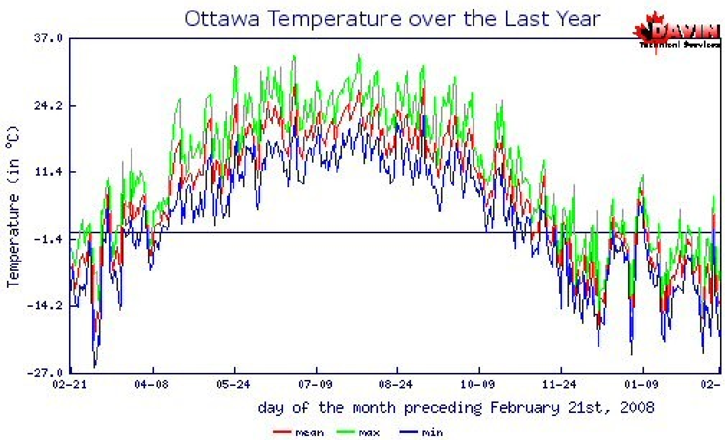
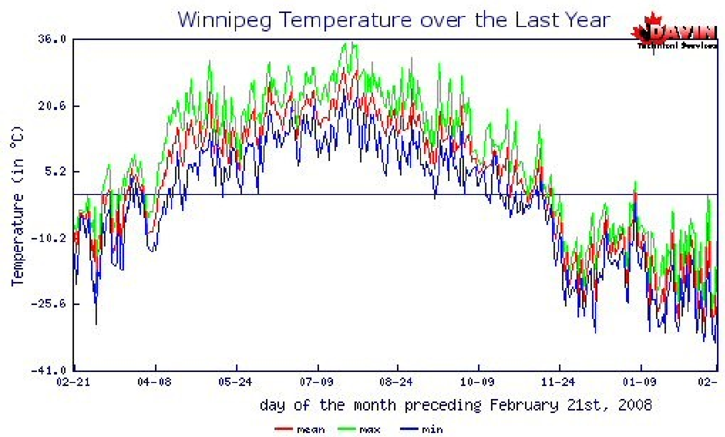
Configurations

Vancouver has only about 5 days per year when the temperature falls below zero. In contrast, Winnipeg's winter temperature falls below -25 deg. for weeks at a time (second graph). Ottawa falls in between as shown in the following graph for the past year.



The 4-borehole configuration is suitable for use in Ottawa but not for Vancouver or Winnipeg, so different configurations are needed for such cities.



The configurations of interest are a single borehole system, the 4-borehole system described in “Heating Homes and Small Buildings” and a 6-borehole variant that has the outer boreholes arranged in a rectangle. The 6-borehole system occupies more space but the heat storage capacity of its center is about an order of magnitude more than that of the 4-borehole configuration. That makes it possible to both store more heat in total and to cope with protracted periods of very cold weather. Note that in Ottawa the cold periods are relatively short lived and that is what makes it feasible to employ the smaller and simpler design.

At the construction stage the storage capacity of the system can be adjusted by selecting the appropriate borehole depth and even after construction there is a considerable range of adjustment that can be accomplished by adjusting the injection cutoffs.

Single borehole systems do not incorporate a high temperature storage region so in some cases they will require peak demand backup. However, they extend the range of situations where air-source heat pumps can be employed. Because their ground heat exchangers are short they can optionally be installed in trenches dug by a trenching machine, or in larger trenches that have been filled with a suitable storage medium in cases where dry soil or flooding would otherwise rule out heat storage.

Note that such systems can store cold instead of heat. However, they store large quantities of heat and cold by creating only small temperature differences in a very large mass of storage material, which implies that heat pumps are generally needed to generate the desired home temperatures. For storing cold the larger systems described in earlier articles on district heating and cooling are more attractive because they can maintain much lower temperatures, obviating the need for heat pumps. Canada is one of the few countries that has both large heating and cooling demands, so we can employ ground storage for both purposes.

Other countries Seasonal storage is only useful in locations that have wide seasonal temperature differences. It is not a candidate for use in a country like Bermuda. In a city like New Delhi, which has hot and extremely humid summers but mild winters there is a huge surplus of heat available in the summer so the heat extracted from the buildings could be stored in single borehole systems for use for winter heating. Transferring air conditioner waste heat into the ground instead of into the air is highly desirable to avoid the “heat island” effect that makes the downtown areas of many large cities so uncomfortable. Most large US cities suffer from this problem.

Canada Canada is exceptional in that most of our cities need to cope with both cold winters and hot summers. We can put that wide temperature swing to good use by using seasonal storage for heating and cooling. At the present time we use natural gas, furnace oil and electricity for heating and electricity to drive our air conditioners. The demand for these seasonal needs has created huge electricity demand peaks in both the winter and the summer. While Canada may produce half of its electricity from hydro sources, and Ontario may produce half of its annual electric power from nuclear stations, those baseload sources are not capable of meeting the winter and summer demand peaks so in practice we are really using fossil fuels to heat and cool our buildings. In Ontario the estimated demand for power from gas fired generators will increase from 4,570 MW to 11,501 MW by 2027. We need instead to switch to natural sources of heat and cold.

The primary cost element for seasonal storage systems is the cost of drilling the boreholes. The systems described here are directly cost competitive with fossil fuels because they reduce the drilling cost by a factor of 2 to 5 times. They produce no greenhouse gases and they would protect us from the cost escalation and potential supply irregularity if we continue to rely on oil and what little remains of our natural gas.

Ron Tolmie
tolmie129@rogers.com **http://sustainability-journal.ca**