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District Heating Production with Heat Pumps based on Geothermal Energy

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ABSTRACT

Lunds Energi AB is a municipality owned company, situated in the province Skåne, in south of Sweden. The owners are four municipalities, Lund 82,4 %, Eslöv 12 %, Hörby 3,5 % and Lomma 2,1 %. The services supplied by the company are district heating, district cooling, distribution and selling of electricity and natural gas.

Lunds Energi produces 930 GWh of district heating annually, based on geothermal heat pumps, sewage heat pumps, combined heat and electricity generation with gasturbine and heat recovery boiler and bio, oil and natural gas fired heat only boilers.

The geothermal system was taken into operation 1984 and 1986 in two steps. The system consists of 4 production and 5 injections wells. From the production wells 550 to 700 meters deep, a saline water (5%) at a temperature of 20 °C is pumped by means of electrical submersible pumps, installed at 80 meters depth. The geothermal water with a maximum flow 1 600 m3/h is taken to our production plant in GAP (Glasfibre reinforced plastic) pipelines. In the production plant we have two heat pumps capable of producing 19 MW and 21 MW heat. The compressors are running on electricity.

The geothermal water is cooled down to four degrees C after the evaporator of the heat pump. The heat pumps raise the temperature of the district heating water from 45 to 80 ° C, which is sufficient for our district heating system during 8 months. During wintertime we have to peak the temperature up to 118 with gas boilers if necessary.

After the heat pumps the geothermal water is transported to the five injection wells also between 550 and 700 meters deep.

The distance between the production wells and the injections wells is approx. 3 km with the production plant in between.

The energy to the district heating network from the geothermal heat pumps is around 35 % of the total energy needed, which means a substantial saving in oil- and gas consumption, not to mention the decrease in emissions from carbon dioxide. The geothermal system has saved approximately 500,000 tonnes of oil since the commissioning in 1984.

PRESENTATION LUNDS ENERGI AB

History

The company started in 1863 as a town gas company. Coal was gasified and the gas was distributen in a steel pipe network for mainly illumination purposes, but also for heating and cooking.

In 1907 the electricity works was established with the installation of a small generator. The municipality decided in 1912 that all technical utility was to be in one department, the municipal technical works. In this department the district heating started in 1963 with one boiler plant supplying a new area with apartments.

In 1982 all energy related works was put under the municipal energy authority, which in 1993 was transformed to Lunds Energi ltd.

Description

Lunds Energi AB is a municipality owned company, situated in the province Skåne, in south of Sweden. The owners are four municipalities, Lund 82,4 %, Eslöv 12 %, Hörby 3,5 % and Lomma 2,1 %. The services supplied by the company are district heating, district cooling, distribution and selling of electricity and natural gas.

Lunds Energi produces 930 GWh of district heating annually, based on geothermal heat pumps, sewage heat pumps, combined heat and electricity generation with gasturbine and heat recovery boiler and bio, oil and natural gas fired heat only boilers.

We provide IT services and are responsible for the expansion and maintenance of the local networks. We sell heating, cooling and gas. Our energy services consist of customer service, advice, maintenance and subcontracting. The supply of electricity is managed by Lunds Energi Försäljning AB, of which we own 100%. Our technical systems and the framework of the company have an unusual flexibility. Access to electricity, gas and oil can vary, prices can fluctuate, the weather can change from an extremely cold winter to an extreme heat wave. For the district heating production in Lund 33% of the needed energy input is taken from 21 degrees warm water pumped from 600 to 800 meter under the surface. Approximately 325 GWh of geothermal energy is taken from the formation. The other heat sources are sewage heat pumps, combined heat and electricity generation with gasturbine and heat recovery boiler and bio, oil and natural gas fired heat only boilers.

DISTRICT HEATING

A district heating system can be divided into three major parts, the production plants, the distribution system, and the substations (consumer interface) in each connected building.

District heating can operate with any type of central production plant, Heat Only, Combined Heat and Power, Waste Heat, etc. This makes district heating system very flexible in respect of energy and fuel sources. The most economical plant is in operation as much as possible and the other are only started when the demand is high. Furthermore, a switch from one fuel source to another is comparatively easy, as only the central plant is affected.

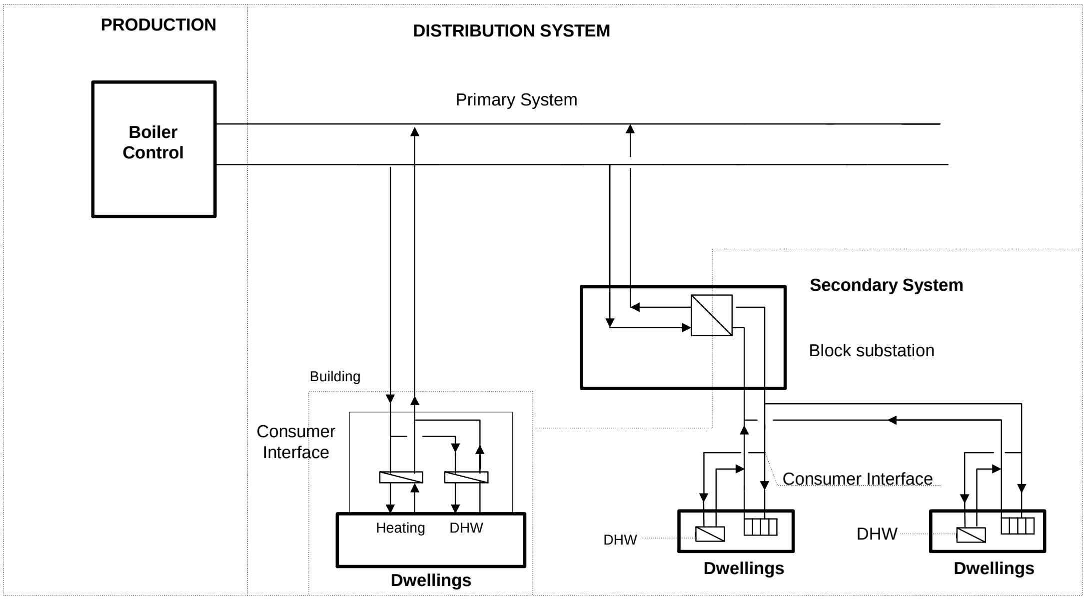

Figure 1: District heating system

When using individual heating systems, each consumer has to change his heating plant, which in many cases is impossible due to space limitations, etc.

A large district heating system may consist of primary and secondary systems, as indicated in Fig. 1. The primary system has a higher temperature level and pressure level than the secondary system The distribution system is often made of pre-insulated steel pipes, installed 600 mm below surface.

The consumer interface is one or two heat exchangers with pumps, control equipment and valves.

Production

The total capacity of central production plant has to be designed to meet the peak heat demand of the system, including heating, DHW-generation and heat losses, including sufficient back-up capacity to assure reliable supply. Base load, is supplied by means of production plants using the cheapest energy, but with higher capital costs, that is with low variable cost. The peak and reserve capacity is provided from units with higher variable production cost. Typically base load is supplied from solid fuels, waste heat or CHP-units, while peak load is provided from oil or gas fired heat only units. The production capacity may be located at one place in the distribution system, or at several.

Lunds Energi produces approximately 930 GWh thermal heat annually. The heat production is based on heat pumps, bio fuel, combined heat and power production, natural gas and oil fired heat only boilers. We have four production plants;

1. Gunnesboverket which is the main production plant. Here the two big heat pumps for the geothermal energy are located. We have two electrical boilers, three oil fired boilers, one gas fired boiler, accumulator tank and a gas turbine producing both heat and electricity. The total capacity is 442 MW_{th} and 21 M_{wel}.

2. Ångkraftverket, is the plant where the production of district cooling take place. Two boilers and three heat pumps for heat and cooling production. An accumulator for the district cooling network has been built here. The total installed capacity is 60 MW_{th} and 18 $MW_{cooling}$.

3. Södra verket. The first production plant from 1963. Two oil fired boilers and a heat pump utilising the heat from the cleaned sewage water. The heat pump produces cooling to a industry and apartments in the neighbourhood. The installed capacity is 40 MW of heat and 7 MW of cooling.

4. Återbruket in Lomma. In 1998 the district heating networks in Lund and Lomma was connected. In Lomma at Återbruket there is a bio fuelled combined heat and power plant using recovered wood from buildings and other sources. The plant is rated for 12 MW of heat and 4 MW of electricity.

Distribution

An underground pipe system transports heat from the production plant to the heat consumer in a closed loop. Hot water is pumped from the central in the forward pipeline to the consumer and returned to the central in the return pipe after giving away requisite amount of heat to the consumer. If necessary, booster pumps can be strategically located in the network to maintain pressure levels. In medium sized networks with moderate level differences booster pumps are not necessary.

Modern pipe systems consist of a media-pipe covered by polyurethane foam and a jacket of polyethylene, so called pre-insulated pipes. The media pipe can consist of plastic pipe (PEX), copper or steel. The plastic pipes are only usable up to 95^{o}C and 6 bar, while pre-insulated steel pipes are usable up to 120^{o}C and 16 bar.

The main pipe system is equipped with a leak detection system, which enables immediate location of a pipe leakage.

In case a distribution system consists of both primary and secondary systems a hydraulic break is required between the systems. This is achieved by means of a block sub-station that principally is designed in a similar fashion as the primary consumer interface (fig. 3.2) exclusive of the DHW heat exchanger.

The distribution system in Lund is 240 km long with diameters ranging from 28 to 700 mm. The pipelines are designed for 16 bars and 120 degrees.

The water is treated by means of a osmotic filters to get rid of oxygene and salts# check a small amount of oxygene reducing chemicals are put into the system as a buffer if some oxygen comes into the system.

Substations

Substation or consumer interface are often installed in the basement of the buildings. In the primary system consumers are connected by means of a heat exchanger that provides a hydraulic break between the consumer internal installations and the large system. This is primarily necessary to protect the consumer installations against the higher pressure and temperature levels in the system. The consumer interface consist principally of:

- Heat exchangers, one for the heating system and one for the DHW system, if necessary a third heat exchanger can be installed for the ventilation system.
- Requisite tanks
- Pumps
- Valves
- Control and monitoring system on a BEMS (BuildingEnergyMonitoringSystem) outstation basis with facilities to communicate to a central monitoring centre.
  The control will for the heating system be based on weather compensation of the forward temperature, according to the design characteristics of the wet internal system.
  The DHW generation circuit will be controlled to a constant forward temperature of 55-60°C.
  The scope of monitoring includes:
  - Forward and return temperature of heating circuit and DHW circuit
  - Outdoor temperature
  - System pressure
  - Heat metering

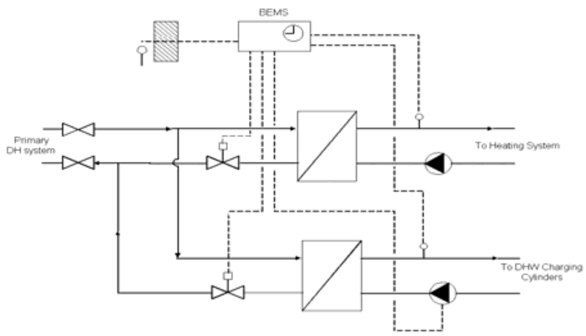

Figure 2: Consumer Interface Direct Connection to Primary System

In a secondary system, with low pressure and temperature levels, consumers are directly connected to the distribution system. That is without hydraulic break (heat exchanger) between the distribution system and consumer installations.

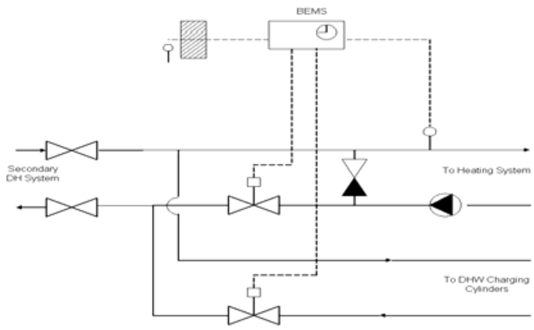

Figure 3: Consumer interface, Secondary System

Domestic Hot Water

DHW can be generated by means of a heat exchanger, or in a charging cylinder. District Heating, electricity or propane can heat the charging cylinder.

The heat exchanger has the advantage of giving a lower return temperature. A low return is beneficial from the point of view of distribution system sizing and in case of CHP-production, where the electric output increases with lower temperature levels. The disadvantage is a higher peak demand as hot water is generated instantaneously and large groups of clients are likely to use hot water at the same time.

Charging cylinders have the advantage of smoothing the load curve by their storage capacity. The cylinder may be equipped with an electric coil allowing DHW to be generated by cheap off-peak electricity e.g. in summertime. Such practice gives the option of closing the distribution system for the summer months, thus reducing the distribution losses. Furthermore, existing installations may already be equipped with DHW cylinders that could be reused.

The temperature has be kept above 55 degrees when keeping the water in a storage cylinder, to get rid of legionella bacteria.

GEOTHERMAL SYSTEM

History/Background

The district heating production was originally based on oil fired heat only boilers. The oil price increased dramatically 1973 and then later on in 1979, which lead to a search for other energy sources for the district heating production. During the same period Sweden had launched a nuclear power programme with the building of 12 reactors. This meant that there was a surplus of electricity to a low cost.

One way of using the cheap electricity and get away from the oil was to install big heat pumps in the heating systems. The heat sources were mainly heat from rivers, lakes, the see and low temperature waste heat from process industries.

Also a search for oil and natural gas was done in south of Sweden. Approximately 20 wells were drilled to different depth, some was down to 2 000 meters, but without any oil was found. The data from those drillings was given to the Department of Technical Geology at Lunds University.

In the beginning of 1980:s professor Leif Bjelm approached Lunds Energy Authority with the idea of using geothermal energy as a mean of district heating production with big heat pumps. The first two test wells was finance by the governmental oil replacement found, Atlas Coopco and

Sandvik. A production well to 800 meters and an injection well to 550 meters were drilled and tested during 1982.

The tests shown that it was possible to produce a flow of 120 l/s from a well with a the temperature was 21 ° C.

The first phase with two production wells, two injection wells, distribution pipelines and one heat pump was done during 1984 and commissioned in November that year.

In 1986 the second phase with two more production wells for a total of four and three new injection wells for a total of five, and a second heat pump was done.

Geology

The geology differs in south of Sweden compared to the rest of the country. In the south east of Skåne the sedimentary rocks is almost 3 km thick. Parts of Skåne do geological belong to the contintal Europe. In the rest of Sweden the basement comes all the way up to the surface.

The temperature gradient measured in the many exploration wells from the oil and gas drilling during the seventies is around 30 to 35 degrees per km.

The heat energy is originating to 80 % from natural radioactivity and the other 20 % is from conductivity of heat from the inner of the earth.

The formation where the warm water is taken from is called the Campan sand layer. The layer has a small inclination (500 meters at Lund and 1500 meters In Malmö) and is also getting thinner the deeper it gets.

Drilling

Four production wells and five injection wells were drilled and completed in two phases. Three of the wells one production and two injections wells are deviated with a 30 ° angle.

The casing program for the wells do not differ much, the productive zone is inclined so the depth from surface differs.

A 20” J55 (500 mm) conductor was set through the clay in the lime stone the depths varied from 25 to 75 meters. This casing also protected the shallow water zones where farmers got the drinking water.

The next step was drilled with a 17,5 “ bit down to the deep where the production zones starts, 470 to 635 meters. A 13 3/8” K55 BTC (340 mm) casing was run and cemented to the rock.

A bentonite based mud was used for this section of the hole.

The last section to be drilled was the production zones. The mud was changed to a KCl polymere mud to protect the zones. The size of the bit was 12 ¼”. The productive zones were reamed up to 15”. The last section was completed with 7 5/8” stainless blanks and 7 5/8” Johnsson wire wrapped screens. The slots of the screens were 0,5 or 0,8 mm depending on the size of the gravel used for gravel packing. Two sizes of gravel were used 0,7 to 1,2 mm or 1,0 to 1,7 mm, which were used depended on the size of the formations sand. The avarege size of the grains in the formation sand is between 0,5 and 0,8 mm.

Flow loggings made shown big differences in water flux along the screens, this was anticipated and the screens were designed to be 2,4 times longer than if the hole section had been productive based on a maximal speed of 0,03 m/s through the slots.

Water Chemistry

Geothermal water has chemistry which differs from ordinary water. The amount of dissolved salts are much higher. One reason is that when the sediments were created it was a period of high evaporation. In the sand stones of Skåne the TDS is between 3 and 20 %. The geothermal water in Lund has a salt content of 6 %. The dominating salts are calcium chloride 33 % and natrium chloride 66 %.

The geothermal water contains 2,5 litre gas per 100 litre of water. The gas is 92 % Nitrogen, 3 % methane and 3 % helium. To keep these gases solved in the water the lowest pressure has to be around 5 bars all the time.

Water chemistry from the 17:th of October 2000 is shown below;

Table 1: Water data

Content	**Value**
PH	6,9
O_2	1,5 ppb
Chloride	26 625 mg/l
Iron	28 mg/l

Well design

The void in the wells is filled with nitrogen gas to prevent corrosion.

Production well

The static water level is 10 meters below surface and the dynamic level is around 30 meters at 400 m3/h. The ESP are installed at 80 meters below surface. The pumps are over hauled every second year, due to the electrical motor. We use pumps from KSB-Mörck.

The risers are 200 mm rubber coated steel pipes. We did have epoxy coated in the beginning but the epoxy was very easily cracked when handling the pump. Cracks meant corrosion in the risers and during one of the pump lifts there was just material left in the risers to bear the weight of the pump. After that all pipes were exchanged to rubber coated instead and no problem have been noticed.

Temp level was 21 degrees from the beginning. The two production wells closest tom the injection wells have now a temperature of 17 °C. Hydraulic calculation showed that the temperature of the water when it got back to the production well would have the temperature of 17 °C. There is also a decrease in temperature due to the fact that colder water from higher levels is precipitating down faster then normal, when pumping. The proof for this is that the salinity has also decreased during the years from 6,5 to 5,5 %.

In 1996 a small decrease in temperature was noticed and in 1997 it was confirmed that water temperature from SK 2 was decreasing with approximately 0.4 degrees per year. That is 12 years after the system was taken into operation. The decrease for SK 1 was noticed in 1999 and 2000, 16 years after the system was taken into operation. The distance between the production wells SK 1 and SK 2 and the injection field is the same.

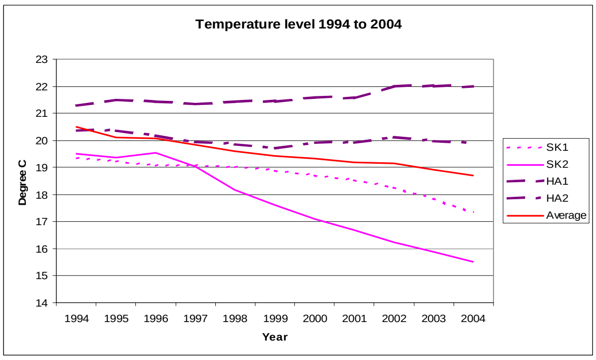

Figure 4: Years vs. production well temperature.

The formation depth for the four production wells.

	Top campan sand	Screen start	Screen end	lentgh
HA 2	545	601	691	90
HA 1	542	600	705	105
SK 2				87
SK 1				63

Depending on where the water is coming from in the formation the temperature may vary between the wells.

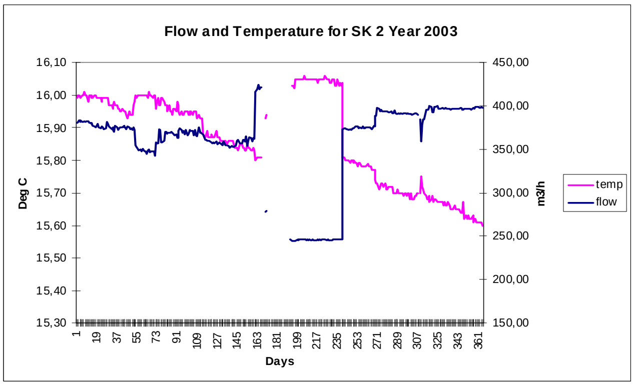

Figure 5: SK 2 temperature during 2003

The arrows shows where the cleanings have been made. During the cleaning the flow is decreased due the fact that only four out of five injection wells are in operation. This minor decrease in flow is enough for the temperature to increase. The second is during the summer overhaul and the system is closed down and the temperature has some time to recover even more. During the third cleaning in November the time with decreased flow was very limited and thus the impact on the water temperature.

<u>Injection wells</u>

The capacities for the injection wells are shown in the table below, in m^3/h..

Table 2: Injection flow

	Filter level below surface in m	**Filter ends below surface in m**	**Origin flow** m^3/h	**Flow before cleanin g** m^3**/h**	**Fow after cleaning** m^3**/h**
VÄ 2	514	649	380	220	348
VÄ 3	504	630	380	235	349
VÄ 4	507 619	619 658	300	275	316
VÄ 5	646	766	360	274	335
VÄ 6	576	671	200	199	251

Each injection well has a 80 mm pipe installed in the well head for cleaning purposes. The pipe is 80 meters long. The cleaning is done by means of a compressor pumping air into the well i.e. mammoth pumping.

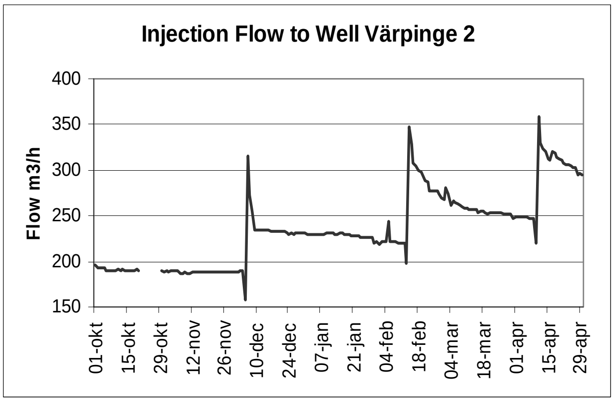

Figure 6: Injection capacity before and after three cleaning operations year 2000 for one well.

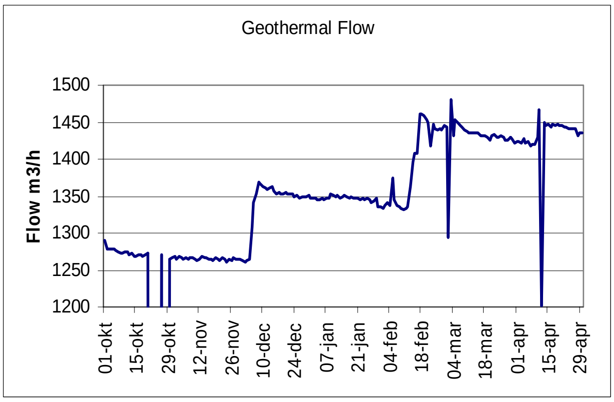

Figure 7: Injection capacity before and after three cleaning operation year 2000 for the whole system.

Injection pressure increases due to cold water and that the gravel packing settles. A dramatic increase in injection pressure is noticed every time we get a unplanned stop of the power supply and the pumps are stopped. When the pumps stop in an uncontrolled way, there is a pressure surge through the system and this shakes the gravel packing in the injection wells in a negative manner. The injection pressure goes up or the capacity goes down, when maximal injection pressure is reached.

In the beginning we only did one cleaning operation per year and then only the well that would be cleaned was shut of and the rest of the system was in operation.

In 1998 a trend was noticed with higher and higher injection pressure. It was not enough with one cleaning per year. The first step was to re-educated the operation staff in the importance of cleaning and why it was done. One of the injection wells is weaker than the others and we did have lot of problems while drilling this deviated well. The staff is always very gentle while dealing with this well and it shows the best result after cleaning. Actually it has better chacteristics now than just after it was taken into operation. VÄ 6.

This was taken as evidence that the cleaning should be done in a gentle way.

The cleaing interwall was increased to three to four times a year and every well got the treatment sometimes two times instead of one. Apart from that the cleaning during the summer is done with the whole system shut of.

Logging made in year 2000 in three of the five injection wells shown very little particles in the sump in the two oldest wells. The third well VÄ4 had approx 8 meters of particles in the bottom, of which 4 meters is screen. The two deviated wells were not logged.

Geothermal distribution pipelines

Pipe material Glas fibre reinforced plastic pipes with ballast of quartz sand of the branch HOBAS is used in the system. They are rated to 16 bars and 35 °C. The system is 4,2 km long with a diameter of 600 mm.

Leakage resulting contamination of the surrounding farmland has occurred. All of them have been smaller leaks. The soil was replaced. All leakages was in the same area and it was found out that level of the ground water was so high that the foundation for pipeline was damaged. The soil sank a little and this meant then pipeline was stressed and cracks in the pipes and in the coupling as a result. This section was in 2002 replaced with new pipes and a better foundation and drainage was made.

Valves in the pipelines in the subterranean chambers had to be replaced after 12-15 years of operation. Butterfly valves.

Maintenance and Operation

During winter time with high heat demand the injection temperature is around 4 °. With lower demand of the heat from the heat pumps the injection temperature can go up to 12 ° before the production is shut down. Then only one heat pump is in operation.

The last two summers we have used the geothermal system for cooling of the district heating network during some hot afternoons. The district cooling production is based on heat pumps and the excess heat is used for district heating production as well. The heat demand is very low during those hot afternoon and the only way of continue to produce cooling is to get rid of the excess heat. Cooling towers is one solution, but since it is only for a couple of hours each year, the cheapest solution was chosen. The nicest solution would have been to install a ESP in one of the injections wells and thus charge the formation with heat. With increasing numbers of hours the cooling is needed this may be feasible in the future.

HEAT PUMPS

Data

Both heat pumps VPG 1, installed and commissioned in 1984, and VPG 2 installed and commissioned in 1986 are manufactured by ASEA STAL.

VPG 1 has a maximum heat out put of 21 MW, and VPG 2 has 27 MW. Both machines have a minimum load of 12 MW heat out put.

The compressors for the refrigerant are two steps turbo compressors with an inlet pressure of 16 bars, intermediate pressure of 25 bars and the pressure after the compressor is 40 bars. The compressors have a rotating speed of 7327 r.p.m. and are driven by one electrical motor each. The electrical motors fed with 10,5 kV has a rotating velocity of 1491 r.p.m. and thus a gear box is necessary. The motor to VPG 1 is rated at 6,5 MW and the motor to VPG 2 at 9 MW.

In VPG1 we have 15 ton of the refrigerant 134 A and the amount in VPG2 is 20 ton.

Table 3: Condenser data

	VPG 1	VPG2
Tubing material	Carbon steel	Carbon steel
Tube length	10 m	14 m
Tube diameter	22 mm	22 mm
No of tubes	1729 pcs	1800 pcs
Area	3840 m^2	4494 m^2

Table 4: Evaporator data

	VPG 1	VPG2
Tubing material	Titan	Titan
Tube length	10 m	14 m
Tube diameter	19 mm	19 mm
No of tubes	2038 pcs	2038 pcs
Area	2868 m^2	3850 m^2

<u>Temperature and flow</u>

The temperature from the geothermal system into the heat pumps is 20 C and the out going temperature is between 4 and 12 degrees, depending on the load. Maximum inlet temperature to the evaporator is 16 C. The geothermal water is re-circulated. The lowest evaporation temperature of the refrigerant is 1 C.

District heating incoming temperature is ranging from 45 to 60 degrees. The outgoing temperature from the heat pumps is ranging from 50 to 82 depending on time of the year and temperature demand for the district heating system.

The maximum geothermal flow through the evaporator is 1600 m^3/h and the maximum district heating flow through the condenser is 2 500 m^3/h.

Major repairs and events

General

- The control system hang up 3 to 5 times annually due to low capacity. It was exchanged in 1999.
- Mechanical packings to the compresser were bad, short life span and high leakage. Partly new construction and new material.
- Leakage of refrigerant in both the evaporator and condensor. The leakage in the evaporator is the most problematic, we have higher pressure in the geothermal system thatn in the refrigerant system. This results in saline water in the evaporator, which them must be cleaned and dried out very thouroughfully.

VPG1

- 1986 Exchange of the “prall” protector in the condensor. The original was too weak and there was a big risk that it would break and damage the tubes. The ”prall” protectors is there to divide the streaming gas over the inlet of the condensor.
- 1987 A short cut in the motor M1.
- 1995 The freon R500 was exchanged to R134a. Both impeller wheels in the compressor were exchanged, all gaskets in the refridgerant system and lubricants were also exchanged.
- 1997 The tubings in the condensor were replaced to a titan alloy.

VPG2

- The condenser were magnetic when delivered. The magnetism “wandered” via the district heating system over to the condenser of VPG 1 as well. The condenser and cooler of VPG and the condenser of VPG2 got equipment, that put a magnetic field on the equipment. This field takes out the permanent one.
- 1986 Exchange of the ”prall” protection in the condenser.
- 1988 Exchange of a radial bearing in the gear box due to high bearing temperature.
- 1988 The second impeller wheel exchanged. A plate in the flashing vessel had got lose and damaged the compressor wheel..
- 1990 Break down of the electrical motor.
- 1994 The freon R500 was exchanged to R134a. Both impeller wheels in the compressor were exchanged, all packings in the refrigerant system and lubricants were also exchanged.
- 1998 The tubing in the condenser were replaced to a titan alloy.
- 2003 Exchange of the impeller in the compressor. The first stage was damaged. The cause is not yet clear, probably moist or oil in the refrigerant.

Revision

The heat pumps are over hauled every year. Every second year there is a major overhaul and the other year there is a minor overhaul. That is why there is this every second year difference in the annual operation hours in the diagram below.

The decrease in the annual operation hours is due the decreased need of the energy from the heat pumps and the extended cleanings of the injection wells which started in the year of 2000.

Since 1996 Lunds Energi has had district cooling production. This done by means of three heat pumps in an other production plant in the city. The excess heat from those heat pump is used for producing district heating as well. The cooling production comes first and during summertime the heat from this cooling production is enough for producing the necessary heat to the district heating network.

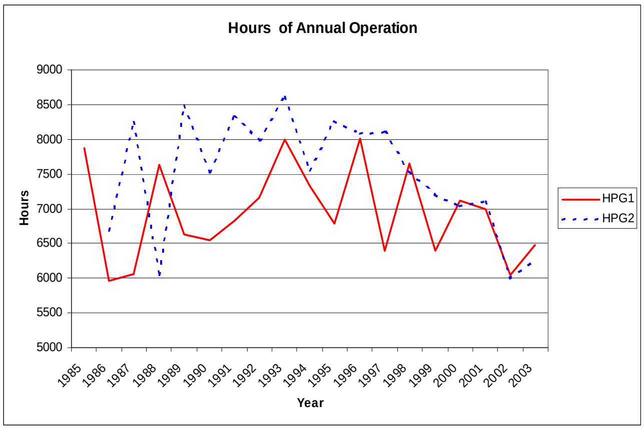

Figure 8: Annual operation hours of the heat pumps since 1984

DISTRICT HEATING PRODUCTION

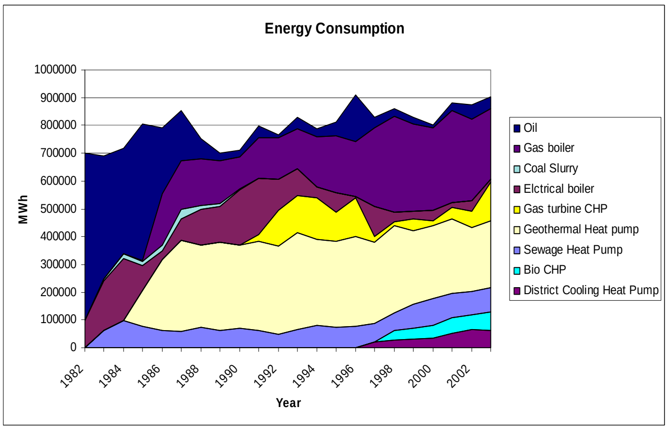

Figure 9: Energy Consumption for the district heating production since 1984

FUTURE

Investigation and calculations for utilising more of the capacity of the heat pumps . The capacity has decreased due to the decrease of temperature and it may be feasible to increase flow and/or temperature. The flow could be increased by better injection capacity and a more thorough cleaning, jetting of the injection wells has been considered. Other possibilities is to drill an extra injection well or drill one more production well and one injection well.

New system in the Tornquistzone

Briefly, the geological setting from surface to about 1950 m is sedimentary deposits resting on a basement of igneous rock. The sedimentary deposits are mainly limestone, sandstone, shale and siltstone. The total salinity of the geothermal water in the sedimentary section can be as much as 15–20 %.

The production was initially planned to take place from fractures at about 3500-3700 m depth, but initial tests showed that the flow here is insufficient for an economical production, and other possible production zones at higher levels may have to be considered. Further tests have shown that it is possible to extract over 70 l/s at a temperature of 40°C from sandstones above 1950 m.

The production area is part of a very large tectonic deformation zone, the Tornquist zone, which is one of the major geological structures in northern Europe. During 2001 extensive reflection seismic surveys were carried out in an area due east of the city of Lund. These investigations have confirmed the deformation zone, with intensive reverse faulting along a horst ridge close to Lund (Romeleåsen).

Fill in seismic investigations were carried out during the fall of 2001. This was done to enhance the structural understanding, and in order to define drill sites for the new geothermal project in Lund. Important parts of the geological evaluations have been carried out in co-operation with the Swedish Geological Survey (SGU) and its local office in Lund.

Also the drilling and measurements in the well have confirmed the presence of major fracturing in the area. The overall concept, that it is possible to find water and fractures at these depths, is thus supported by both measurements and the drilling. The flow was 7 to 10 l/s and the temperature at 3 700 meters was 85 ° C, which is not enough to build a commercial energy system.

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