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IEA Geothermal Annex VIII – Direct Use of Geothermal Energy

Katharina Link

Dr. Roland Wyss GmbH, Zürcherstrasse 105, 8500 Frauenfeld, Switzerland

link@rwgeo.ch

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ABSTRACT

Direct Use of Geothermal Energy is one of six Annexes of the International Energy Agency (IEA) Geothermal Implementing Agreement (Geothermal). Annex VIII Direct Use of Geothermal Energy was initiated in 2003.

Geothermal water has been used for millennia for various applications. During the last several decades, the use of geothermal energy for a range of heating purposes has become more and more important worldwide, and the number of applications has increased dramatically. Many applications, which require heat up to a specific temperature, can use geothermal energy, such as: heating buildings, raising plants in greenhouses, drying crops, fish farming, snow melting, bathing, therapeutic purposes, and also industrial processes. In recent times, cooling by geothermal energy has become more and more important.

In 2012, four of the existing five Tasks of Annex VIII were successfully completed. These were: Resource Characterization, Cost and Performance Database, Barrier and Opportunity Identification, and Publication and Geographical Presentation on the Web. The Task "Design Configuration and Engineering Standards" will be continued. In spring 2013, Annex VIII was completely restructured and the Annex members defined four new Tasks: A) New and Innovative Geothermal Direct Use Applications, B) Communication, C) Guidelines on Geothermal Energy Statistics, D) Guidelines on Statistics for Geothermal Heat Pump Applications and E) Design Configuration and Engineering Standards (continued). Current members of Annex VIII are the Canadian Geothermal Energy Association (CanGEA), France, Iceland, Japan, New Zealand, Republic of Korea, Switzerland, United Kingdom, and United States of America.

The new mission of Annex VIII is the provision of unbiased active and passive information, communication and knowledge transfer to mitigate the barriers and to enhance deployment. The main objectives are to cooperate and share knowledge and to increase the use of existing technologies, especially by boosting awareness. New participants are always welcome. The relevant industries, organizations and research laboratories of member and non-member countries interested in participating are encouraged to join the Annex.

Figure 1: Thermal spa in Lavey-les-Bains, Switzerland (Source: Les Bains de Lavey).

1. INTRODUCTION

Annex VIII – Direct Use of Geothermal Energy is part of the International Energy Agency – Geothermal Implementing Agreement (IEA Geothermal or IEA GIA). April 2015 sees the IEA Geothermal completing its 18th year of operation. IEA Geothermal, which operates under the auspices of the IEA, provides a formal, but flexible framework for international cooperation on a broad spectrum of contemporary geothermal research and technology topics. Direct collaboration among experts of member countries, industries and organizations increases capabilities; avoids duplication of efforts; improves cost effectiveness through information sharing and joint effort; provides easier access to key information, research results and technological resources; and more. Emphasis is placed on the collection, analysis and dissemination of impartial, authoritative data and information. IEA-Geothermal thereby contributes to the IEA's efforts to promote global sustainable energy policies that help ensure the provision of reliable, affordable, clean energy, while contributing to the mitigation of climate change. To achieve its goals and attain its 4th Term mission: to promote the sustainable utilization of geothermal energy worldwide by optimizing international collaboration to improve technologies, thereby

rendering exploitable the vast and widespread global geothermal resources, by facilitating knowledge transfer, by providing high quality information and by widely communicating geothermal energy's strategic, economic and environmental benefits, hence contributing to the mitigation of climate change, IEA Geothermal is currently pursuing activities in seven topics, or Annexes: I – Environmental Impacts of Geothermal Energy Development, III – Enhanced Geothermal Systems (EGS), VII – Advanced Geothermal Drilling and Logging Technologies, VIII – Direct Use of Geothermal Energy, X – Data Collection and Information, XI – Induced Seismicity, and XII – Deep Roots of Volcanic Geothermal Systems.

IEA Geothermal membership currently comprises: 14 countries (Australia, France, Germany, Iceland, Italy, Japan, Mexico, New Zealand, Norway, Republic of Korea, Spain, Switzerland, United Kingdom, United States), the European Commission, two industry members (Green Rock Energy, Ormat Technologies) and two national organizations (CanGEA [Canada] and Geothermal Group APPA [Spain]). The GIA continues to seek new members who can contribute to the achievement of its mission, increase its expertise, and extend its global geothermal collaboration.

For further details please see Mongillo and Bromley (2015) and/or visit the IEA Geothermal Web site: http://iea-gia.org/.

2. GEOTHERMAL DIRECT USE

Geothermal water has been used for millennia for various applications. The Romans, Chinese and Native Americans used geothermal water for bathing, cooking and for therapeutic purposes. In the Icelandic Sagas, written in the 12^{th}–13^{th} centuries A.D., reference to the use of geothermal water for bathing is frequently made (Gunnlaugsson, 2010). During the last several decades, the use of geothermal energy for a range of heating purposes has become more and more important worldwide, and the number of applications has increased dramatically. Many applications, which require heat up to a specific temperature, can use geothermal energy, such as: bathing (Figure 1), heating buildings, raising plants in greenhouses, drying crops, fish farming (Figure 2), snow melting, therapeutic purposes, and also industrial processes. In recent times, cooling by geothermal energy has become more and more important. In Switzerland even tunnel water is used seasonally alternating for heating or cooling.

Figure 2: Wairakei Prawn Farm using geothermal heat to grow fresh water prawns (waste geothermal water from Wairakei power in the background; photo from Ian Thain).

At the end of 2009, according to Lund et al. (2010), the estimated installed thermal capacity for direct utilization was 50,583 MW_{th}, which is almost a 79 % increase over the 2005 capacity, growing at a compound rate of 12.3% annually. The thermal energy used was 438,071 TJ/year (121,696 GWh/year), about a 60% increase over 2005, growing at a compound rate of 9.9% annually. The distribution of thermal energy used by category was approximately 49.0% for GSHP, 24.9% for bathing and swimming (including balneology) and 14.4% for space heating (of which 85% was for district heating). Several other smaller applications included: greenhouses and open ground heating (5.3%), industrial process heating (2.7%), aquaculture pond and raceway heating (2.6%), agricultural drying (0.4%), for snow melting and cooling (0.5%) and other uses (0.2%; for details see Lund et al., 2010).

Geothermal ground-source heat pumps (GSHP) represent the largest sector of geothermal direct use, with an annual growth of 10% in about 30 countries over the past 10 years (Lund et al., 2004). Their main advantage is that, in general, they use low temperatures of about 5 to 30°C, which are available in all countries of the world, and which therefore do not restrict the potential of GSHPs to selected geologically favorable regions.

3. ANNEX VIII –DIRECT USE OF GEOTHERMAL ENERGY

In 2012, four of the existing Tasks of Annex VIII were successfully completed. These were: Resource Characterization, Cost and Performance Database, Barrier and Opportunity Identification, and Publication and Geographical Presentation on the Web. The work results were presented in several publications and also at WGC2010 (e.g., Gunnlaugsson [2010], Muraoka et. al. [2010], Song et al. [2010]). In spring 2013, Annex VIII was completely restructured and the Annex members defined four new Tasks: A) New and Innovative Geothermal Direct Use Applications, B) Communication, C) Guidelines on Geothermal Energy Statistics, D) Guidelines on Statistics for Geothermal Heat Pump Applications, with E) Design Configuration and Engineering Standards continued. Current members of Annex VIII are the Canadian Geothermal Energy Association (CanGEA), France, Iceland, Japan, New Zealand, Republic of Korea, Switzerland, United Kingdom, and United States of America.

The new mission of Annex VIII is the provision of unbiased active (e.g. in workshops etc.) and passive (on the web site) information, communication and knowledge transfer to mitigate the barriers and to enhance deployment. The main objectives are to cooperate and share knowledge and to increase the use of existing technologies, especially by boosting awareness. New participants are always welcome.

3.1 Task A: New and Innovative Geothermal Direct Use Applications

Geothermal direct use technologies are in general mature and competitive. One current focus of research and development and in the industry is the development of innovative applications to, e.g., open up new possibilities of utilization, to enhance efficiency, and to reduce costs. Also the issues of "smart cities" and "anergy grids" have become more and more important. Regarding GSHPs, there is a trend towards larger systems, sometimes combined with other energy sources (e.g. solar thermal energy) and/or underground energy storage system. In the agricultural or industrial sector there is also a huge potential for new and innovative direct use applications. The first workshop of Task A, which took place in Fukushima, Japan in October 2014, concentrated on innovative applications with heat pumps, as this is of great relevance for all member countries. The Task Leader is Brian Carey from GNS Science, a research facility skilled in all kinds of geothermal direct use.

Figure 3: A Greenhouse in Korea heated by geothermal energy (photo from Yoonho Song).

3.2 Task B: Communication

Although the worldwide technical and economic potential of geothermal direct use applications is enormous, knowledge of it by the general public and among politicians and decision-makers is relatively low; though the level of awareness varies widely from country to country. In some countries like many in Europe, the potential of GSHP systems for heating residential houses is very well known, but the fact that there are many other applications is less known. Even in a country like New Zealand, which is characterized by an obviously huge potential, the many possibilities of geothermal direct use are generally poorly known compared to power production. Clearly, for boosting geothermal direct use and to enhance deployment, "communication" is essential. In the first phase, the available information material from member countries and cooperating organizations will be collected. The exchange of experiences is fundamental to identify barriers and opportunities, and to optimize communication activities. Annex VIII members decided in 2013 to financially support a CanGEA geothermal direct use project. This project delivered a report on direct use technologies, a how-to guide on evaluating direct use opportunities, and several factsheets and workshop materials. This material, the lessons learned from the workshops recently held in Canada, and the material from other countries and organizations, will help to optimize communication in other countries. The Task Leader is Alison Thompson from CanGEA.

3.3 Task C: Guidelines on Geothermal Energy Statistics

Geothermal energy statistics, especially the geothermal direct use statistics, have been a major point for discussion.

A report is being prepared by Orkustofnun (Iceland) on a comparison of energy statistics reporting. The aim of the report is to give an overview of international collection of geothermal energy statistics by various international agencies, offices, organizations and associations, to enable successful exchange and interpretation of shared energy statistics, increase reliability and decrease fragmentation.

The report is based on highlighting the differences in data submission to various statistics agencies by comparing requirements for data submission and actual data. This is done to enable analysis for comparability, transparency, and flexibility, and to provide a possible common ground with the purpose of supporting more concerted data reporting by and to the geothermal community. Orkustofnun and the other Annex members also share their experiences of submitting data to different agencies.

In the report, the datasets of IEA Geothermal, European Geothermal Energy Council (EGEC) and IGA will be referred to as "industry statistics". However the industry statistics among these multinational associations is not coherent from one to the other, and are also different from the "official statistics" (IEA, OECD, UNECE, EUROSTAT and the UN statistics). The fact is that the industry statistics are quite fragmented, although consistent within each respective association. With time, databases have been developed and special annual questionnaires have been established within each association, and which make up what is here referred to as industry statistics. In some cases, the data collection is similar, but often there are important differences that result in the data not being interoperable across associations, so when numbers are compared from one to the other, drastic differences can be found which can be difficult to resolve.

The draft report will be reviewed by relevant organizations involved in geothermal energy statistics. The first meeting of Task C with the IEA Statistics group took place in spring 2014.

Orkustofnun is one of the few institutions in the world that, in the past, has accumulated, interpreted and disseminated both the official statistics and the industry statistics on geothermal data, and hence has a broad overview of the various data being collected by different organizations.

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Task Leader Jónas Ketilsson, from Orkustofnun, is responsible for this project, with Tryggvi Sigurðsson, also from Orkustofnun, the main author of the report. This work is conducted within the scope of the Geothermal ERA NET supported by the European Commission.

3.4 Task D: Guidelines on Statistics for Geothermal Heat Pump Applications

Different load factors among the various types of direct utilization, such as heating residential houses, office buildings, and green houses, are often not considered when estimating capacity factors. In contrast to large-scale district heating systems, it is almost impossible to monitor flow rate or thermal load for GHPs, except in applications for large office buildings. Therefore, there is significant uncertainty in the statistics for geothermal energy use with GHPs, both on national and world levels. In order to determine a method for estimating geothermal energy utilization with GHPs as accurately as possible, Annex VIII initiated a collaborative task (Task D) starting with the comparison of methods used in computing the national statistics of several countries. Each country has its own approach for estimating thermal usage, mostly reflecting major utilization types and climate condition. However, a recommended method may be established, or reference table developed, if the statistics for each application type and the standard load pattern of each type are made available. Many countries do not separate cooling with GHPs from heating, which causes another uncertainty in the statistics.

The main objective of Task D is to develop a suitable form of statistical table to be adopted both for national and for world statistics. The table will include all types of GHP utilization, and consider cooling as well as heating. This will hopefully lead to comparable statistical data, and less confusion. The GHP statistical work is part of the Annex VIII development of guidelines for geothermal direct use statistics. The Task Leader is Yoonho Song, from the Korea Institute of Geoscience and Mineral Resources (KIGAM), Republic of Korea.

For further detail please see Song et al. (2015), or visit our Task D on the IEA Geothermal website.

3.5 Task E: Design Configuration and Engineering Standards

The Scope of Task E is to collect, characterize and exchange standardized designs and practices for various applications, with the goal of minimizing the engineering related to various applications. The main concerns are quality, reliability of operation, long term efficiency and sustainability, and cost reduction through standardized procedures. Examples of successful co-operation are the dissemination of experience with quality certificate systems for ground-source heat exchangers and of results from long-term monitoring of direct-use installations.

Task E also includes the collection and re-distribution of a list of national and international standards, engineering practices and other relevant documents. This list is made available to the GIA members through the Annex VIII section of the IEA Geothermal website. Due to the importance of such standards, the Annex members decided in 2013 to continue the Task and to update the list continuously. The actual version – May 2014 - contains about 40 national and 7 international documents. Most of the documents refer to near-surface systems from countries where there is already a large market. They originate mainly from Germany, Austria, Switzerland, France, and Sweden. The Task Leader is Rudolf Minder, Minder Energy Consulting, Switzerland.

3. CONCLUSION AND OUTLOOK

Annex VIII – Direct Use of Geothermal Energy, as part of IEA Geothermal, provides an international platform for cooperation and knowledge transfer. Annex VIII members are regularly realigning their goals to the current needs of their geothermal direct use communities and industries. The recent Tasks and their outputs are of importance for most of the countries in the world. The Annex helps to provide unbiased active and passive information, communication and knowledge transfer to mitigate the barriers and to enhance deployment of geothermal direct use applications. New participants are always welcome.

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