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Geothermal Energy Use, 2015 Country Update for Denmark

Birte Røgen[1*], Claus Ditlefsen[2], Thomas Vangkilde-Pedersen[2], Lars Henrik Nielsen[2] and Allan Mahler[1]

[1] Danish Geothermal District Heating, Lyngsø Allé 3B, DK-2970 Hørsholm, Denmark, www.geotermi.dk

[2] Geological Survey of Denmark and Greenland (GEUS), Øster Voldgade 10, 1350 Copenhagen K, Denmark, www.geus.dk

[*] br@geotermi.dk

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ABSTRACT

The geothermal resources in Denmark are available at relatively low temperatures suitable for heat production while electricity production is not possible with the present technologies. Both shallow and deep geothermal resources are used in Denmark.

Denmark has three geothermal plants with deep wells producing heat for district heating. Other projects are at different levels of maturation. The first geothermal plant started production in Thisted 1984 and now has a capacity of 7 MWt from 43°C saline water from a Gassum reservoir at 1.25 km depth. A plant in Copenhagen at 14 MWt from 74°C saline water at 2.6 km depth started production in 2005 from a Bunter Sandstone reservoir and the latest plant at up to 12 MWt from 48°C saline Gassum water at 1.2 km depth started production in Sønderborg in 2013. The plants have one production and one injection well producing heat from the sandstone reservoirs through heat exchangers and/or LiBr based absorption heat pumps, where the driving heat primarily comes from biomass boilers for heat and / or combined heat and power production.

Shallow geothermal is mainly used for domestic heating via arrays of closed loops in about 1 m depth in combination with heat pumps. Closed loop boreholes to around 150 m depth are also beginning to be used for domestic heating, both for single houses, for smaller collective networks and for heating of larger office buildings. Borehole Thermal Energy Storage (BTES) for seasonal storage of heat is applied in a test plant at the district heating network in Brædstrup. Few installations use a groundwater aquifer for heating, cooling or seasonal storage (Aquifer Thermal Energy Storage, ATES). The number of smaller ground source heat pumps extracting shallow geothermal heat has been assessed to be around 27,000.

The public Danish RD&D programs have identified Energy Storage as one of three priority areas for reaching the energy political goals of green energy transition towards 2050 and a report from the Danish Energy Agency from November 2013 concludes that at least half of all Danish district heating networks potentially can benefit from implementing heat storage technologies in combination with large-scale heat pumps.

1. INTRODUCTION

Widespread geothermal aquifers in Denmark can be used to produce heat for district heating networks, for individual houses or for industrial use. The relatively low available temperatures available in Danish aquifers normally makes it profitable to use heat pumps for district heating, either compressor based or absorption heat pumps e.g. driven by heat from biomass.

2. DEEP GEOTHERMAL ENERGY

2.1 Geology and Deep Geothermal Resources

The deeper geothermal resources in Denmark are mainly related to two deep sedimentary basins: the Norwegian-Danish Basin and the North German Basin. Pronounced temperature anomalies are absent. Instead a fairly consistent temperature gradient of 22-28˚C/km dominates primarily depending on variations in thermal conductivity of the geological strata. The two basins are separated by a series of high-lying basement blocks with a thin sedimentary cover of approx. 1 km forming the WNW-ESE trending Ringkøbing-Fyn High. The Norwegian-Danish Basin to the north of the high constitutes the major part of the Danish subsurface, whereas the northern rim of the North German Basin constitutes the subsurface in the southernmost part of Denmark south of the high (Figure 1).

Comprehensive research based on seismic and well data primarily from previous hydrocarbon exploration campaigns have shown that the fill of the Norwegian-Danish Basin contains several lithostratigraphical formations with sandstones of sufficient quality and temperature to serve as geothermal reservoirs. These are primarily the Lower Triassic Bunter Sandstone Formation, the Triassic Skagerrak Formation, the Upper Triassic–Lower Jurassic Gassum Formation, the Middle Jurassic Haldager Sand Formation and the Upper Jurassic–Lower Cretaceous Frederikshavn Formation. Of these formations especially the Gassum and Bunter Sandstone Formations are widely distributed at appropriate depths. The two formations are dominated by marginal marine and fluvial sandstones, respectively. The Skagerrak Formation is widely distributed along the northeastern basin margin, but its quality as geothermal reservoir is yet less understood owing to its heterogeneous nature. The Haldager Sand and Frederikshavn Formations occur mainly in northern to mid-Jylland, where they form good reservoirs at relatively shallow depths. In addition to these formations, Lower Jurassic, Lower Cretaceous and various mid-Cretaceous sandstones are present along the northeastern basin margin and especially in the eastern part of the basin on Sjælland they seem have a good potential.

In the North German Basin straddling southern Denmark the Bunter Sandstone Formation constitutes the principal geothermal reservoir as the Gassum Formation is only sporadically preserved at fairly shallow depths and the younger formations are completely absent. On the Ringkøbing-Fyn High sandstones are sparse due to non-deposition and erosion, and the few sandstones preserved are shallowly buried and thus of low temperature.

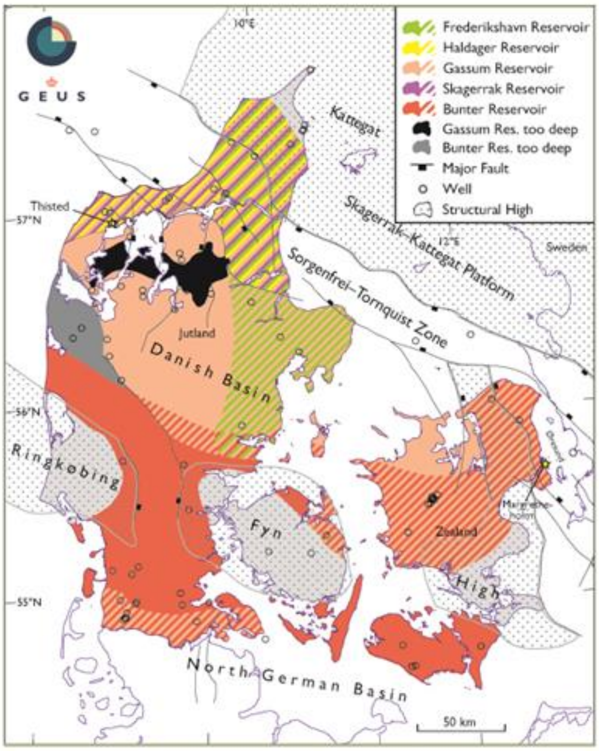
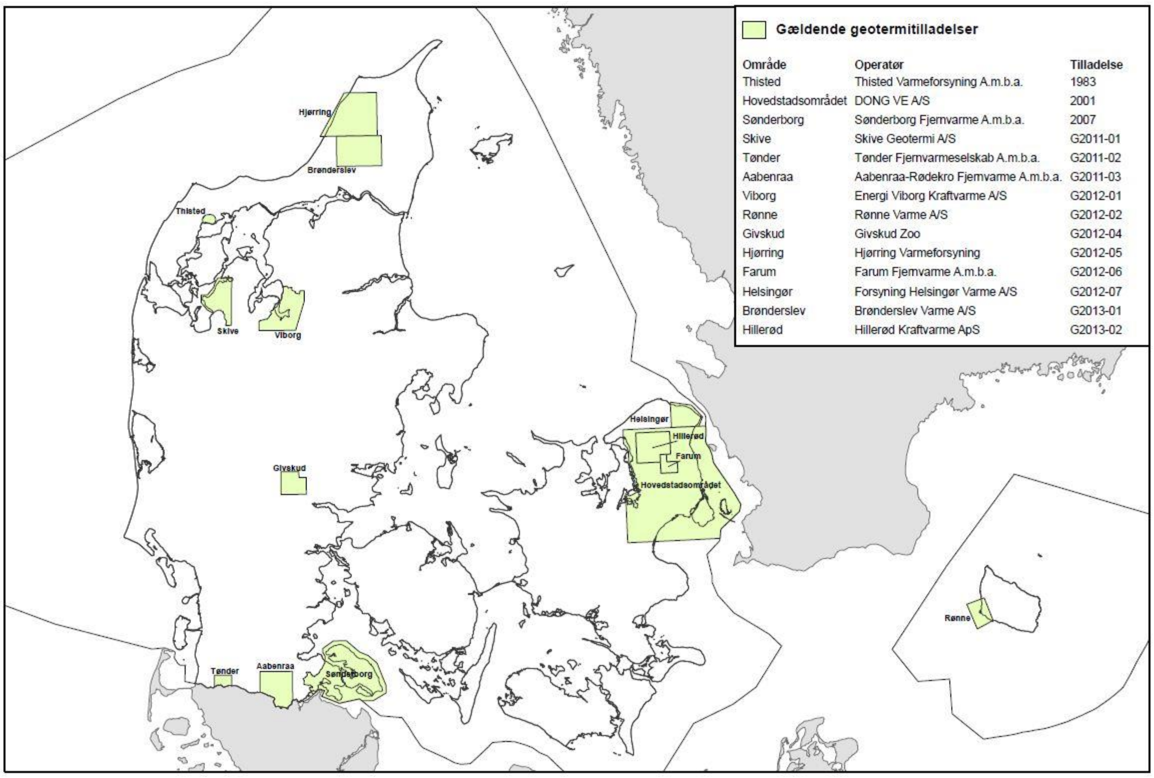


Figure 1: Map of potential geothermal reservoirs in Denmark.

2.2 Legislation and Administration of Deep Geothermal Energy

Exploration for and production of geothermal energy requires a license pursuant to the provisions of the Danish Subsoil Act. In Denmark, several licenses have been awarded (Figure 2) and projects are at different levels of maturation. The Danish Energy Agency administers licenses and supervision.



Område	Operatør	Tilladelse
Thisted	Thisted Varmeforsyning A.m.b.a.	1983
Hovedstadsområdet	DONG VE A/S	2001
Sønderborg	Sønderborg Fjernvarme A.m.b.a.	2007
Skive	Skive Geotermi A/S	G2011-01
Tønder	Tønder Fjernvarmeselskab A.m.b.a.	G2011-02
Aabenraa	Aabenraa-Rødekro Fjernvarme A.m.b.a.	G2011-03
Viborg	Energi Viborg Kraftvarme A/S	G2012-01
Rønne	Rønne Varme A/S	G2012-02
Givskud	Givskud Zoo	G2012-04
Hjørring	Hjørring Varmeforsyning	G2012-05
Farum	Farum Fjernvarme A.m.b.a.	G2012-06
Helsingør	Forsyning Helsingør Varme A/S	G2012-07
Brønderslev	Brønderslev Varme A/S	G2013-01
Hillerød	Hillerød Kraftvarme ApS	G2013-02

Figure 2: Map of geothermal licenses in Denmark.

2.3 Geothermal District Heating Plants

In Denmark 63% of all households are heated by district heating. The district heating network is supplied with heat from many different heating installations based on many different fuels. The renewable share is over 50%, and of this a small part comes from geothermal heating plants. The annual heat extracted in 2012 from geothermal water and used for district heating were about 300 TJ. Approximately 90% of the investments in the use of geothermal heat for district heating are private.

Three geothermal district heating plants are in operation in Denmark and the first has now been in operation for 30 years.

The three plants are described below. More information about the plants has been included in previous Country Updates including Mahler 1995 a & b, Mahler 2000, Mahler & Magtengaard 2005, Mahler & Magtengaard 2010, Magtengaard & Mahler 2010, Mahler et al 2013 – the last: An EGEC Country Update regretfully has an error mentioning an option for “new geothermal power plants” – read: “new geothermal plants”.

2.3.1 Geothermal Plant in Thisted

The geothermal plant in Thisted has been in operation since 1984, transferring heat from geothermal water to the district heating network in Thisted. The geothermal reservoir is a Lower Jurassic Gassum Formation sandstone at 1,250 m depth producing saline water at 43°C. It started as a pilot plant and it has undergone several changes and expansions over the years. The plant was established as a pilot plant by the company “Dansk Olie og Naturgas A/S” in 1984 and later expanded in cooperation with the local cooperative district heating company “Thisted Varmeforsyning”. In 2011, the local district heating company became the sole owner. The pilot plant was established with an electrically driven heat pump and with a geothermal flow rate of 35 m^3/h. This heat pump was exchanged with absorption heat pumps and enlarged to around 150 m^3/h geothermal water in 1988 and further expanded to the present capacity at 7 MW from 200 m^3/h geothermal water in 2001, see principle sketch in figure 3. The absorption heat pumps are driven by heat primarily from a straw boiler, contributing to an environmentally friendly district heating in Thisted.

The Thisted geothermal plant has one production well and one injection well, i.e. a doublet. The wells are vertical and located 1.5 km apart with an injection pump and cartridge filters facilities at the injection site. The 43°C warm and 15% saline water is filtered to about 2 micron in bag filters before the heat extraction and to about 1 micron in cartridge filters before reinjection. Good productivity and low injection pressures has been maintained.

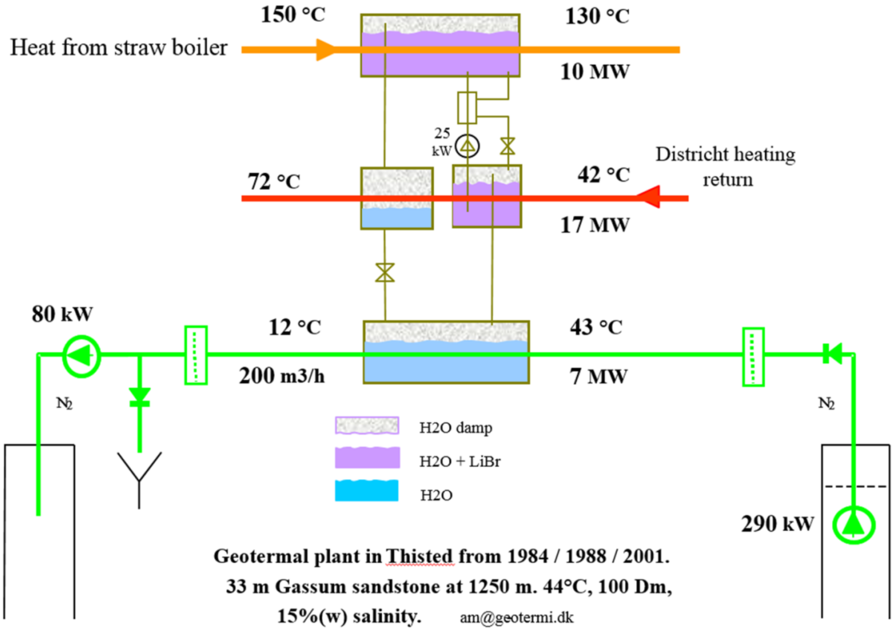


Figure 3: Principle sketch of the geothermal plant in Thisted.

The plant has carbon steel piping with 3 mm corrosion allowance and AISI 316 moving parts in valves. Annual corrosion rates in carbon steel exposed to the geothermal water are at around 0.06 mm. It is protected towards air intake by nitrogen maintaining an overpressure when the plant is shutdown, and furthermore by an operating system avoiding low pressures when the plant is operating and shutting down. At restarts the water content in the production well and in the surface plant is flushed to the sea.

The absorption heat pumps are driven for free when the driving heat comes from the straw boiler. The boiler produces heat for district heating with or without the geothermal plant and uses the same amount of straw when producing heat through the absorption heat pumps to the district heating network as it does, when producing directly to the network. The power to heat ratio (COP) for the geothermal plant in Thisted is at 15 - 20 depending on the load. The local incineration CHP has in the past also been used to supply driving heat to the heat pumps.

The total investment costs are at 11.1 million euros including Pilot Plant costs and an unused deep section of the production well.

2.3.2 Geothermal Plant in Copenhagen

The geothermal plant in Copenhagen is developed as a demonstration plant at a site next to the sea at the Amager CHP plant. It was inaugurated in 2005 and the plant is owned by HGS (Hovedstadsområdets Geotermiske Samarbejde) which is a joint venture of heat and power producers and district heat transmission companies.

The plant exploits a geothermal reservoir in the Lower Triassic Bunter Sandstone Formation at 2.6 km depth where 19% saline geothermal water is available at 74°C. The geothermal water is produced through a deviated well and reinjected through a vertical well next to it at ground level and 1.3 km apart at reservoir level. The plant is designed to extract 14 MW heat from 235 m^3/h geothermal water and transfer 27 MW heat to the district heating net by heat exchange and through 3 absorption heat pumps driven by 14 MW steam primarily from a wood pellet based CHP plant. See Figure 4 for principle sketch of plant.

The investment has amounted to 28 million euros and the plant was established with the following milestones:

- In 1999, five partners started planning for a geothermal plant in the Greater Copenhagen area.
- A joint venture was established in 2000.
- A seismic survey was made in 2000.
- In 2001, a geothermal energy license was granted.
- First well was drilled vertically in June 2002 to the basement in 2.7 km depth.
- Production test showed that the Lower Triassic Bunter Sandstone Formation could be produced at acceptable rates.
- Second well was drilled deviated in June 2003.
- Construction of surface plant started in 2003.
- Inauguration of geothermal plant in 2005.

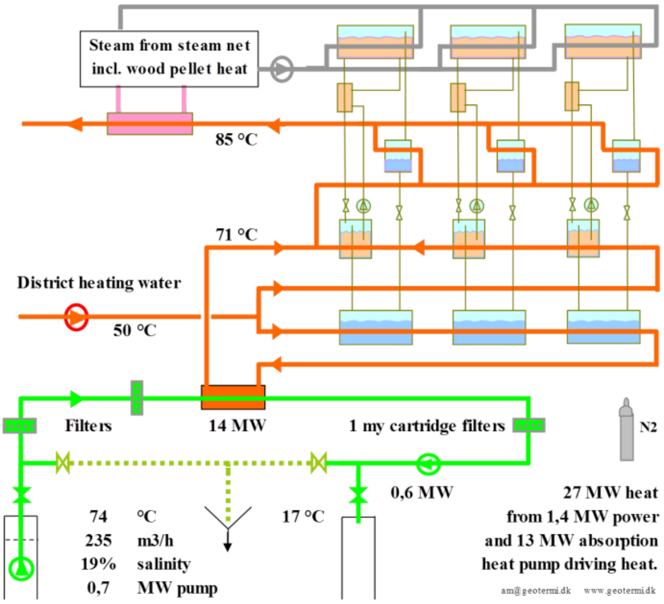


Figure 4: Principle sketch of the geothermal plant in Copenhagen at Amager. Heat is produced using heat exchangers and absorption heat pumps. Geothermal loop and heat pumps are separated in two locations on the Amager CHP plant site, with a spacing of 800 m.

The geothermal water is pumped to the surface by a 700 kW submersible pump located at 650 m depth, pre-filtered to 30 micron in a self-cleaning filter unit, filtered in 2 layered bag filters to first 10 then 1-2 micron, cooled from 74°C to 17-18°C in titanium plate heat exchangers, filtered to around 1 micron in cartridge filters and reinjected at up to 70 bar using a 700 kW injection pump.

The geothermal loop is designed with 5 mm corrosion allowance in carbon steel piping and with AISI 316 filter houses with sacrificial Fe anodes. Corrosion rates in carbon steel are about 0.2 mm/year, mainly due to high salinity and a content of CO_2. Like in Thisted, the plant and wells are protected against air influx with nitrogen at a slight overpressure, and geothermal water is flushed to the sea at restarts, to avoid injection of air contaminated water if any, and to reduce injection of water where precipitations may have accumulated at plant shutdowns.

The injection pressure has increased over the years after an initial clean-up of the injection well. The reason is believed to be many plant shutdowns from no driving heat, summer periods with no heat demand and pump frequency converter failures etc. together with periods with low injection pressures caused by injection without injection pump and increased injection temperatures from insufficient cooling in the heat pumps in period with low driving heat steam pressures and from insufficient vacuum pumping or internal leaks.

The injection pressure has been reduced by soft acidizing and a system for the soft acidizing with a small acid pump and an acid / inhibitor mixing tank has been installed in a small container next to the injection well. An example of the result of mixing a little HCL into the injected geothermal water reducing pH to 1-2 is shown below in Figure 5.

The soft acidizing has been repeated several times and more acid will be injected to reduce the injection pressure, but the well completion with perforations carries a risk of perforation collapses if too much acid is injected. Therefore and because the acid injection has not been able to maintain a satisfactorily low injection pressure an effort is put into avoiding the believed reasons for the injection problems.

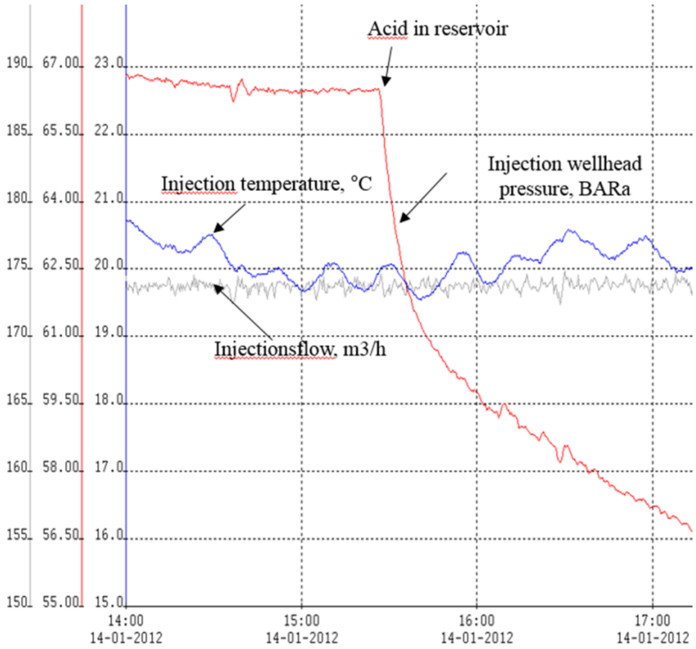


Figure 5: 10 bar injection pressure drop from mixing 250 l of 15 % HCl into the injection water.

Furthermore, preparations for a full restoration of the injectivity has been initiated and a bailer based bottom hole sampling, a spinner log run and an optional camera inspection is planned to identify the nature and properties for the flow restriction before methods for a clean-up of the perforations or other methods to improve the reservoir contact are chosen. Such methodx may include installation of the production pump in the injection well to carry out a clean-up pumping, well stimulation with a stronger acid, new perforations or maybe another type of well completion in case the injection problem is caused by a collapse of the perforations. The production pump can, by now, produce up to 270 m^3/h in the production well and it is thus likely that it can carry out a clean-up pumping of the 75 m long perforated injection zone without setting packers to split it in smaller sections.

2.3.3 Geothermal Plant in Sønderborg

A license for the area was granted in 2007 and a seismic survey was made the same year. A production well and an injection well, both deviated, were drilled in 2009-2010. The primary target, the Bunter sandstone formation, was not found. It was decided instead to base the production on the Gassum sandstone at 1.2 km depth. The wells were completed with gravel packs 0.8 km apart at reservoir level and well tests showed that the well communication transmissivity was high, but regretfully also, that the skin factor was very high in both wells. It was concluded that the initial attempt to remove the mud cake with enzymes to dissolving starch in the starch bound carbonate mud cake should be supplemented by a clean-up pumping and soft acidizing after the installation of the surface facilities.

Surface facilities were installed in 2012-2013 and a submersible pump based clean-up pumping and the soft acid injection was successful. The plant was inaugurated in 2013 and the wished 350 m^3/h can be produced, but the injectivity has regretfully dropped again, and the injection well needs a clean-up again to allow injection at full capacity.

Preparations for a well inspection and the clean-up has begun including a camera inspection, a bailer based bottom hole sampling and a spinner flow log run. The open area in the gravel pack screen slots is quite small, and the injection problem is hopefully solved, when the slots are cleaned, the injection well is clean and the injection water is kept clean. Precipitations should not be a problem unless carbonates are allowed to build up blocking acid access according to water analysis and precipitation index calculations.

The production well produces 48°C warm water from the Lower Jurassic Gassum sandstone reservoir at the 1.2 km depth. The plant is designed to produce up to 12 MW from the 15% saline geothermal water using absorption heat pumps (see Figure 6).

The plant is located at two separate sites 4 km apart – one with the geothermal loop and another with the heat pump plant due to surface and subsurface constraints. The heat pump plant with absorption heat pumps driven by wood chip boilers is placed close to an incineration and CHP plant, and the risk of sealing fractures in the subsurface advised against placing the geothermal wells there.

The geothermal surface loop at the well site includes pumps, heat exchangers and filters - and a basin to collect geothermal water from filter drains and to remove “old water” in the production well and the surface facilities after a plant shutdown. The basin is drained by pumping the water into the sea after mixing it with fresh water from a sewage water cleaning plant.

The heat pump plant has 4 absorption heat pumps cooling district heating water to about 12°C before it is pumped the 4 km to the geothermal heat exchangers reheating the district heating water to about 45°C. Driving heat for the heat pumps is provided by two wood chip boilers and the cooled water is also used to increase heat extraction from the boiler flue gas.

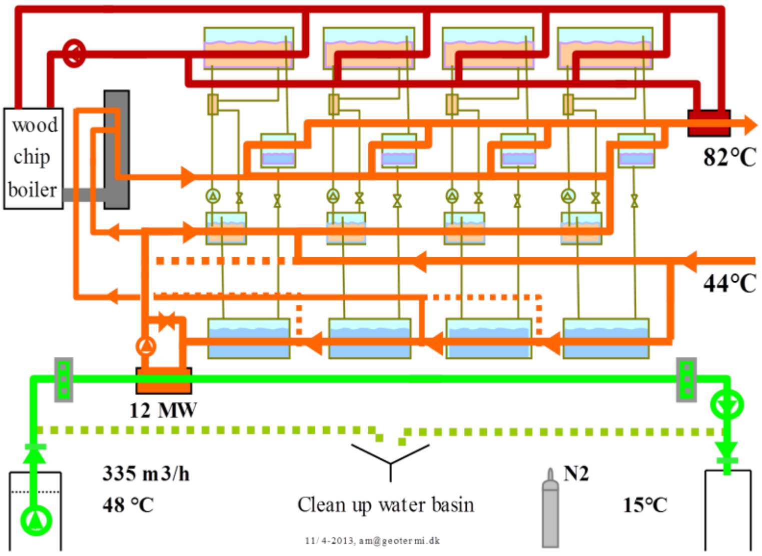


Figure 6: Principle sketch of the geothermal plant in Sønderborg. The geothermal loop with heat exchangers is placed 4 km away from absorption heat exchangers.

2.4 Research and Development of Deep Geothermal Energy

Activities at different levels from feasibility studies for plant establishment to basic research on geology related to geothermal production are ongoing. The Danish Government has a political target of 100% renewable energy in the energy system in 2050. As part of many initiatives working towards this goal, also research and development in geothermal energy has increased. In January 2014, a white paper on establishment and operation of geothermal plants for district heating was published by the Danish Energy Agency. Here the reader is being guided through all project phases from development of the idea, through feasibility studies and construction to operation and decommissioning. Also an investigation on options for hedging in geothermal projects was published. A new web-based GIS database with existing and quality-controlled data relevant for assessment of the geothermal potential is being developed, with the aim to focus planning of new geothermal heating plants on prospective areas and to speed up the process of establishing a geothermal heating plant.

The Danish Council for Strategic Research supports two ongoing research projects within geothermal energy: “The geothermal energy potential in Denmark – reservoir properties, temperature distribution and models for utilisation” and “Heat Storage in Hot Aquifers”, both running until 2015, and establishing a network between the geothermal players in Denmark. Danish geothermal players are also active in the EU Intelligent Energy Europe Programme project “GeoDH” in collaboration with partners in 12 countries.

Preliminary plans exist to erect a geothermal plant in Copenhagen with 11 wells of which some of the production wells may be prepared for long term heat storage. Such a plant is expected to be designed to extract around 64 MW from 1000 m^3/h geothermal water.

2.4.1 Heat Storage

A geothermal plant may be used for seasonal heat storage in combination with the exploitation of the natural resource. Heat for seasonal storage may e.g. be excess heat from focused or plain solar collectors or from incineration plants in the summer time. Storage in warm deep geothermal reservoir reduces heat losses. The very low natural flow if any in deep compared to shallow aquifers will decrease energy loss. Furthermore, the production of more water than injected will reduce losses. Shallow seasonal heat storage for district heating companies has been established as borehole heat storage in Brædstrup storing heat from solar collectors. A heat recovery at 80% is expected from this borehole heat seasonal storage.

Heat may be stored in a production well by injecting heated water into the well in the summer time, and producing it when needed during the winter. The heated water may come from an injection well in a traditional doublet well configuration. This will, however, create a heat loss when reheating the water from the injection temperature to the reservoir temperature. A more efficient concept will be to use an additional combined storage and production well. Preliminary simulations have indicated that recovery of stored heat e.g. can be at about 40% in the doublet configuration and around 90% in a configuration where the doublet is supplemented with a combined storage and production well.

The storage of heat at an elevated temperature can make it possible to produce heat without heat pumps from aquifers relatively close to the surface with high permeability normally too cold to allow this. It may also become possible to store heat at a sufficient temperature level to produce power from such aquifers. Power may then be stored indirectly e.g. storing incineration heat instead of using it to producing power when enough power – or store power more directly using excess power to drive heat pumps to store geothermal heat at an elevated temperature level.

3 SHALLOW GEOTHERMAL ENERGY

3.1 Shallow Geology

The shallow geology of Denmark 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. 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 groundwater flow as well as the thermal properties of the sediments surrounding the heat collectors, (e.g. Vangkilde-Petersen et al., 2011).

3.2 Legislation and Administration of Shallow Geothermal Energy

Since all drinking water in Denmark is based on groundwater resources, ground water protection is of major concern in most areal regulations. Ground Source Heating and Cooling is regulated pursuant to the Danish environmental protection act and permissions are issued by the Municipalities, who must include groundwater interests in their considerations.

Protection of the groundwater is however normally not a limitation for horizontal collectors and in 2013 a new notification scheme for such plants has been established whereby applicants can simply report their plans to the authorities who have four weeks to object. 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. However research has led to an increased knowledge about the potential environmental impact from BHE in relation to drilling techniques and composition of different brines while new materials and brine substances are beginning to emerge. Therefore, work to revise the regulations regarding groundwater protection and the related safety distances has been initiated. Furthermore in 2013, it has become mandatory to report new borehole heat exchangers (BHE) to the national borehole database at GEUS (Hansen and Pjetursson, 2011) and to send in representative soil samples for geological characterization as has previously been the case with boreholes for extraction of water and for mineral exploration.

The regulation of groundwater based open loop systems is rather strict and specifies 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. Furthermore, numerical modelling is required in order to document 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 modeling. These requirements are rather costly and imply that only larger installations are economically feasible.

3.3 Shallow Geothermal Installations

Despite a large potential, the application of shallow geothermal energy in Denmark is relatively limited compared to e.g. Sweden or Germany. Today, the total number of ground source heat pumps in Denmark is around 40,000, and currently increasing with around 7,000 per year. Most of the existing installations are horizontal collectors. Only a few hundred are BHE and some are groundwater well open loop systems. During the last 5-6 years the number of borehole heat exchangers has increased significantly with more than a hundred boreholes constructed each year, see Figure 7.

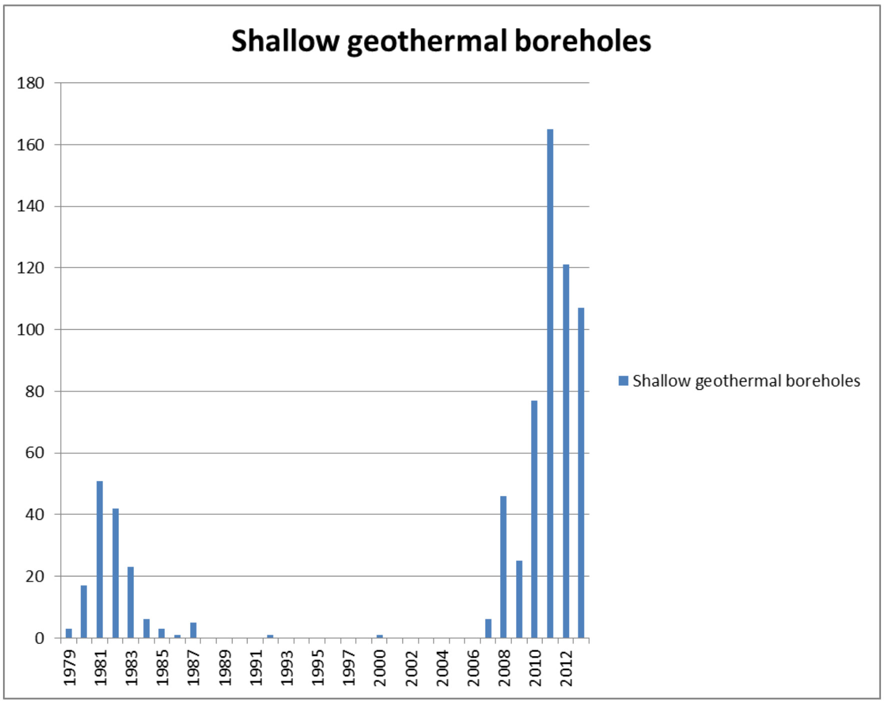


Figure 7: Number of shallow geothermal boreholes reported to the national borehole database Jupiter.

The number of shallow geothermal installations is increasing and this energy source is expected to become more widespread in the future especially in areas with no district heating network or natural gas supply. The regulations of shallow plants are being revised at the moment to meet this demand.

3.4 Research and Development of Shallow Geothermal Energy

A three year project supported by the Danish Energy Agency aims to pave the way for a wider use of BHE (borehole heat exchangers) by acquisition and dissemination of know-how and developing tools and best practice for the design and installation of systems (Figure 8). The projects end in 2014 and has addressed a number of different topics related to ground source heating and cooling such as the thermal properties of common, shallow Danish deposits (Ditlefsen et al. 2014), drilling and grouting techniques in soft sediments, mapping of shallow geothermal gradients in Denmark, modeling of heat and groundwater flow as well as groundwater protection and other environmental considerations. Results from the project can be seen on the project homepage www.geoenergi.org.

Figure 8: Installation of borehole heat exchanger at test site.

4 CONCLUSIONS

A vast resource of low enthalpy geothermal energy is available in Denmark, and there is growing interest in making this energy source contribute to reaching national targets on renewable energy.

Three geothermal district heating plants are in operation, and several deep geothermal district heating projects are being considered in Denmark. Main obstructions for development are high investments and few options for risk hedging.

The number of shallow geothermal plants is increasing and this energy source is expected to become more widespread in the future especially in areas with no district heating network or natural gas supply. The regulations of shallow plants are being revised at the moment to meet this demand.

Altogether, the use of geothermal energy in Denmark shows a slow but positive trend.

ACKNOWLEDGEMENTS

The Danish Council for Strategic Research is acknowledged for support to the two research projects: “The geothermal energy potential in Denmark – reservoir properties, temperature distribution and models for utilisation” and “Heat Storage in Hot Aquifers”.

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STANDARD TABLES

TABLE 4. GEOTHERMAL (GROUND-SOURCE) HEAT PUMPS AS OF 31 DECEMBER 2014

Locality	Ground or Water Temp. (°C)[1]	Typical Heat Pump Rating or Capacity (kW)	Number of Units	Type[2]	COP[3]	Heating Equivalent Full Load Hr/Year[4]	Thermal Energy Used (TJ/yr)	Cooling Energy (TJ/yr)
Thisted (1,2 km deep)	43	7000* (evaporator)	2 AHP	W	Absorption HP	3000	75*	
Copenhagen (2,6 km deep)	74	14000* (5 MW direct + 9 MW evaporator)	3 AHP	W	Absorption HP	7400	180*	
Sønderborg (1,2 km deep)	48	12000* (evaporator)	4 AHP	W	Absorption HP	4000	100*	
Space heating in Denmark; residential, commercial and institutional	5-25		approx. 40000	H, V, W				
TOTAL								

* Plant with absorption heat pumps. Energy and capacity are given for heat from subsurface exclusive driving heat.

TABLE 8. TOTAL INVESTMENTS IN GEOTHERMAL IN (2014) US$

Period	Research & Development Incl.	Field Development Including Production	Utilization		Funding Type	
			Direct	Electrical	Private	Public
	Million US$	Million US$	Million US$	Million US$	%	%
1995-1999	1	5,5	-	-	10	90
2000-2004	1	36	-	-	90	10
2005-2009	1	20	-	-	100	-
2010-2014	7	55	-	-	90	10