Interview 7 - Dr. Claus Ditlefsen, Denmark

Profile
Name: Claus Ditlefsen
Age: 59
Education: PhD in geology
Activity: Senior Consultant
Lives in Aarhus
Experience in the thermogeology sector: 7 years
Geographical working area: Denmark

Thermogeology in Denmark

Mr. Ditlefsen works for the Geological Survey of Denmark and Greenland (GEUS). He has about thirty years of professional experience in glacial geology and mapping of groundwater and mineral resources. He has recently been project manager on a three year inter-institutional project investigating closed-loop boreholes for energy extraction for the Danish Ministry of Energy, Utilities and Climate and is currently managing a similar project aimed at mapping the possibilities for geological heat storage in Denmark.

What are the main features of the Shallow Geothermal Energy (SGE) in Denmark?

In Denmark, the shallow geology is dominated by soft sediments and characterized by a variable depth to the groundwater table. The sediments consist of glacial sand and clay deposits of variable thickness: to the west they are found on top of Miocene fluvio-deltaic sands and marine silts and muds, while to the east and northeast the glacial deposits overlay relatively soft limestones from the Danien and Cretaceous.
The energy extraction from shallow installations depends on the thermal properties of the sediments surrounding the heat collectors. However few investigations of thermal properties of Danish sediments have been carried out so far. Thermal conductivity values for different rock and sediment types published by e.g. VDI (standards by the Association of German Engineers) show large variations for sediments relevant in a shallow geological context.

How is SGE managed under the regulation point of view?

In general, ground source heating and cooling is regulated pursuant to the Danish environmental protection act, while single permissions are issued by the municipalities, who must include groundwater interests in their considerations.
Concerning the closed-loop systems, for borehole heat exchangers the regulation provides the municipalities with a possibility to increase the required safety distance to water wells and to stipulate special conditions in the permit regarding e.g. the construction of the installation, in order to protect a water catchment against contamination. Some municipalities reject applications for borehole heat exchangers if there is uncertainty regarding a possible content of anti-corrosives in the brine. Others are generally very reluctant to issue permits for borehole heat exchangers because of general considerations regarding the groundwater protection and drinking water quality, or more specifically because they fear spilling of circulation brines with chemical substances in water protection areas.

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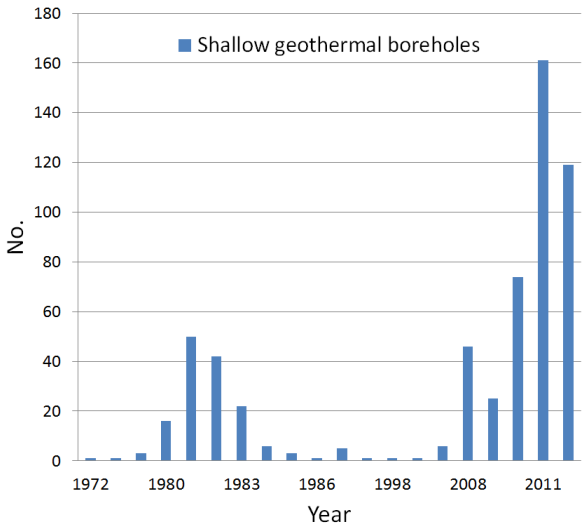
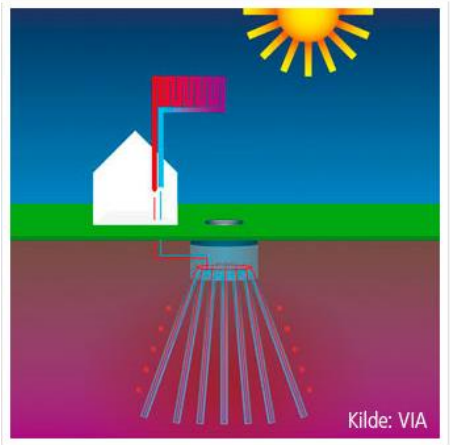
The regulation of groundwater based open-loop systems is rather strict, since almost all drinking water comes from groundwater reservoirs. Naturally, there is great concern to protect these resources, thus specific investigations and documentation - regarding the geology and hydrogeology of the aquifer as well as the hydraulic and hydrothermal properties and the chemical and microbiological conditions - are required. Furthermore, numerical modelling must prove that the temperature of the groundwater in existing catchments will not increase more than 0.5 degree Celsius. For "areas of specific drinking water interests" it is required, that the groundwater resource must be exploitable again 10 years after the closing of the installation, which should also be documented by numerical modelling. These requirements are rather costly and imply that only larger installations are economically feasible, so this issue represents an obstacle to a further diffusion of this technology.

What is the general state of development of SGE?

Despite a large potential, the application of shallow geothermal energy in Denmark is relatively limited compared to e.g. Sweden or Germany. In 2013 the total number of ground source heat pumps in Denmark was around 27.000, and it is currently increasing with around 5.000 per year. Installations include horizontal collectors, borehole heat exchangers (vertical or inclined), and groundwater based open-loop systems.
One peculiarity is that most of the existing installations are horizontal collectors, since they can ~~be~~ easily be installed in the soft sediments present at the surface in almost all of Denmark and permits are relatively easy to get. Furthermore, there are more contractors offering horizontal loops than drillers (with a drilling permit) offering boreholes, so that also the prize is lower for a horizontal plant. Only a few hundreds are borehole heat exchangers and some tens are groundwater well open-loop systems. During the last couple of years the number of borehole heat exchangers has increased significantly with more than a hundred boreholes constructed each year. In this domain, some contractors offer a solution with a circular array of inclined boreholes all connected at the top (known as a "sun well"). This gives some advantages in relation to space and surface tube. Sometimes there are solar collectors taking up heat from the roof to be stored in the ground connected to the borehole array.



Number of shallow geothermal boreholes reported to the national borehole database Jupiter.



Scheme of a "sun well".

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Some open-loop systems were installed in the eighties for house heating, later installations were primarily for industrial cooling and now large systems are applied with alternating operation (heating in winter and cooling in summer). One local district heating company has established a borehole heat storage (48 boreholes, 45 m deep) in combination with a solar heat installation, while another has established a pit storage also combined with solar energy.
In many cities and towns in Denmark heat is supplied from central district heating companies. In their supply areas house owners are often not allowed to install individual ground source plants. However more and more district heating companies are trying to include ground source energy in their heating grid. This calls for new innovative technical solutions.

Are there particular best practices examples (or projects aimed to foster thermogeology)?

A three year project supported by the Danish Energy Agency was conducted from 2011 to 2014. The purpose was to pave the way for a wider use of borehole heat exchangers by acquisition and dissemination of know-how and developing tools and best practices for the design and installation of systems. The results serves as guideline for Danish planners of shallow geothermal installations. Results from the project can be seen on www.geoenergi.org

Installation of borehole heat exchanger at test site, photo Inga Sørensen VIA UC.

At the moment (from 2017 to 2019), GEUS is involved in a related project concerning the possibilities to store heat in shallow and semi deep formations. The project aims to explore the possibilities to store and retrieve heat from relevant geological formations in Denmark to be used at larger and smaller district heating plants etc. when needed. Selected geological settings will be mapped and the potential, risks and investment costs of different types of storage facilities and geometries will be examined.

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