GEOTHERMAL ENERGY

LUND (Sweden)

Geothermal energy rather takes a subordinate position among renewable energy sources. There are two possible sources for it: the radioactive decay of natural radio nuclides which causes the spreading of heat onto the earth surface, and the storage of solar energy in the top earth layers. For this reason, geothermal energy is available in many places and independent from the different seasons of the year, even if some regions do have a higher potential than others. In the city of Lund in Southern Sweden the potential is present and is exploited by the Municipality-owned utility.

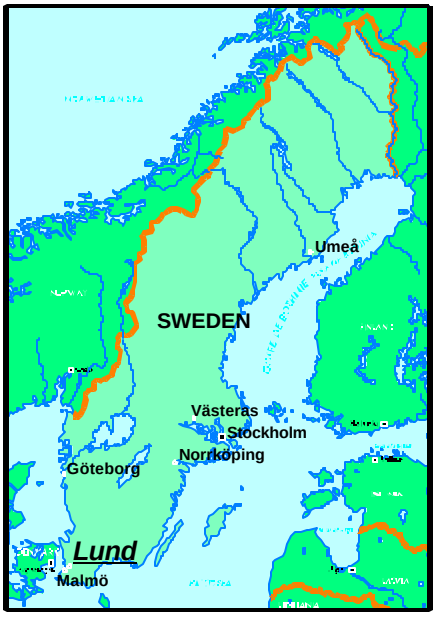
GENERAL ASPECTS

Lund is a city with 75,000 inhabitants. It is situated in the Southwest of Sweden in the region of Skåne. Its history goes back more than 1,000 years and the city has an impressive cathedral built in the 12th century. The major neighbouring city, Malmö, is quite close and due to the building of a new bridge crossing Øresund, the Danish capital Copenhagen will be only 20 kilometres away by the summer 2000. This makes the city quite attractive for future businesses. The ancient city centre and the presence of a big university makes the city quite charming.

Climatic data:

Degree Days (Basis 17 °C): 3154

Annual Mean Temperature: 7.5 °C



CONTEXT

Already in 1963, the Municipality-owned utility, Lunds Energi AB, started implementing district heating (DH) in the Municipality and today the entire city centre's heat demand is covered in this way. The aim in the future is to further expand the district heating network to the housing areas around central Lund. The heat demand in these areas is currently covered either by electric heating, by oil furnaces or by natural gas furnaces. Due to the presence of hot water in the soil under Lund, two geothermal power plants were commissioned in 1985 and 1986. The hot water (21 °C) is pumped from 800 metres underground. At present, the geothermal system supplies 40% of the heat demand in the district heating network. The remaining part of the heat demand is covered by a combination of oil, biomass and natural gas combustion.

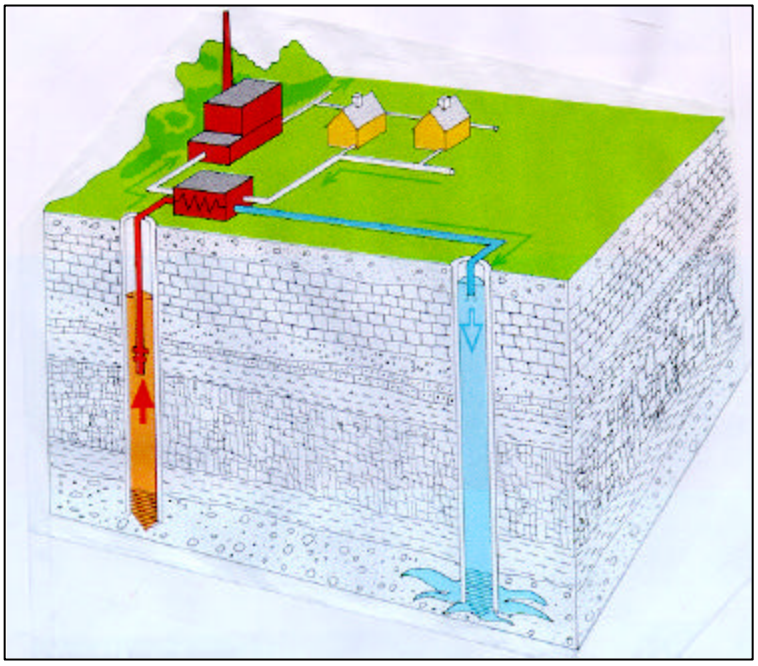
Apart from the geothermal application, the utility is also active in biomass, using wood chips in a combined heat and power implementation (CHP). The erection of three wind turbines (with a total installed capacity of 950 kW) and utilisation of district cooling as well, completes the picture of Lunds Energi and the Municipality as green minded and forward-looking actors in the energy market. The variety of different energy technologies makes it easy for Lunds Energi to fit the heat and power production to the current price level of the future liberalised energy market.

EXPERIENCE OF LUND

The basis for the supply of heat in Lund is the pipes used for distributing energy. – One network is used for distributing hot water (district heating) and one for cold water (district cooling) The production facilities within Lunds Energi include:

- Base load capacity: geothermal heat pumps,
- Biomass co-generation plant,
- Modern gas and oil boilers,
- Electrical boilers,
- Extensively extended district heating network,
- Gas turbine co-generation,
- Hot and cold water accumulator tanks.

The geothermal plants



Due to the presence of the hot water in the ground below Lund, two geothermal plants with a maximum heat output of respectively 20 and 27 MW were commissioned in 1985 and 1986. The project involved close co-operation between Lunds Energi and the University of Lund. The principle is to pump the 21 °C hot underground water from a 800 metre deep well. This amount of energy (flow of water) is then enriched by a heat pump using electricity. This means that the temperature of the underground water increases to about 80 °C[1]. The water then passes a heat exchanger that cools the water to 4 °C. After cooling, the underground water is re-injected into the ground. The water for district heating, heated by the heat exchanging system, is now at 77 °C and is used for the heat demand in the city. In ideal working conditions, the heat pump has an overall coefficient of performance (COP) of approximately 3.3, meaning that an input of one kWh electricity gives an output of 3.3 kWh heat. This is quite high and is due to the use of the hot water from the underground. Normal heat pumps installed for example in dwellings work with a COP of around 2.7

Maximum heat capacity	47 (20 + 27)	MW
Coefficient Of Performance	3.3	-
Flow of source water	120	L/s
Temperature of source water (in – out)	21 – 4	°C
Coolant	R134a	-
Heat produced in 1998	313	GWh
Electricity consumed in 1998	102	GWh

Technical specifications for the geothermal plants

[1] It is possible to increase the temperature to 84 °C, but for technical reasons only 80 °C is used.

The temperature gradient in the underground is approximately 3 °C per 100 metres. This means that with a deeper well it would be possible to achieve higher temperatures. This is not done because of technical problems. Already at 800 metres the water contains large amounts of salt (6 % volume) and gasses (2.5 litres of gas per 100 litres of water, the gas consists of 92 % NO_x, 3 % methane and 3 % helium). To keep these elements in the underground water, it is pressurised to 3 Bar. With a deeper well, a higher amount of gasses and salt would be present and therefore higher pressure would be necessary. The method consisting in only pumping water from 800 metre deep is cheaper and more secure than drilling deeper, even though the water would then be at a higher temperature with a higher COP-figure as a natural result.

The implementation of the geothermal plants has led to a remarkable decrease in the use of fossil fuels and associated emissions. It has been calculated that in the first 5 years of running the environmental figures can be shortened to:

Amount of fossil oil fuel saved	200,000	m^3
CO_2-emission saved	580,000	tons
SO_2-emission saved	4,000	tons
NO_X-emission saved	1,400	tons

The coolant has until recently been Freon – which, if emitted into the atmosphere, contributes to depleting the ozone layer. In 1995 this was changed to the less aggressive R134a. This technique, supplying Lund with inexpensive and independently produced heat is now called "the Lund Model" and is viewed as a good example by experts both in Sweden and on an international level.

Finance

The total investment in the geothermal installations amounts to € 11,7 million[2] (nominal value). The investment was spread over three years with € 5,480,000 in 1984, € 4,850,000 in 1985 and € 1,050,000 in 1986. Later on, an additional € 320,000 was invested. Part of the money was cheap loans from the government – at that time investments with the objective of minimising the dependency on oil received support.

District cooling

A district cooling network has been built over the last few years. The network has its own pipes where cold water is distributed. Water at a temperature of 4 °C is delivered to consumers and when the water returns, the temperature has risen to 12-15 °C. The district cooling production plants have their own heat pumps. - The geothermal heat pumps are not used to produce district cooling due to the long distance from the heat pumps to the cooling demand. On the warmest summer days, the surplus heat from the district cooling heat pumps – fed into the district heating network - is almost as high as the total heat load in the entire district heating network. This means that in the summer, the geothermal heat pumps produce less heat than before the installation of district cooling. However on a yearly basis, the geothermal heat pumps produce much more heat than the district cooling heat pumps.

Biomass plant

Lunds Energi has recently invested in the neighbouring utility giving them access to a new biomass combined heat and power plant. This is situated 7 kilometres from the city of Lund, but with a new connection pipe, the citizens of Lund are now also supplied with biomass-based heat. The investment in the neighbouring utility is another step in the effort to prepare

[2] One € equals here 9.49 Swedish Kroner

Lunds Energi for the liberalised energy market and to make the utility more independent of price fluctuations and other factors that Lunds Energy does not have the possibility of influencing.

The future liberalisation and Lunds Energi

Lunds Energi has recently invested in a huge accumulator tank for storing surplus heat production. A new accumulator for cold water for district cooling was also installed just before Christmas 1999. This is a very good example of flexibility strategy that they are aiming at in Lund. The combination of heat pumps and electrical boilers that consume electricity, co-generation capacity – partly based on biomass - that produces electricity, and large scale possibilities for accumulating cold and warm water, makes Lunds Energi's business profitable for the company and the consumers regardless of the fluctuations in the electricity-, oil,- and gas markets. The new accumulator option gives an additional short-term flexibility, and the co-operation with the neighbouring utility, Eastern Group, as well as investments in Norwegian Hydro Power, complete the picture of an independent energy supplier ready for the full liberalisation of the energy market.

EVALUATION AND PERSPECTIVES

Lunds Energi AB and its partners have been forward-looking in their energy planning. The use of a wide range of different energy technologies makes the utility very flexible and prepared for the free energy market. The advantages in using the local source – the underground hot water – are remarkable. Independence in foreign markets, use of local knowledge and thereby local employment, improved environment due to less use of fossil fuel and the fact that Lunds Energi is now able to sell the know-how to other countries are all factors that stress the profitable investment – for the region as a whole. Further progress in changing from electricity based heat pumps to natural gas based heat pumps has so far been postponed due to low electricity prices and possible plans for a future CHP plant. If such a plant is implemented, the geothermal heat pumps will produce far less energy than today. In this case, there will probably be no new investments in the geothermal systems. If and when the CHP plant is implemented depends on electricity prices which at present are quite low in Sweden.

FOR FURTHER INFORMATION

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