairakei Binary Power Plant.

2.2 Work Progress

Task A has regularly held meetings in conjunction with the biannual Executive Committee Meetings.

A number of international workshops have been organized in the period 2017 to 2020.

Task A and B were involved in organising a two-day geothermal workshop in Hanoi, Vietnam in November 2017. Presentations can be downloaded from the IEA Geothermal web site.

Three events were organized during 2018;

The first was as a part of the 2018 GeoTHERM Expo and Congress in Offenburg, Germany on 28 February 2018 focusing on Asian countries. The symposium presentations can be downloaded from the IEA Geothermal web site.

The second was conducted in Vienna, Austria in May 2018 as part of the IEA Geothermal Executive Committee Meetings and focused on project developments in Austria and neighboring countries. Presentations can be downloaded from the IEA Geothermal web site.

The third was a one-day workshop in Daejeon, South Korea, in November 2018, to share knowledge and information about innovative direct use applications, to boost the awareness and deployment of geothermal direct use and heat pump applications, and highlight the advantages and opportunities for these technologies in the development of green economies. The event was held on 9 November 2018, just prior to the 12th Asian Geothermal Symposium. The presentations from this workshop can be downloaded from the IEA Geothermal web site.

During 2019 two events organized, in part, by Tasks A and B were; the April 2019 two-day Canary Islands Workshop and the November 2019 Costa Rica workshop. Both events promoted geothermal direct use and heat pump applications by presenting innovative case studies and highlighting the opportunities and benefits of geothermal energy use. Presentations from both workshops can be accessed and downloaded from the IEA Geothermal web site.

3. TASK B – COMMUNICATION

3.1 Introduction

Task Leader: Katharina Link, Geo-Future GmbH, Switzerland

Although the worldwide technical and economic potential of geothermal direct use applications is enormous, knowledge amongst the general public, politicians and decision-makers is generally at a low level or lacking. The level of awareness varies widely. In some countries, such as the European nations, the potential of geothermal heat pump systems for heating residential houses is well known, but that there are many other geothermal applications less so. Even in a country like New Zealand, which has obvious potential, the many direct uses for geothermal energy are relatively poorly known when compared to geothermal electricity generation which is well known. To boost geothermal direct use and to advance deployment, communication is essential. Activities are concentrating on collecting available information from member countries and cooperating organizations exchanging experiences, which is fundamental to identifying and removing barriers, and to opening up opportunities through workshops held at different locations around the globe.

3.2 Work Progress

The Communication Task B organised several international events in cooperation with Task A, with these described under Task A in Section 2.2 above. Two photos from 2016 workshops in Mexico and in Thailand are included as Figure 3 and Figure 4.

Figure 3: IEA Geothermal – 2-day Direct Use Workshops in Cuernavaca, Mexico in April 2016.

Figure 4: IEA Geothermal – 2-day Direct Use Workshop in Chiang Mai, Thailand November 2016.

At least one event is planned for each year.

Additionally, fact sheets about innovative projects worldwide are being collected and compiled to be included on the IEA Geothermal website (www.iea-gia.org). Future work will continue to be carried out in conjunction with Task A.

4. TASK C – GUIDELINES FOR GEOTHERMAL ENERGY STATISTICS

Task Leader: Jonas Ketilsson, Orkustofnun, Iceland; Task closed in November 2017

Geothermal energy statistics, especially direct geothermal use statistics, have been a major point for discussion. The Working Group members decided to investigate the reporting of energy statistics. The aim was to provide an overview of the collection of geothermal energy statistics internationally by various agencies, offices, organizations and associations. The work was seeking to enable successful exchange and interpretation of energy statistics, to increase reliability of the data collected and to decrease fragmentation.

A report, entitled "International Collection of Geothermal Energy Statistics – Towards reducing fragmentation and improving consistency" was published by Orkustofnun in February 2015 (Ketilsson et al 2015). In the report, the datasets of IEA Geothermal, European Geothermal Energy Council (EGEC) and IGA are referred to as "industry statistics". The industry statistics are not consistent and differ from the "official statistics" provided by IEA, OECD, UNECE, EUROSTAT and the UN. The industry statistics are fragmented, although consistent within each respective association. With time, databases have been developed and questionnaires established by each association. In many cases, the data collection is similar, but often there are differences that result in the data not being interoperable. This means that when numbers are compared from one association to another, differences will be found which can be difficult if not impossible to resolve.

Based on the 2015 report, the task for the years 2016/17 was to adapt the IEA Geothermal statistical questionnaire and to develop guidelines for geothermal energy statistics. In May 2017, an international workshop was conducted in Florence (Italy) together with the International Geothermal Association (IGA) for this purpose. In 2017, the IEA Geothermal statistics questionnaire for direct use of geothermal energy was revised based on the results of the workshop. The work of revising the statistical questionnaire for heat pump applications and for developing guidelines on the collection of statistical data for geothermal heat pump applications is discussed under Task D in Section 5 below.

In November 2017, Task C was closed at the Executive Committee Meeting in Hanoi, Vietnam, after the revision of the statistical questionnaire for geothermal direct use had been completed.

5. TASK D – STATISTICS FOR GEOTHERMAL HEAT PUMP APPLICATIONS

5.1 Introduction

Task Leader: Yoonho Song, Korean Institute of Geoscience and Mineral Resources (KIGAM), Republic of Korea.

Different load factors are applicable to various types of direct utilization, such as heating a residential house, an office building, or a green house, but different load factors are not usually considered when estimating capacity factors of the different applications. In smaller applications, as opposed to large-scale district or other heating systems, flow rate monitoring is not often undertaken and the thermal loads for GSHPs are not determined. There is therefore significant uncertainty in the statistics for geothermal energy use in GSHPs, at both a national and global level. In addition, many countries do not separate the statistics for cooling with GSHPs from heating, which causes further uncertainty in the statistics. Consequently, Task D was initiated in 2013 to determine a method for estimating geothermal energy utilization with GSHPs as accurately as possible.

If the statistics and the standard load pattern of each application type could be determined, it might be possible to establish a recommended method, or develop a reference table for calculating GSHP statistics.

5.2 Work progress

Collecting statistical data on geothermal heat pump applications that incorporates the appropriate estimates of utilisation in a specific country is difficult, especially if the (seasonal) cooling mode is to be accounted for.

The overall objective of the Task was to seek to achieve consistent and comparable energy statistics for geothermal heat pump installations. At the IEA Geothermal international workshop in Florence (Italy) in 2017 on statistical data of geothermal direct use and heat pump applications, the challenges of collecting good GSHP data were highlighted. Suggested solutions were presented that resulted in the revision of the IEA Geothermal questionnaire for GSHP data.

The work of Task D was finished in 2018. The revised IEA Geothermal questionnaire was distributed in 2018 for collecting the data for the 2017 calendar year. Detailed information on the work and the recommendations can be found in Song et al. (2020).

6. TASK E – DESIGN CONFIGURATION AND ENGINEERING STANDARDS

Task Leader: Kasumi Yasukawa, JOGMEC, Japan

The Scope of this Task is to collect, characterize and exchange standard design and practice information between countries, with the goal of minimizing duplication. Issues to consider are quality, reliability of operation, long term efficiency, sustainability, and cost reduction achievable through standardized procedures. Examples of successful cooperation are in dissemination of the value of using experienced quality certificated ground source heat exchanger installers and the results from long-term monitoring of direct use installations. Task E also includes the collection and distribution of a list of national and international standards, engineering practice and other relevant documents. The list of design and engineering standards that have been assembled will be updated over the next year and uploaded to the IEA Geothermal website.

7. TASK F – COSTS OF GEOTHERMAL HEAT PUMP APPLICATIONS

Task Leader: Alfonso Garcia Gutierrez, CeMIEGeo and iiDEA Group, UNAM, Mexico

Geothermal Heat Pump costs are a key issue in most countries worldwide: not only in industrialised countries, but especially in emerging economies and developing countries. Knowledge about the costs of geothermal heat pump applications and the influencing factors are crucial for boosting deployment uptake of these systems. Cost data from the Working Group member countries and selected countries from Europe will be collected and analysed with the influencing factors being deduced. The results should allow conclusions to be drawn on how costs might be minimized while maintaining high quality standards.

The kick-off meeting took place in Daejeon (South Korea) in November 2018. A comprehensive study on life cycle costs of geothermal heat pump systems was conducted in Switzerland in 2019 (Figure 5). It is intended to incorporate the results of this study into the work of Task F and to make the report available as a case study.

Information about the costs will be collected from the Working Group member countries. The results will be analysed and interpreted. Based on the results, the influencing factors on costs will be identified and recommendations for action for the public sector will be given for efficient and sustainable cost minimisation. The outcome will be published in a report and the main outcomes and action recommendations summarized in a factsheet.

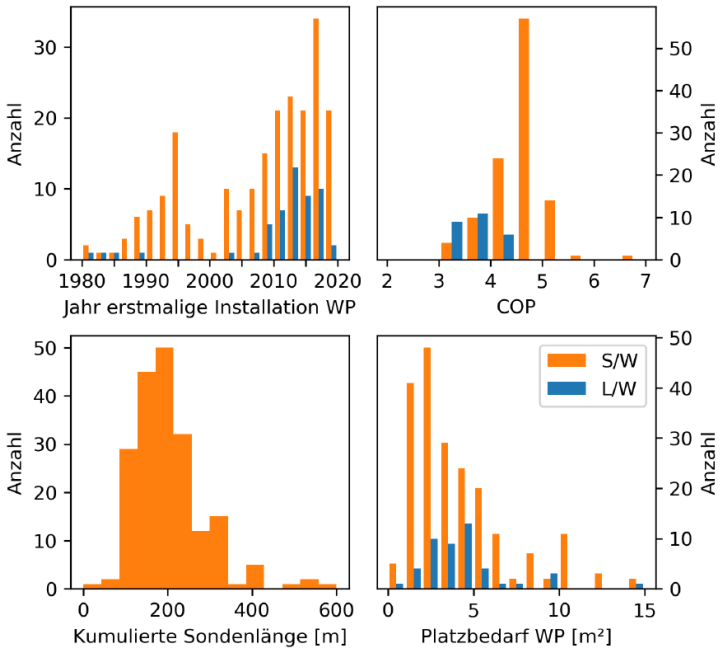

Figure 5: The Swiss study on the life cycle costs of geothermal ground source heat pump (GSHP) systems also included questions related to the year of installation (top left), the COP (top right), the cumulated length of the tubes (lower left) and the space needed by the installation (lower right graph). Orange = GSHP systems; blue = air-water system

CONCLUSION

The Direct Geothermal Use Working Group of the IEA Geothermal TCP is a collaborative network that keeps abreast of the latest developments in Direct Geothermal Use technology and disseminates through the IEA Geothermal web site material from workshops that the Working Group organizes. Join the group and visit the IEA Geothermal workshop web pages for up to date information.

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