

# Analysis of a Ground Coupled Heat Pump Heating and Cooling System for a Multi-Storey Office Building

In the last few years, high energy consumption due to an increase of the heating and primarily cooling demand raised the interest in the efficient use of energy in buildings. This highlighted the need for new configurations and strategies for heating, ventilation and air conditioning systems of buildings.

One of the most essential decisions guidance to use a technology are examples of best practice proving the capability of the technology. The aim of the project is to analyse the energy supply system based on a ground coupled heat pump heating and cooling system installed in a multi storey office building in Vienna, Austria.

The STRABAG HOUSE (Figure 1) was constructed as a multifunctional office property. The 21000m<sup>2</sup> area of the 50m high building is divided in 13 floors with about 18000m<sup>2</sup> office area and 3000m<sup>2</sup> for shops and commerce. The building is heated by floor convectors and cooled through micro perforated sheet-metal cooling ceilings.

Energy supply needed for heating and cooling is effected through a ground coupled heat pump system with an installed cooling capacity of 3\*693 kW. The heat pumps are linked to a closed loop heat exchanger comprising of cast-in-situ driven piles integrated into the foundation. In total 68000m of PE-pipes were furnished partly in the foundation of the building and partly in 250 17m long cast-in-situ driven piles; the thermal energy is exchanged in 800 circuits.

The system was designed in a way that the office and retail space require no additional power supply - apart from the electric power needed for the operation of the energy supply system.

The main objective in this work was to collect and to analyse real data dealing with the operation of the energy supply system. To ensure detailed information the monitoring data was also analysed for the different operational modes:

- ▮ Heating (Figure 2)
- ▮ Heating + Free Cooling
- ▮ Cooling + Free Cooling (Figure 3)
- ▮ Cooling

The energy balance was drawn as indicated in Figure 2 and Figure 3.

The monitoring results can be summarized as follows:

- ▮ Heating demand: 3000 MWh
- ▮ Cooling demand: 1600 MWh
- ▮ Electricity consumption: 1750 MWh
- ▮ Seasonal Performance Factor: 2.6

The monitoring during its second year of operation in the period from the 27<sup>th</sup> of December 2004 to the 1<sup>st</sup> of January 2006 of the STRABAG HOUSE has shown that the installed system can accomplish the requirements with respect to the heating and cooling demand of the building. Less than 0.1 percent of the heating demand was supplied by the electric flow water heater.

The results (Figure 4) have shown a seasonal performance factor of 2.6 for the total energy supply system in the second year of operation.

2.5 percent of the heating and cooling demand of the building was provided in the two free cooling modes. In comparison to the results for 2004 the utilisation of free cooling could be doubled due to control optimisation.

For future implementation of such a system it is recommended to decrease the flow temperature of the heating system to improve the performance of the energy supply system.

From an ecological point of view the installed system shows a favourable CO<sub>2</sub> balance compared to conventional heating and cooling systems based on natural gas, fuel oil or on the usage of district heating.



Figure 1: STRABAG HOUSE

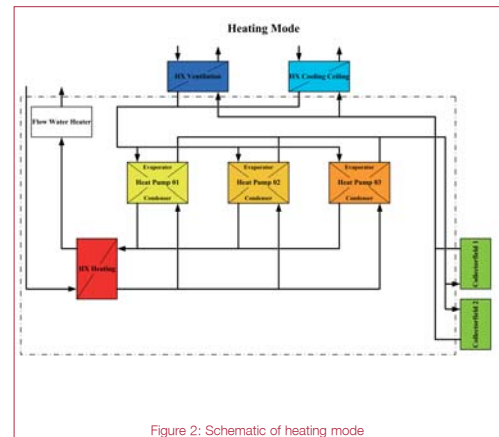


Figure 2: Schematic of heating mode

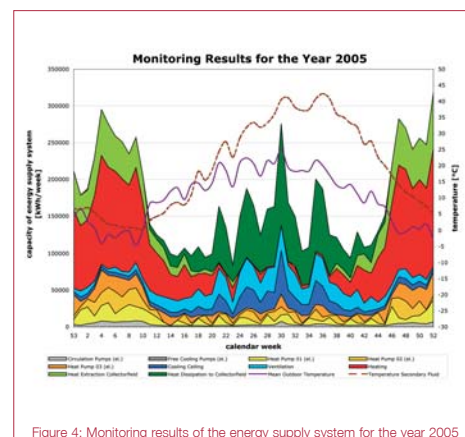


Figure 4: Monitoring results of the energy supply system for the year 2005

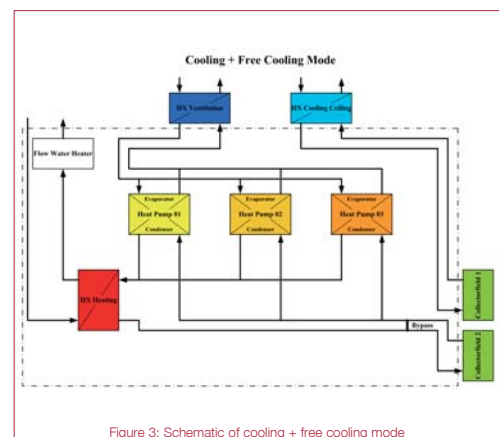


Figure 3: Schematic of cooling + free cooling mode