Geothermal Heating Concepts

The amount of heat delivered into the house is the sum of the electrical energy consumed by the heat pump system (EKW) plus the heat extracted from the Cold Reservoir (QC).

Q_H=Q_C+E_KW

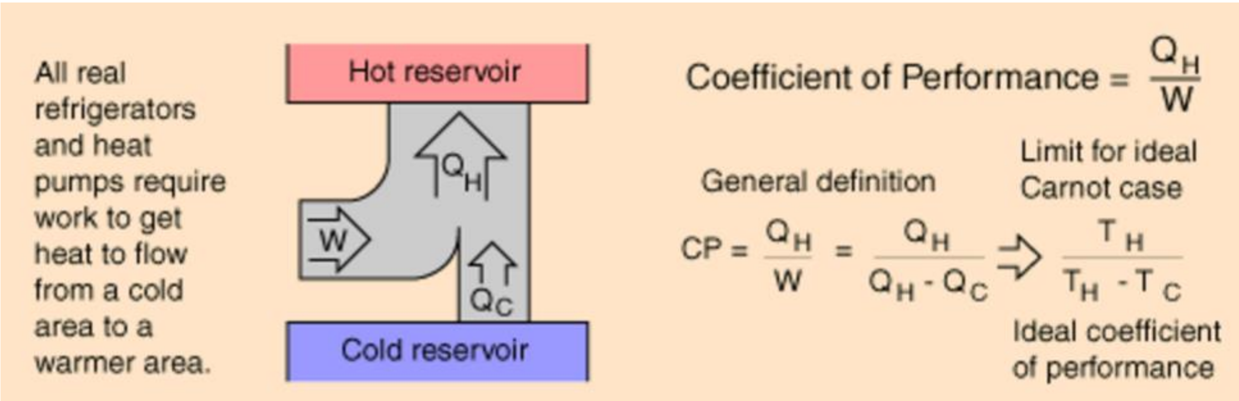
The Cold Reservoir is the earth and the water from the ground loop piping picks up heat from the earth/ground and delivers it to the basement heat pump.

The electrical energy consumed by the heat pump system (EKW, or W in the diagram below) includes the power consumed by all of the following:

Heat pump refrigerant gas compressor (vapor compression heat pump)

Fan motor used to circulate air through a refrigerant to air heat exchanger (refrigerant piping with fins) and into the house

Water pump used to circulate water through the ground loop and the heat-pump water-to-refrigerant heat exchanger (a pipe within a pipe, or coil in coil, heat exchanger)



Above figure and equations were obtained from:

http://hyperphysics.phy-astr.gsu.edu/hbase/thermo/heatpump.html

The surprisingly high theoretical maximum COP of 17.65 is not practically achievable. Real heat pumps deliver a COP in the range of 3 to 4 in the above conditions. This is not too bad – you pay for 1 kWhr of electricity and get 3-4 kWhr of heat transferred into the house. The tradeoff is the capital expense needed to implement the system. The higher priced paid per KW the faster the payoff return on investment.

Cooling, or summer time air-conditioning, is much more efficient. In this case, the ground loop temperature is actually lower than the desired house temperature. The heat-pump operates like a standard air-conditioner but the heat-sink is the cool earth, not the warm (or hot) outside air. It should work exceptionally well, but there is a catch to summer time cooling and that is removing water from the air. There is a lot of stored energy in the warm water-vapor that must be extracted and sent to the earth. (Note: This is also why winter time humidifiers consume heat – the energy it takes to vaporize the water must be supplied by the heating system and will then lose due to air exchange with the outside air). At a room temperature of 75 °F, the heat exchanger coils must be driven down below 55 °F to get below the dew point at 50% humidity. If the coils do not get colder than the desired dew point, the air will get cool but will stay humid.