Estimating Thermal Production for a Large Ground Source Thermal Technology Project

A review of the attendee downloads in the section "earth properties for commercial application of GSTT" provides data for this estimation. Although the detailed calculations are beyond the scope of this course (for details see M546 Ground Source Thermal Technology), a simple example is included here. An example case for a commercial application might occur in the northern area of the East Coast such is in the Appalachian mountain areas such as the region north of New York where the winters can be bitter and cold. Such an area could benefit immensely.

Although the nominal temperature gradient is 30°C per kilometer near the surface, that is in the near crust, the actual temperature gradient at a particular location will be a variable. That is for any particular location the test well should be drilled to determine the actual temperature as well as the composition of the block of earth. Knowing the thermal conductivity will allow an estimate of the spacing between the wells. Knowing the temperature gradient that exists determines how deep the wells should be get drilled. Referring to downloads, the data for crust temperature profiles and compositions at various locations and depths at depths of 1500 to 2000 meters (~6000 ft) show temperatures would be between 80 and 110 °C (176 and 228°F) and that the physical properties of the earth at these depths are: density 96 pounds / cu ft; thermal conductivity,k, 0.36 Btu/ (hr – square ft); thermal conductivity = function of heat capacity of the solids and the weight fraction of solids, the remaining being water. An estimate of the thermal energy transferred by the Ground Source Thermal Technology (GSTT) is calculated for the producing volume [for a producing depth of 500 meters (1500 ft) = 1500 x 3.14 10^2] = earth for spacing of 20 feet. The thermal heat transferred is = [producing volume] $\times$ [density] $\times$ [k] $\times$ [c_p]. This calculation is shown on the attached spreadsheet download "Calculation of heat production.pdf".

In a Northern cold climate such temperatures would be very beneficial for reducing power costs. As shown by the attached calculation, the monthly thermal power generated has a valued of $544,000 per well per month. Therefore drilling to depths of 1000 m, (3000 feet) might be justified. Obviously it will be require an optimization of the well diameter and spacing to optimize production and minimize costs.

Type 2 VERTICAL Closed-loop System

Large commercial and public buildings, as well as small local district heating systems often use vertical systems, Fig. 12, because it is more economic than for horizontal systems. Vertical loops are also used where the soil is too shallow for trenching, and they minimize the disturbance to existing landscaping. See Figure 8 for a large small structure such as a large residence.

For a vertical system, holes (approximately 4 inches in diameter) are drilled about 20 feet apart and 100 to 400 feet deep. Into these holes go two pipes that are connected at the bottom with a U-bend to form a loop. The vertical loops are connected with horizontal pipe (IE, manifold), placed in trenches, and connected to the GTHP pump in the building.

Figure 12. a & b Vertical closed-loop “Ground Source” system for larger structures.