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IEA GIA Annex VIII – Direct Use of Geothermal Energy

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ABSTRACT

Direct use of geothermal energy is the topic of Annex VIII of the IEA Geothermal Implementing Agreement (IEA GIA). Today geothermal water is used for many applications that require heat such as heating buildings, either individually or whole towns, raising plants in greenhouses, drying crops, heating water at fish farms, and several industrial processes. The purpose of this Annex was to promote further direct use of geothermal water and to learn from each other the best practice.

Work has started in four tasks. The first one is dealing with resource characterization and the aim is to define the available geothermal resources in the various participating countries and how it affects the utilization of geothermal energy. Another task focuses on collecting, analyzing and disseminating the characteristic cost and performance data for installations with emphasis on establishing a baseline and then validating the improvements from innovative components and better designs. The third task is related to design configuration and engineering standards with the goal of minimizing the engineering related to various applications. The forth task deals with geographical presentation of information finding suitable form to present data on direct use of geothermal water geographically on the web. Six geothermal countries participate in this annex, Iceland, Switzerland, Japan, New Zealand, Korea and USA. Two more countries will be joining soon and others are welcome.

1. INTRODUCTION

The IEA began its involvement in geothermal energy in 1978, with the launching of two 3-year long studies which were completed in 1981. Then there was a break in the activity until 1995. Then the IEA Implementing Agreement for a Cooperative Programme on Geothermal Research and Technology, or Geothermal Implementing Agreement (GIA), was officially established in 1997.

The GIA provides a framework for international cooperation in geothermal research and development. It promotes cooperation between countries, industries and scientists for exploration and development of geothermal resources. Today 12 countries and the European Commission (EC) participate in IEA-GIA. The member countries are Australia, France, Germany, Iceland, Italy, Japan, Mexico, New Zealand, the Republic of Korea, Spain, Switzerland and the United States.

The GIA's programme operates through participation in collaborative projects within Annexes. Nine Annexes have been formulated and at present work is in progress in four of the Annexes. These are: Annex I. Environmental Impacts of Geothermal Development, which has also recently included sustainability. Annex III. Enhanced Geothermal Systems. Annex VII. Advanced Geothermal Drilling Techniques and Annex VIII. Direct Use of Geothermal Energy.

2. DIRECT USE OF GEOTHERMAL ENERGY

Direct use of geothermal heat and water dates back thousands of years and it continues today. The Romans, Chinese and Native Americans used geothermal water for bathing, cooking and for therapeutic purposes. In the Icelandic Sagas, written in the 12th-13th century A.D., reference to the use of geothermal water for bathing is frequently made. The bath of the famous historian and saga writer Snorri Sturluson (1178-1241) in Reykholt in W-Iceland has been preserved (Fig. 1). A recent archaeological excavation at that site suggests that space heating also existed there in the 13th century (Sveinbjarnardottir 2005). When Icelanders adopted Christianity as the formal religion of Iceland in the year 1000 A.D. they refused to be baptized in cold water and instead were baptized in warm geothermal water.

Figure 1: Snorralaug in W-Iceland, an historical thermal pool from 13th century

Today geothermal water is used for many different applications depending on the temperature of the water.

The Lindal diagram (Fig.2.) is widely used in the geothermal community to depict temperature as a guideline of direct applications. The diagram shows several current and potential uses of geothermal energy, ranging from fish farming and soil heating at low temperatures, through space heating and drying at intermediate temperatures, to electric power generation and industrial processing at high temperatures.

The main types of direct applications of geothermal energy are space heating 52% (thereof 32% using heat pumps), bathing and swimming (including balneology) 30%, horticulture (greenhouses and soil heating) 8%, industry 4%, and aquaculture (mainly fish farming) 4% (Lund et al., 2005). The use of geothermal heat pumps has increased considerably during last decade. This is due to the ability of geothermal heat pumps to utilize groundwater or ground-coupled temperatures anywhere in the world. Many countries which are not specially known for geothermal activity have been ranking high in geothermal direct utilization due to the use of geothermal heat pumps (Lund et al. 2005). The ground source heat pumps are using the earth as a heat source for heating or as a heat sink for cooling, depending on the season. For this reason all countries are able to use the heat of the earth for heating and/or cooling.

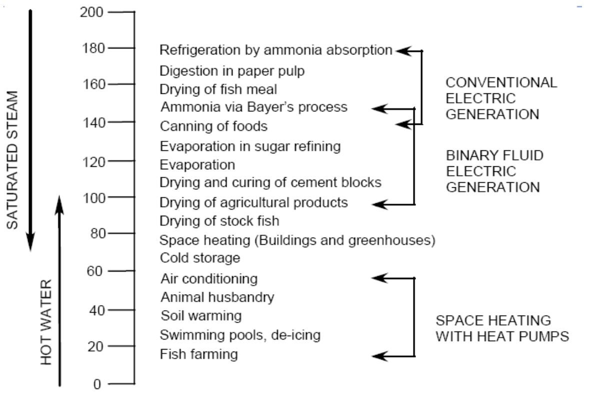

Figure 2: The Lindal diagram showing the potential use of geothermal energy in relation to the temperature of the fluid

3. ANNEX VIII – DIRECT USE OF GEOTHERMAL ENERGY

The main purpose of the Annex on Direct use of geothermal energy was to promote further utilization of geothermal energy for direct applications. The Annex was initiated in 2003 when the agreement entered into force. The participate countries in this Annex are: Iceland, Japan, Korea, New-Zealand, Switzerland and the USA. Other countries like Spain and France have shown interest to participate.

The main objectives of Annex VIII are to:

- Define and characterize the direct use applications for geothermal energy, with emphasis on defining barriers to widespread application.
- Identify and promote opportunities for new and innovative applications.
- Define and initiate research to remove barriers, to enhance economics and to promote implementation.
- Test and standardize equipment.
- Develop engineering standards.
- Define suitable forms to present data geographically on the web.

The hope is that the primary results of Annex will be improvements in systems and equipment, reduction in cost of delivered heat and an increase in the number of direct use applications. Cooperation between the countries and increased exchange of technical and scientific information within the field of direct use of geothermal energy will be beneficial for all partners and hopefully also others.

Specifically, the results of this Annex will include:

- Development of an international database on direct use applications by each of the participating countries. The database will be based on standardized instruments and reporting techniques.
- Reports on state-of-the-art in direct use of geothermal energy, including areas needing improvement.
- Cooperative research to accomplish the needed improvements.
- Participant reports on the status of research and development in new and improved technology that shall be presented in appropriate journals and meetings.

To achieve the objectives the work was divided into specific tasks and a task leader appointed for each task.

3.1 Task A- Resource Characterization

The aim of this task is to define the available geothermal resources in the various participating countries.

First evaluation of data on temperature of the geothermal manifestations and chemistry from Korea, Iceland, Japan and USA has been made. The results show that differences in chemistry are related to the different rock types and geological environments. Data from New Zealand, Switzerland and the USA has now been included and the result is presented at this conference (Muraoka et al. 2010). The next step under this task is to define how resource characteristics area are affecting direct use of the resources. A paper derived from this work on discharge temperature of geothermal water in Japan has been published (Muraoka et al. 2006).

3.2 Task B- Cost and Performance Database

This task focuses on collecting, analyzing and disseminating the characteristic cost and performance data for installations in participating countries, with emphasis on establishing a baseline and then validating the improvements from innovative components and better designs.

To be able to collect comparable data from the countries participating in this Annex a questionnaire was designed. The first evaluation of the Questionnaire for Direct Use of Geothermal Energy with data from Japan, Korea, New Zealand, USA, Iceland and Switzerland was done. The questionnaire needed to be revised especially to obtain realistic information regarding cost and performance. The result of the revised compilation is given in paper at this conference (Song et al. 2010).

3.3 Task C- Barrier and Opportunity Identification

Based on Tasks A and B, this task will define the barriers which must be overcome to gain widespread use of geothermal heat for various applications. The research activities necessary to take advantage of these opportunities will also be defined and initiated. The first part of this task has been operated in parallel with Task B through the Questionnaire

3.4 Task D- Equipment Performance Validation

The aim of this task is define and test critical and innovative equipment; such as submersible and line shaft pumps, compact heat exchangers, down-hole heat exchangers, non-metallic piping, heat pumps and other equipment to characterize performance for various applications and for various geothermal brines. Work in this task has not yet begun.

3.5 Task E- Design Configuration and Engineering Standards

The work here is to develop and characterize standardized designs for various applications, with the goal of minimizing the engineering related to various applications. Develop engineering standards for designs, equipment and controls.

The first step is to collect available information and compile a list of references regarding published material which are available regardless of language. The plan is to have the list available at the Web.

3.6 Task F- Publication and Geographical Presentation on the Web

The aim of this task is to define a suitable form to present data on direct use of geothermal water geographically on the web. Tests have been made to present data in files which can be opened on the web through Google Earth. This method looks promising and further work will be conducted to develop the method further. Example of this is Fig. 3 showing location of all geothermal swimming pools in Iceland and Fig. 4 shows example of detailed information of the main swimming pool in Reykjavík.

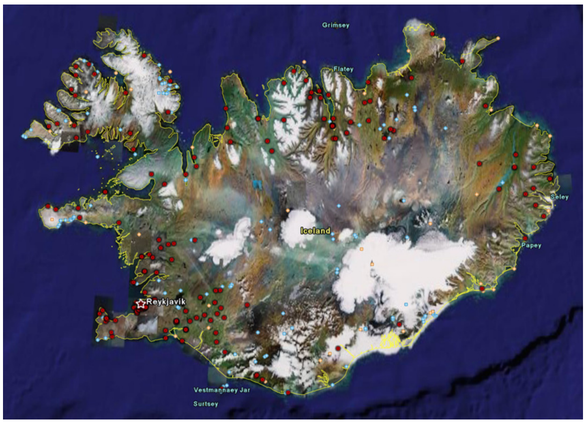

Figure 3: Google-Earth map showing location of geothermal swimming pools in Iceland

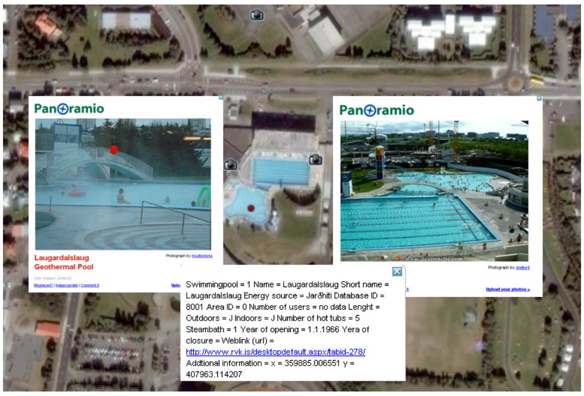

Figure 4: Detail information for the Laugardalslaug swimming pool in Reykjavík

In Switzerland the BDFGeotherm database compiled in 2007 on ACCESS code has been modified and improved to be available by using Google-Earth (Sonney et al. 2008). General information about water use, geology, flow rate, temperature and mineralization are given in small window by clicking on the desired pinpoint. Fig 5 shows the geographical location of data points on Google-Earth map of Switzerland.

CONCLUSION

The cooperative work within the Annex VIII of the IEA-GIA framework has connected personnel from nations which already have been using geothermal heat directly for decades and countries which are starting to develop this energy source. It is our hope that this work will promote further direct use of geothermal heat and distribute knowledge and practice between participants.

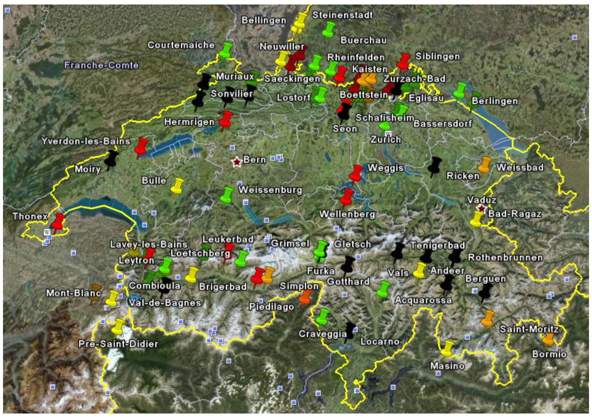

Figure 5: Google-Earth database for Switzerland

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