Using exergy storage systems for cooling

For buildings that have predominantly cooling needs the exergy systems designs tend to be different. The following are three examples:

1) Very large buildings (or buildings in which a large amount of heat is generated) The direction of heat flow in a concentric heat store can be reversed. The principles are similar - the difference is that the exergy heat pump extracts heat from the center and injects it into the ground at the periphery of the store, where an air heat exchanger extracts the heat and transfers it into the winter air. The result is that over the winter a large amount of heat is extracted from the ground, in effect storing cold that can be used to air condition the building in the summer. In the process the electric energy that is used to drive the heat pump is effectively recovered during the summer because no power is needed at that time for the cooling operations. At the present time many thousands of MW of power is needed in Ontario during the summer to drive the existing air conditioning systems and that is in some years the primary peak power load, so that summer load disappears. The load reduction is particularly important because it occurs during the daytime when the power is needed for other applications. Since the exergy heat pumps only work at times when there is a surplus of power available, the demand is shifted from the peak demand periods to the minimum demand periods.

The cold can be extracted from the core using an anti-freeze filled loop that transfers the cold into a tank filled with containers of water. The freezing water stores the cold for use during the periods of peak cooling demand. The provides two advantages: 1) the rate of heat exchange during the peak period can be very high, minimizing the borehole length, and 2) the distribution loop within the buildings can use ordinary water, which is simpler, safer and cheaper than anti-freeze.

Since such a configuration does not provide for space heating or DHW there should normally be two stores in use, one for cooling and a smaller one for heating and DHW.

2) Medium size buildings for which the annual heating and cooling loads are the same Actually, this category can include district heating/cooling systems in which there is a mix of large and small buildings that balance the seasonal loads. For an individual building the typical size that meets this requirement is about 10,000 square metres. Normally a heat store should be used rather than a cold store because the former can provide all three functions.

It is not necessary to exactly balance the winter and summer loads. If there is an imbalance the store will either draw heat from the surrounding ground or dissipate any excess heat into the surrounds. Since ground stores inherently have very long lifetimes this tolerance is likely to be important as the building configurations change over the years. If the imbalance becomes excessive an air-heat exchanger can be added to handle the imbalance.

3) Stores for which the peripheral temperature must be maintained at the ambient ground temperature If there are multiple heat stores in a congested downtown area then they could interfere with each others' operations if their peripheral temperature drops during the summer to meet the AC needs. To avoid that interference a dual heat pump configuration can be used, employing one heat pump to extract heat from an ice storage tank (used for cooling) and transferring the heat to the peripheral boreholes from which it is subsequently pumped into the core of the store, thus returning the peripheral temperature to the ambient value.