A GEOTHERMAL HEAT PUMP PROVIDES, SINCE 2008, HEATING THE SWIMMING POOL IN MOULINS (France)

AVERAGE 2008-2012

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ABSTRACT:
The swimming pool in Moulins, France, is equipped with a geothermal heat pump on water table, which provides the heating (air and water) and dehumidification. EDF R&D ensures the energy monitoring of this particularly powerful installation. From 2008 to 2012, the heat pump produced, on average, 3311MWh ch/an for hot average costs of 17.6€/MWh(*); the cost of maintenance represents an increase in cost of hot MWh of 6%, or 1.08€/MWh hot produced. It should be noted that if the heating had been produced by a boiler room gas, it would have been at a cost of 44€/MWh. Thanks to the heat pump, the CO_2 rejections are reduced by 81%. The geothermal heat pump required an over-investment of 209k€ compared to a boiler room gas heater; the annual economy generated is on average 87k€, yielding a 3 years payback.

(*)all of the costs indicated in this article are excluding tax

Key Words: geothermal heat pump, energy efficiency, COP, ground water, CO_2 reduction

1. INTRODUCTION

The Moulins Urban Area Community launched a project to build a recreational water centre in 2002. After an initial assessment phase and discussions with local stakeholders, a decision was made to restructure the existing water centre, of which the facilities dated back to 1967.

Project management was entrusted to the Moinard and Blanchet firms and to architect Stéphane Pichon (photo 1 , 2). It should be noted that this operation was unique in that it consisted of two stages to keep the existing swimming pool operational during the first phase of construction.

Water is a key element in Urban Area Community given the importance of the Allier River. The community therefore decided to use a water-source geothermal heat pump to meet the site's heating and dehumidification needs.

The technical department of the urban community has ensured the project owner of the operation and oversees the technical monitoring facilities.

2. TECHNICAL SITE CHARACTERISTICS OF THE SWIMMING POOLS

The indoor area of the recreational water centre includes:

- a sports pool: surface area = 25*20.4 = 510m^2; volume = 1200m^3 (photo 3)
- an initiation pool: surface area = 20*10 = 200m^2; volume = 180m^3
- a wading pool: surface area = 10*7.7 = 77m^2; volume = 15m^3
- a leisure pool: surface area = 10*15 = 150m^2; volume = 142m^3
- a spa: surface area = 8*1 = 8m^2

The total indoor surface area is therefore 945m^2 with a water volume of 1545m^3. The buildings span a net floor area of 4443m^2.
The outdoor area features a recreational pool spanning a surface area of 400m^2 with a volume of 380m^3. These pools are open from June to August.
The total surface area of the pools is therefore 1345m^2.
The total cost of the operation was 10.7 million euros, or €7780 per m² of pool area.

3. TECHNICAL CHARACTERISTICS OF THE HVAC SYSTEM

The heat pump
The Saunier research firm was in charge of studies on the heating, ventilation and dehumidification of the recreational water centre. It was entrusted to Crystal Clermont Ferrand. Heating and cooling represented an investment of €801,000 or €712/m² of pool area. The installation of the geothermal heat pump required an over-investment of €209,000. The cost of the heat pump with its installation cost approximately €83,000, while the cost of drilling (off pump) is €43,000.

The installation includes a CARRIER-brand Type 30HXC 230A (with R134a) heat pump, the heating power of which is 911kW heat for 204kW absorbed electric power (photo 4).

The heat pump provides heating water for the basins pool, preheating domestic hot water and heating fresh air, which is carried out by Air Handling Units.

The cold produced by the heat pump is used to dehumidify the room air. In the summer, when the heating needs are insufficient to perform the dehumidification, it is achieved via water from the groundwater (by heat exchanger), which is at a temperature of 14°C. This is a recommendation by EDF R&D.

The Air Handling Units (AHU)
This heat pump heats the centre's pools, preheats its domestic hot water and supplies its two CIAT-brand air-handling units with heating and cooling. The flow rate for the sports pool's AHU is 45,000 m^3/hr, while for the recreational pool's AHU it is 27,000 m^3/hr with energy recovery. During the night, and when the outside temperature is above 5° C, the AHU are set at a rate reduction of 50% which reduces 80% of the energy consumed by the fan motors. This is a recommendation of EDF R&D, and yields a two-year pay back.

The pumping
Hydrogeological studies were carried out by Antéagroup agency Clermont Ferrand.

The installation also features two pumping wells (2*35m^3/hr) and two reinjection wells. Groundwater is at 6.2m, while drilling (1 pumping and injection 1) descends to 13m.

The two pumping wells are made of stainless steel (316L). The two drilling injections are fabricated out of PVC. The pumps are at variable speeds and are submerged at approximately 10m below the surface.

The exchanger is stainless steel (316L).

All of the installations are run by a SIEMENS-brand engineering management system.

The operation and maintenance of technical installations (HVAC and water treatment) of the site are made by Dalkia Auvergne.

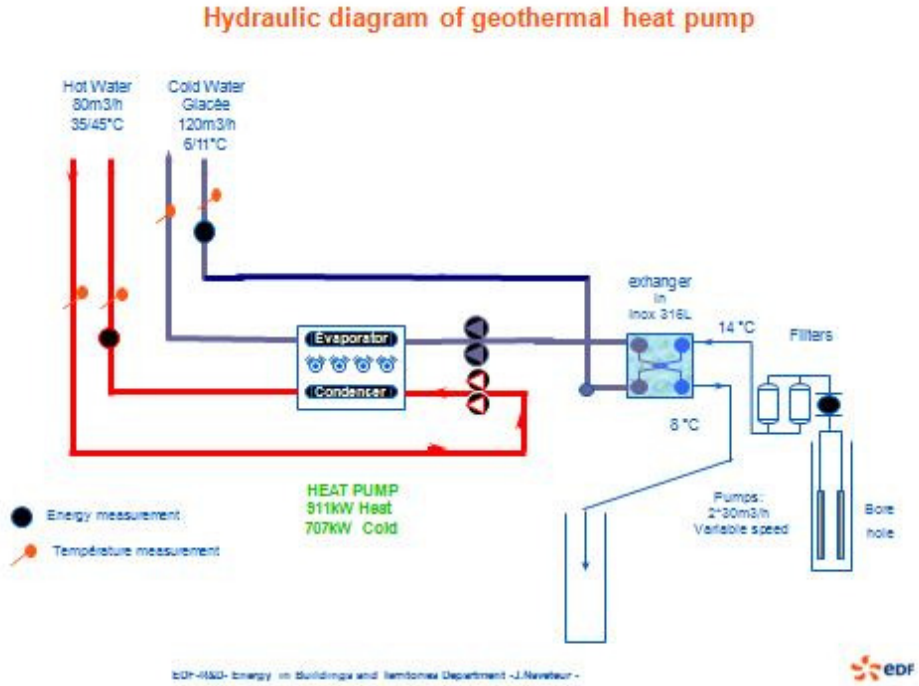


Figure 1. Hydraulic diagram of geothermal heat pump

4. MEASUREMENT RESULTS (2007-2012 AVERAGE)

Given its experience in other facilities equipped with geothermal heat pumps (1 to 7), the community of Moulins chose EDF R&D to provide assistance in mastering energy including work regarding the design and construction of the facilities' HVAC systems. We paid particular attention to the geothermal part (heat pump and drilling). We monitored the energetic monitoring facilities beginning with their commissioning in 2008, with the following main results:

Consumption and cost of consumption

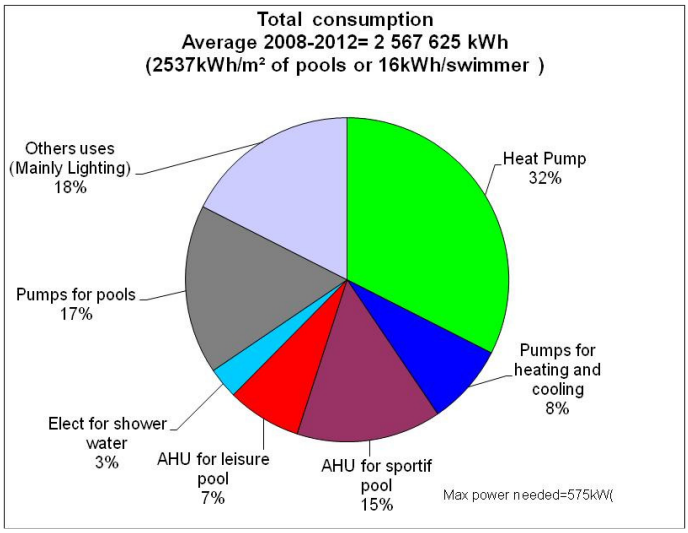


Figure 2. The average consumption is 2,567,425 kWh/year

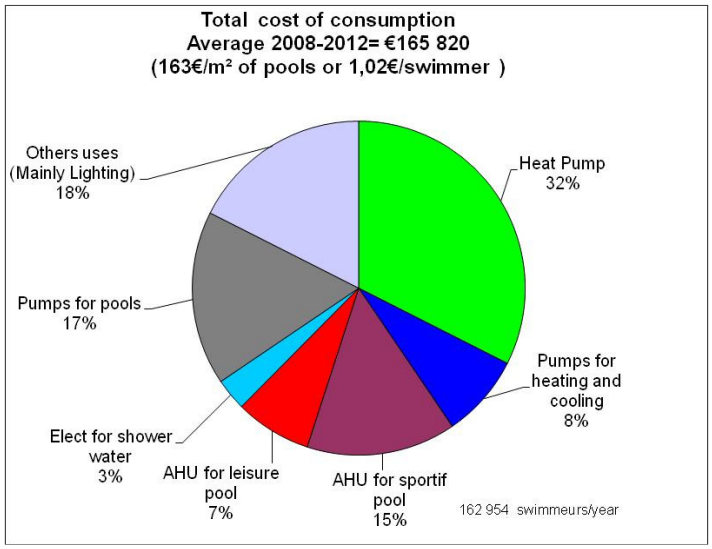


Figure 3. The average cost of this consumption was €165,820/year.

Excellent performance

The heat pump supplied 3311 MWh of heating and 1110 MWh of cooling for dehumidification. The heat pump and boring pumps consumed 873 MWh for a heating + cooling COP of 5.07!

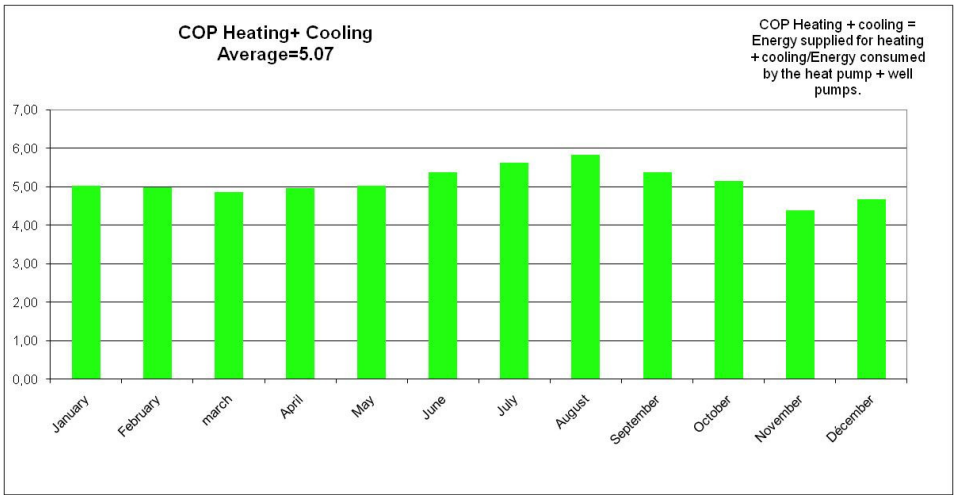


Figure 4. COP Heating + cooling = Energy supplied for heating + cooling/Energy consumed by the heat pump + well pumps.

Significant savings for a payback of 3 years

The average cost per MWh of heat produced by the heat pump was less than €17.6/MWh. If heat had been produced by a gas boiler with an efficiency of 94%, it would have cost over €44/MWh!

When compared to a solution in which heat would have been produced by a gas boiler, the annual savings generated by the heat pump totals €87,432.

The installation of the geothermal heat pump required an over-investment of €209,000, which means a 3 **years payback time!**

A low maintenance cost

Maintenance of the heat pump is assigned to the constructor that happens, on average, twice a year, during technical monitoring breaks. In model averagely cost of maintenance is €3569, representing a higher cost of MWh of heat produced at €1.08, or +6% of the average cost per MWh of heat produced. Note that this machine is heavily used since it is operating more than 350 days / year with an average load rate of 43%.

And less CO_2

The heat pump solution also made it possible to reduce CO_2 emissions by 81% when compared to a gas boiler.

5. CONCLUSION

This energy monitoring of a geothermal heat pump for a swimming pool showcased savings that quickly justified the investments made, all the while reducing CO_2 emissions.

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Photo 1



Photo 3



Photo 2



Photo 4

