WHY GO GEOTHERMAL? BENEFITS OF INTEGRATING GROUNDCOUPLED HEAT PUMP IN HOSPITAL

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1. Introduction

The Flemish health sector is characterized by a high, constant and simultaneousness heating/cooling load. Furthermore the energy costs take an increasing part of the operational costs. Cooling of patient rooms becomes more and more important in this sector. Since recent years the demand for cooling has tremendously increased due to the higher internal heat production of medical equipment and comfort requirements. Therefore the health sector is continuously looking for energy-efficient techniques for cooling/heating production/distribution. In the last 5 years, TERRA ENERGY carried out several case studies in the health sector on ground-source heat pumps (GSHP) with vertical ground heat exchangers or borehole heat exchangers (BHE).

This paper will start with a short introduction of the shallow geothermal technologies and heat pumps. Aspects as ATES (aquifer thermal energy storage), BTES (borehole thermal energy storage), CTES (cavern thermal energy storage) and EP (Energy Piles) will be explained. These technologies are ideally suited for hospitals but they require some technical and geological preconditions before they can be considered.

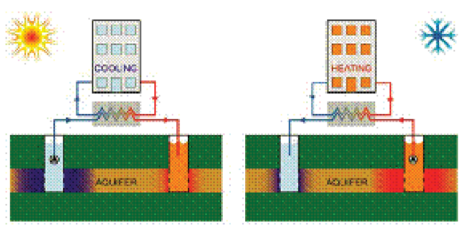
Secondly we will go in detail on the advantages of the technology. The implementation of such a ground coupled heat pump allows you to save a decent percentage on the energy bill. But besides this primary and most obvious advantage, there are some other benefits, maybe not always or everywhere of that great importance, but certainly worth mentioning!
In the presentation, some case studies will be presented, with their technical, economical and ecological impact! These examples of good practice will give the audience a thorough idea of how the implementation in real projects looks like, how feasible (technical, economical) it was, what was learned from these projects and especially why the management of the hospital itself chose to integrate this ground source heat pump!

2. Shallow geothermal technologies

Since 1995, VITO has developed expertise in deep as well as shallow geothermal technologies and applications. Based on this experience, Terra Energy was founded in 2009 as a spin-off company of VITO, offering all kinds of shallow geothermal energy solutions in various applications. The deep geothermal technology can be seen as an experimental technology and will be explored by VITO in order to found a new spin-off in the following years.
These shallow geothermal technologies can be seen as common, non-experimental, technologies:

2.1 Aquifer Thermal Energy Storage or ATES

ATES uses a natural water saturated and permeable underground layer as a storage medium. The transfer of thermal energy is realized by extracting groundwater from the aquifer and by re-injecting it at modified temperature level at a separate well nearby. Low temperature heating and high temperature cooling with groundwater fits very well with new concepts of low exergy heating and cooling systems. Savings on electricity bills for chillers are approx. 75%, and in many cases, the payback time for additional investments is shorter than five years. A major condition for the application of this technology is the availability of a suitable geologic formation. Obviously in the annual average the temperature swing has to be balanced.



2.2 Borehole Thermal Energy Storage or BTES

With BTES, vertical heat exchangers are inserted into the underground, which ensure the transfer of thermal energy towards and from the ground (clay, sand, rock, etc.). The basic system is used in combination with heat pumps, where the ground heat exchanger extracts low-temperature heat from the soil. In summer time, the system can be reversed for free natural cooling with stored cold from the underground. Other applications are about the storage of waste or solar heat in summer for space heating of houses or offices in winter. The vertical heat exchangers can also be integrated in foundation piles (necessary for building stability) to be used as underground energy piles.

3. Benefits

Let's start with the energetic advantages of the technology. Thanks to its renewable character, an Underground Thermal Energy Storage or UTES guarantees substantial energy savings (50 – 90%). Taken into account the more-investment, a realistic simple payback times (between 5 – 10 years) can be obtained. Directly linked to the energy savings, a significant greenhouse gas emission reduction will be reached, compared to a standard energy production unit. The use of primary energy (gas, electricity) will make running cost of the hospital less dependent on the rising prices for fossil fuels. These are all obvious advantages that almost any standard renewable energy solution will provide (eg. PV, wind, biomass…)
But especially compared to these other renewable energy sources, (shallow) geothermal energy has some other important advantages, that make it stand out of the rest:
Geothermal energy focuses on production of heating and cooling, not on green electricity. There where solar, wind and biomass focus on the production of green, renewable electricity! Don't forget that about 50 % of the total energy demand of the European Union is used for heating and cooling applications.
The underground stays available at all times, even on clouded and windless moments. This means that geothermal energy is always there, constant and continuous, in comparison to solar energy or wind energy.
Another big advantage is the opportunity to cool at very high efficiencies (8 times better than a traditional chiller). An ATES or BTES system guarantees an efficiency of 20 or more (COP or Coefficient of Performance) for free cooling purposes. There are not so many possibilities to cool in a green way, geothermal energy can be seen as the most obvious and easy-to-apply green cooling solution. This green cooling also gives the opportunity to improve the comfort in patient rooms (low temperature heating and high temperature cooling) at lower exploitation costs than a traditional energy production system, even if this only focuses on heating! So the comfort is improved at lower exploitation cost than a conventional energy production unit.
Second example, the installation of an electrical-driven heat pump prepares our hospitals for the future energy scene and smart grids. Renewable 'green' energy technologies (photovoltaic, wind, biomass) mainly focus on green electricity, while traditionally, our buildings and hospitals are practically all heated by oil- or gas-fired boilers. The integration by a(n) (electrical driven) heat pump matches this supply of green electricity and guarantees the energy supply in the future. The future energy supply will focus on decentral energy production by wind mills, large- and small-scale photovoltaic systems and, most important, with as less fossil fuels as possible. So that means that in the future, we will have to step away from the traditional decentralized energy production systems (every house its own gas-fired boiler). Making a switch from a gas-fired boiler to a heat pump, which is electrical driven, raises the demand of electrical energy for the hospital, but reduces the fossil fuel demand (gas or oil). This switch allows to use 'green' electricity to drive the heat pumps and thereby enlarge the renewable energy fraction that's been used in the building.
These advantages will be explained on a practical way in our presentation.

4. Conclusions

This paper gives a look at the technical, economical and environmental benefits of the application of BHEs and GSHPs in two Belgian hospitals. An important factor discussed is the reliable calculation of the heating and cooling energy demand. An overestimation of the energy demand could damage the benefits of GSHPs by severely increasing payback period. This effect is more enhanced than with conventional installations (gas-fired boilers, compression chillers), where overdimensioning is not rare. The economic analysis showed that with a wisely designed system, a reasonable pay-back period can be achieved and CO2 emissions can be saved compared to classic primary energy consuming technologies.

BHEs and GSHPs are a promising technique for Belgian hospitals. The recent interest in renewable energies is expected to further enhances their application. In general one may conclude that application of BHEs and GSHPs in Belgian hospitals becomes a promising and growing market.

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