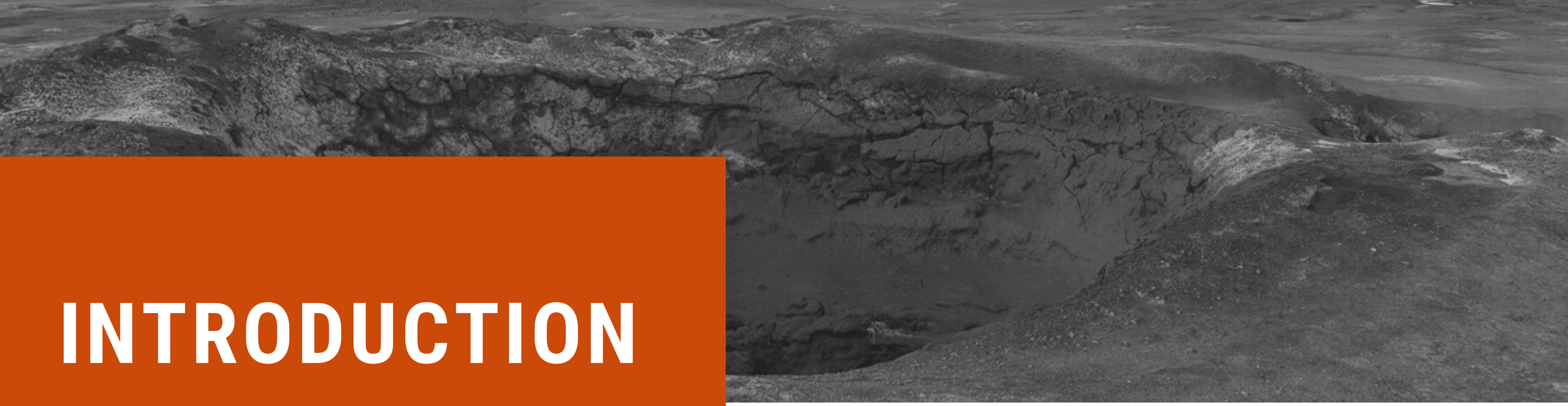
NORDIC KNOW-HOW 2020

NCSH
Nordic Center for Sustainable Healthcare

BEST PRACTICES OF
SUSTAINABLE HEALTHCARE
IN THE NORDICS

**REPORT SERIES BY
NORDIC CENTER FOR SUSTAINABLE HEALTHCARE**

#2 GEOTHERMAL ENERGY



INTRODUCTION

Climate change is one of the greatest environmental challenges faced by societies today and action must be taken from a wide range of sectors – healthcare being no exception. A recent study estimates that the climate footprint of the healthcare sector is equivalent to 4.4% of global net emissions (HCWH, 2019).

Nordic sustainable healthcare is considered to be in the forefront in a global context (Eriksson et al, 2019). Sustainability within healthcare has a long tradition in the Nordics and there are many good examples of best practices.

The aim of this Nordic Know-How report series is to spread knowledge and examples of best practices to international actors in the field of sustainable healthcare.

The theme of this second report in the Nordic Know-How series is **geothermal energy**. If conditions are right geothermal energy can be both cost efficient and substanstially reduce the environmental impact of the building. This report provides good examples from Swedish municipal regions and hospitals on geothermal energy systems.

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#2 GEOTHERMAL ENERGY
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ABOUT GEOTHERMAL ENERGY

The geothermal energy in Sweden mostly consists of shallow geothermal energy systems, since the seasonal swing between hot summers and cold winters is favourable for this type of system. In the last decade, the market for larger shallow geothermal energy systems for residential as well as non-residential buildings is expanding (Gehlin & Andersson, 2019).

In the latest geothermal energy utilization world overview from World Geothermal Congress, Sweden was rated number three world leading country in shallow geothermal energy utilisation (Gehlin & Andersson, 2019).

Geothermal energy is a term for techniques which take advantage of stored heat in the ground through exchange of a heat-bearing liquid, either directly or in a closed system. In this report the term geothermal energy encompasses energy that is sourced from soil, groundwater, lakes and streams. This includes geothermal heating, ground heating, aquifer thermal energy storage (ATES), borehole thermal energy storage (BTES) and surface water energy. Geothermal energy systems also encompass cooling systems where the ground is acting as a heat sink and thus provide cooling to the building (Termén, 2020). In this report we will also include an exmple of snow cooling.

ENVIRONMENTAL IMPACT

The energy extracted from the ground or bedrock is completely neutral in terms of CO_2 and other greenhouse gases, and since it is locally extracted it also does not contribute to CO_2 emissions through transport.

In some areas, the groundwater may be affected. In a few geographical locations in Sweden, for example, an energy well can short-circuit different water-bearing geological layers so that an unwanted influx of groundwater occurs. Also, in conjunction with the drilling of energy wells, local inconveniences with emissions of sludge-containing drill water, as well as noise from the equipment may occur (Svenskt Geoenergicentrum, 2020).

TECHNIQUE
FOR GEOTHERMAL ENERGY

In the last decade, several large hospitals in Sweden have successfully implemented geothermal energy, which has resulted in both cost-savings and a reduced environmental impact.

In general, there are high demands for energy in hospitals. Hospitals are in operation 24/7 and 365 days a year. Heating and cooling supply systems need to be robust and accommodate patient safety (Termén, 2020; Svensk Geoenergi, 2016).

The most common techniques of geothermal energy used for hospitals and other healthcare facilities are ground source heat pump systems with closed loop borehole thermal energy storage (BTES), or open loop aquifer energy storage (ATES) (Termén, 2020).

In below sections these techniques are presented and described in more detail.

BOREHOLE THERMAL ENERGY STORAGE

By drilling deep into the ground, the borehole system extracts stored energy in the ground bedrocks. The thermal exchange between the ground and the system is done through brine filled heat exchanger tubes, also known as ´collectors´, inserted into the boreholes. The boreholes are filled with thermal grout in order to protect ground water reserves, or otherwise filled with groundwater in order to achieve the heat transfer from the collector to the wall of the borehole (Termén, 2020; Offentliga Fastigheter, 2017).

The boreholes are normally between 100-300 metres deep. The temperature on this depth in the ground is constant throughout the year, and usually 2-3 degrees C above mean ambient air temperature. The service need of boreholes is small, and they have a long expected lifetime of around 50-60 years.

This kind of system with several boreholes is well suited for larger buildings such as hospitals and other healthcare facilities (Offentliga Fastigheter, 2017). The benefit from the systems are that they can be used both for heating as well as cooling applications, with an average efficiency ratio (SCOP) of above 5-6 (Termén, 2020).

TECHNIQUE FOR GEOTHERMAL ENERGY

GROUND WATER HEAT AND AQUIFER THERMAL ENERGY STORAGE

A groundwater system requires certain hydro-geological conditions. Such suitable conditions can be found in eskers, alluvial sediments (river basins) and porous sedimentary rocks (Offentliga Fastigheter, 2017).

Groundwater and water systems are open, meaning that the water is pumped directly from the source to a heat exchanger in the machinery room where the energy is extracted. After the heat is extracted the groundwater is returned into to the aquifer, via discharge into infiltration wells (Termén, 2020).

Groundwater has a close to constant temperature year around, which makes it a good source for heat exchange, and therefore as source for both heating and cooling (Offentliga Fastigheter, 2017).

SURFACE WATER ENERGY STORAGE

Surface water systems can be either open or closed. Open surface water systems work in the following way: water from an ocean, lake or other water resource is pumped up to be heat exchanged and then returned to the same water resource.

Closed surface water systems consist of plastic pipes firmly anchored at the bottom of a lake or other water resource. The pipe system is filled with circulating heat carriers which exchange the heat in the surrounding water. The heat carrier is usually a mix of water and ethanol or brine and has a low environmental impact in case of leakage (Offentliga Fastigheter, 2017).

For larger public properties that are located with a connection to an ocean, lake or other water resource, surface water systems can be a suitable alternative or a complement to other systems (Offentliga Fastigheter, 2017).

EXAMPLES FROM SWEDEN

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The conditions for Geothermal energy are good in Sweden and in fact all over Europe. The ground installations can be designed for the local geological conditions. A climate with warm summers and cold winters is beneficial for efficiency of the systems (Termén, 2020). Below we have listed and briefly described some of the good examples you can find in Sweden.

REGION SKÅNE

KRISTIANSTAD CENTRAL HOSPITAL

TYPE OF TECHNOLOGY: AQUIFER THERMAL ENERGY STORAGE

When the main building of Kristianstad Central Hospital was commissioned in 1973, it was heated by four large oil boilers. To cool the hospital, electric chillers were used. In 1995, a geothermal energy plant with aquifer bearings was put into use.

The aquifer layer consists of three warm and three cold wells that take water from about 100 meters deep. Free cooling from the aquifer storage supplies the property with cold to 68 percent and in addition, cooling heat pumps are used that can both deliver heating and cooling. The heat emitted by the cooling heat pumps is used for domestic hot water and for charging the hot wells. In this way, the aquifer layer also delivers almost half of the heating demand. Peak loads are provided by district heating (Svensk Geoenergi, 2016).

FORENSIC PSYCHIATRIC CENTRE IN TRELLEBORG

TYPE OF TECHNOLOGY: AQUIFER THERMAL ENERGY STORAGE, WIND POWER, SOLAR CELLS AND COLLECTORS.

The Forensic Psychiatric Centre in Trelleborg has been built as a so-called passive and plus energy house, which means that the building has the capacity to produce more energy than it consumes. The building covers an area of around 11 900 square meters in total.

The centre is heated and cooled with geothermal energy and ventilation. Solar collectors cover the hot water demand between March and September and wind turbines on the site and solar cells on the roof produces the electricity (Region Skåne, 2019). The facility is Sweden's largest passive and plus energy house and covers the entire energy demand with their locally produced energy from the aquifer storage, the wind turbine, solar cells and solar collectors. Five wells have been installed on the site, two for the cold and three for the heat (Geoenergicentrum, 2016).

EXAMPLES FROM SWEDEN

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REGION VÄSTERBOTTEN

NORRLAND UNIVERSITY HOSPITAL

TYPE OF TECHNOLOGY: THERMAL GRID INCLUDING BOREHOLE THERMAL ENERGY STORAGE, DISTRICT HEATING & COOLING, COOLING HEAT PUMPS, CHILLER, SOLAR COLLECTORS

Norrland University Hospital consists of an area of 330,000 square meters to heat and cool. The energy system invested in is an internal ´thermal grid´ in which it includes two geothermal energy plants, three delivery points for cooling, three installations with cooling heat pumps, solar collectors and a tip load cooler.

The thermal grid provides the possibility to store excess heat and cold in the included borehole layers for later use. The first facility with 20 wells to a depth of 200 metres were built in 2010. In 2016 another storage with 125 boreholes to a depth of 250 meters, a facility divided into two borehole layers with different temperatures, was commissioned. The two geothermal energy plants cover 95% of the cooling demand and 1/3 of the heating demand for the entire University Hospital. The thermal grid has a total turnover of 18,000 MWh/ year. The remaining heating needs are covered by district heating. The geothermal energy plant is now being expanded with two more storages (Offentliga Fastigheter, 2017).

REGION VÄSTERNORRLAND

SUNDSVALL COUNTY HOSPITAL

TYPE OF TECHNOLOGY: SNOW COOLING

The County Hospital in Sundsvall is cooled with the help of snow, a system that was the first of its kind in the world when it was built up. The facility was inaugurated in 2000 and has since been gradually expanded. After the latest expansion, it has the capacity for more than 70 000 cubic meters of snow.

During winter, the snow is tipped from the hospital parking lot and the surrounding streets in a large pit. In the spring, the snow is covered with about two inches of wood chips for insulation. Then, as the snow slowly melts, the melt water is pumped into the cooling system. The melt water, that has reached a higher temperature, recirculates back to the pit and melt more snow. The cold from the snow normally lasts until September. If necessary, snow cannons can be used as a supplement to ensure the snow layer in case winter becomes snow-poor. Artificial snow can be made from around October. The system is also supplemented with so-called "free cooling" with cold outdoor air, which for example can be used during winter (Region Västernorrland, 2016).

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ABOUT NORDIC KNOW-HOW

Nordic Know-How is a report series created by Nordic Center for Sustainable Healthcare (NCSH), within the project *Platform for Internationalisation: Energy and Climate Smart Healthcare*. The project is financed by the Swedish Energy Agency.

This series consists several reports which provide an overview of good examples and best practices of sustainable healthcare in the Nordics.

Each report has a certain theme relating to a sustainability challenge in the healthcare sector. The purpose of this series is to bring Nordic practices and knowledge to international actors, spreading Nordic expertise in this field to the world.

Nordic Know-How:
#1 Nitrous Oxide Destruction
#2 Geothermal Energy

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