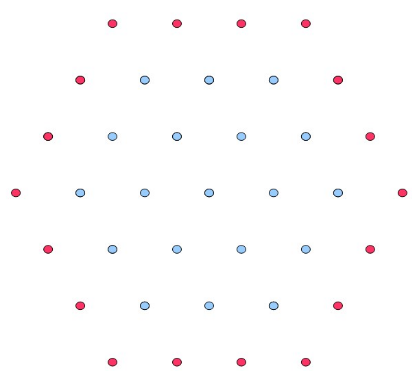
Heating Mid-size Buildings

Large buildings normally dispose of more heat during the warmer parts of the year than they consume for space heating in the winter. Presently most of that excess heat is just wasted. Moreover, most such buildings dispose of the heat by dumping it into the hot summer air, a process that requires an excessive amount of electricity to power the heat pumps. Most of this waste of energy can be eliminated if the heat from the air conditioners is transferred into the cool ground instead of the hot air. The heat can then be stored until winter when it can be recovered to heat the building with its own waste heat.

Very large buildings (over 100,000 square feet) and buildings that house heat generating equipment like computers and communications gear produce a considerable excess of heat. Small buildings like homes have an annual heat deficit so if the heat is stored it can be shared between the two types of buildings, making both nearly energy independent for their heating and cooling. This note covers mid-size buildings that fall in between those extremes. Such buildings can balance the summer and winter heat flows so that they are energy independent without requiring outside connections.



The above pattern shows the normal layout for the ground boreholes into which the heat is transferred. The depth of the boreholes is chosen to achieve the required storage capacity for the building in question. (Very small buildings may lack the outermost shell and very large ones may have one or two additional shells)

The heat is injected into the inner (blue) boreholes. Heat flows very slowly in the ground so it does not reach the outer boreholes (red) until the heating season has begun. Initially heat is then extracted from the outer boreholes, creating an annular well into which heat flows from both the center and from the surrounding ground. By mid-winter heat extraction begins from the inner boreholes as well, with the total borehole length then being able to handle the maximum rate of winter heat demand. With this strategy at least as much energy is extracted in the winter as was injected in the summer, with the option being open to extract some of the natural heat from the surrounding ground as well when that does not interfere with the needs of neighbours.

The cost of such systems is largely determined by the cost of the boreholes and ground heat exchangers. That cost can be minimized by installing buffers on the input and output lines of the heat pump. The buffers limit the temperature swing of the fluid in the exchange loop. Together with quad-tube ground heat exchangers these can reduce the capital cost of the ground system by as much as a factor of four and they will also reduce the amount of power needed by the heat pump.

Buildings smaller than 100,000 square feet will commonly require a source of additional heat to be added to the ground store. The least expensive source of that heat is the summer air. Heat can be extracted from the air and transferred into the ground store to make up for any deficiency using an air heat exchanger like that pictured above.

Mid-size buildings with ground heat stores are the easiest and most economical buildings to heat and cool because their heating and cooling demands are the most nearly matched, but buildings of all sizes can employ heat storage to eliminate GHG emissions, to provide long term sustainability and to save money.

Note that storage systems deliver their benefits during both the winter and summer power demand periods, thus reducing those peaks while also reducing the even larger GHG emissions from heating fuels. Such peak reductions make our hydro power more productive.