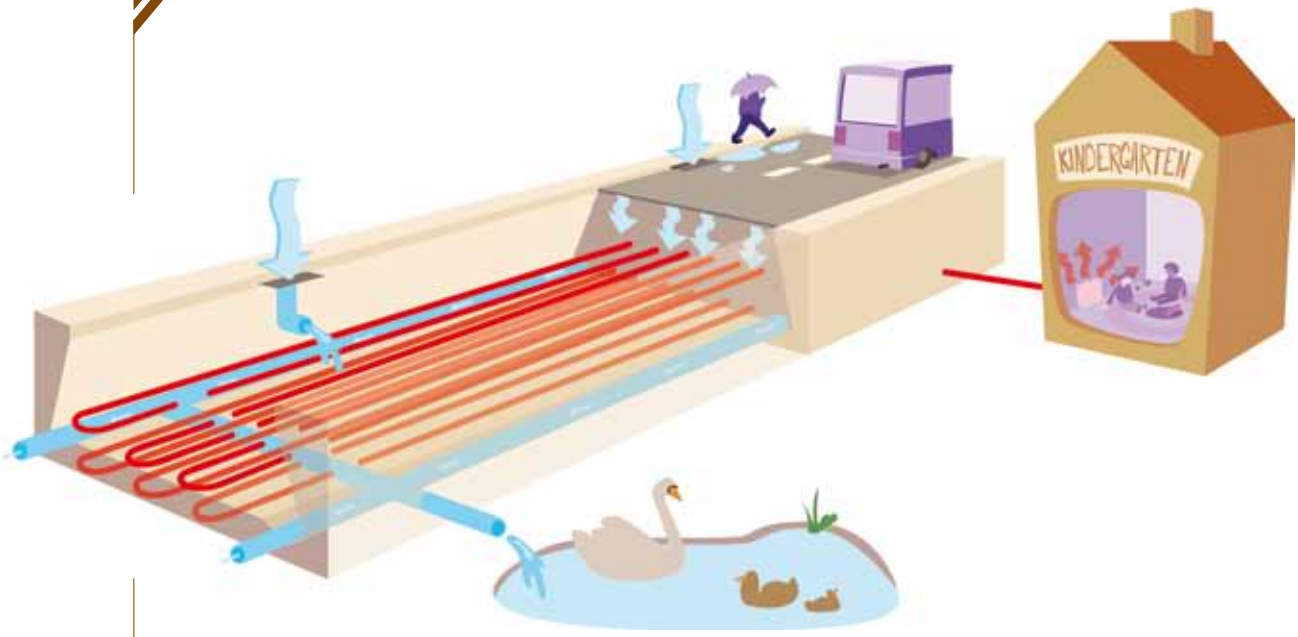

Shallow geothermal energy from a Danish standpoint

TEXT: Henrik Bjørn

Shallow geothermal energy is sadly undeveloped in Denmark compared to the neighbouring countries. However, the general need for transformation to sustainable energy sources combined with what appears to be an increased willingness from the authorities to actively support ground source heating, may change that. Also, hybrid solutions where ground source heat exchangers are incorporated in climate adaption measurements can further support the technology and help reduce construction costs.

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Background

Seen from a European perspective, Denmark is in its formative years regarding ground source heating. Our experience in horizontal ground source heating systems dates back to the early 1980s. Interest in these systems dropped in the late 1980s and through the 1990s as some of the early systems turned out to be incorrectly dimensioned and the cost for alternative solutions generally dropped. However, in the past 10 years the technology has been revived, partly because of increased focus on renewable energy, better heat pumps and the introduction of borehole heat exchangers (BHE). It is estimated that the number of ground source heat pumps (GSHP) in Denmark is around 30.000. The vast majority of these are connected to horizontal heat exchangers. In comparison, the number of air source heat pumps is estimated to be around 100.000 and this type constitute the majority of new installations. Therefore, when we look towards our neighbours in Germany, The Netherlands, UK and Sweden, Denmark has a lot of catching up to do.

The Danish Challenge

There are several reasons for the low spread of GSHP in the Danish market. One of the main reasons is our geology. Practically all our surface geology is unconsolidated sediments. The sediments generally have a low thermal conductivity but they are also much slower to drill, than hard rock or limestone. This increases the cost.

Another factor is that 64 % of all Danish households are supplied by district heating (DH). In many ways, this is positive and for households in a DH area, this will generally be the cheapest form of heating. But it reduces the potential GSHP market.

A third factor, that causes a challenge for construction of BHE is the fact that the entire Danish water supply is groundwater based. Since the waterworks are required to supply drinking water that is solely treated with simple sand filtration, the utilities and authorities keep a very sharp eye on any activity, such as drilling, that may affect the groundwater quality. It makes

sense. Clean water is a very valuable resource. Therefore in some areas it is difficult to obtain a drilling permit for BHEs.

The situation today

The groundwater, that in some areas is a barrier to ground source heating and cooling, is the basis for sustainable heating and in particular cooling in other areas. An estimated 30-40 ATES systems are in operation in Denmark today. They are primarily used for cooling in larger industrial facilities, offices and institutions.

Closed loop systems are currently used primarily for heating only. Since about 2010 there has been a relatively steady production of about 1.000 boreholes in total that are registered in the national database as BHE. Most of these are smaller systems for private households.

DH plants in Denmark also utilize the technology. There are examples of DH plants with open loop systems for groundwater extraction from both shallow and intermediate depth. VIA University College is partner in a project testing a BTES for storage of solar heat for a DH. Another project we are involved in is analyzing the possibilities of storing industrial waste heat for DH at 800 to 1.200 meters depth.

A new development

Previously we have experienced that authorities may act as a barrier to vertical ground source heating systems. This is not caused by a resistance towards the technology as such, but perhaps primarily a lack of knowledge. The questions from the authorities are typical. What is the risk? What about the antifreeze? Will the borehole be sealed properly? And, when in doubt, it's better to be safe than sorry.

In the last couple of years, there has been a change. At least three municipalities have decided that parcelling out new areas for housing should include ground source heating. One municipality sold 19 new parcels including a 100 meter deep borehole pr. parcel for heating and cooling purposes. Another constructed small, low-temperature ground sourced district heating for 45 new houses with two central heat pumps. A third drilled six boreholes and constructed a brine net to supply 15 new houses with individual heat pumps. Presently VIA University College is doing a feasibility study for using thermo-active foundation piles or »energy-piles« for heating and cooling in a planned development area with up to 3000 houses. The local municipality and the local DH plant are among the partners in the project.

The fact that the authorities now are seeing ground source heating as a viable option in their planning of new residential areas may change the situation on the ground source heating market dramatically. New, highly insulated houses have a heat surplus for a large part of the year, even in a relatively cold country like Denmark. A borehole that supplies the heating during the winter can also be used for free cooling during the summer. This is where BHEs perform significantly better than horizontal systems, or air source heat pumps or even DH.

A more holistic approach

In order to mitigate climate changes in Denmark, many sustainable urban drainage systems are being constructed. A small part of a large ongoing LifeIP project is to test a so-called »Climate Road« that basically is a road constructed with permeable asphalt and a roadbed of stable and highly porous gravel. Rainwater seeps down and is temporarily stored in the roadbed before it is led slowly to the recipient. Based on experiments with fascines and ground heat exchangers we suggested combining the road with a horizontal heat exchanger. By a stroke of luck, a kindergarten next door already had a GSHP, where energy produced from the road is put to good use.

The climate road and kindergarten is a special situation, which will be difficult to replicate elsewhere. However, applying ground source heating, not on its own, but in a combination with other functions, technologies and sustainable energy sources is perhaps the way forward in Denmark. ◆

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