Geothermal Tank Brief

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The document is to be used to further explain the buried geothermal tank rational.

1.0 Prior Practice

Almost 30 years ago, the founders of Sustainable Edge Ltd. had developed a residential integrated system that used thermal storage in a similar fashion. The system, called the Solmate, received an award from Popular Science, and was installed in 3 houses including the Advanced House in a Brampton subdivision, and Mario's home. The third unit was designed to be a buried tank version. The system operated successfully according to a 1 year monitoring study by Enermodal Engineering for NRCan. There are many examples of comparative systems.

Although the proposed configuration may be unique, the various elements have been deployed and well documented.

- The Photovoltaic Solar Thermal hybrid (PVT) panel used in conjunction with a heat pump has been well researched and demonstrated. The nearest source is Dr. Stephen Harrison at Queen's University who has several papers on this application regarding field trials lab testing, and simulation studies. His team, with Carlton University Architecture and Algonquin College, recently won the technical award at the Solar Decathlon based on a particular version of this system, borrowed from the work Greg Allen did 30 years ago.
- The general area is called solar-assisted ground-source heat pumps (SAGSHP) and enjoys a world-wide research focus. Danny Harvey discusses this field in his book, particularly in his review of community energy systems using thermal storage.
- Drake's Landing in Okotoks, Alberta is Canada's preeminent demonstration of combining diurnal and seasonal storage of solar and heap pump augmented supply.
- The type of storage with contained water buried in the ground is generally called pit storage, although this is not an apt descriptor. The most appropriate classification is ground-coupled diurnal storage so it is a hybrid of short and long-term thermal storage.

The proposed version draws on these systems and can be engineered. As is always good practice, the proposed site energy system will incorporate redundancy and back-up. Resilience is intrinsic in passive design strategies. During the preliminary design phase, it is our recommendation that the engineering analysis be sufficiently thorough to engender confidence that the system performance will meet expectations.

2.0 OPERATION

The tanks are sized to store enough thermal energy to meet peak daytime cooling and nighttime heating loads. The tanks have antifreeze plumbing to exchange heat with heat pump and solar panels and are in series to provide thermal stratification. During the daytime in winter, there will often be a surplus of solar and internal gains that can be used to warm the tanks along with solar thermal panels to provide source heat for nighttime heat pump operation. During the cooling season, heat is rejected via the unglazed solar panels to the night sky and ambient air to remove the heat required for cooling the building. It is possible to operate the system so that the heat pump cools the storage and rejects heat to the panels at night thereby making cooling directly available for the daytime load. The storage is primarily operating as diurnal storage. By burying it in the earth and insulating above, the tank makes use of soil contact to increase the storage capacity and make use of seasonally averaged deep soil temperatures.

3.0 RATIONALE

Diurnal storage has long been used in the HVAC industry to shift peak and utilize cogenerated and solar heat. Borehole geo-exchange heat pumps typically rely on extensive ground contact and field size to store heat from summer cooling to provide for winter heating. The hybridizing of these approaches has been exploited and researched extensively. Greg Allen has consulted with Dr. Bernier, at Concordia, who is internationally renowned for his work in this field. The proposed system provides synergies between these 2 approaches of thermal storage heap pump systems.

APPENDIX

OAA 2030 RETROFIT REPORT SITE ENERGY (Compiled From SE/DFA Report)

The heating and cooling supply requires hot and cold water temperatures only slightly different from room temperatures which can be obtained for much of the time directly from ambient sources such as low-grade solar heating, night time cooling, and the ground. These sources may have temperature differences augmented by a heat pump. The electricity required for the heat pump is reduced by maintaining source temperatures close to the required supply temperatures.

It is desirable to operate the heat pump during off-peak hours as the rates are lower and the requirement for fossil fuel generation to supply day-time peaks is avoided. This may be achieved by providing thermal energy storage at the required supply temperatures with the capacity to meet the daytime loads. The Transsolar simulation results indicate that internal and solar heat gains are sufficient to avoid the need for heating during the day, most of the time including weekends. On the other hand, cooling is only required during occupied periods. This indicates that thermal storage should be sized to provide for the design cooling day. With seasonal changeover, the same storage can be used to store solar thermal to reduce heating and ensure heat pump operation is limited to night time.

The proposed source for heating and cooling utilizes a buried water tank, sized to meet the peak day cooling demand with sufficient soil contact to ensure storage tank temperatures remain above 5˚C in winter and below 15˚C in summer. The tank has an antifreeze-protected heat exchanger coupled to rooftop hybrid PVT panels that provide solar heat in the winter and nighttime cooling in the summer. In this manner, the cooling water temperature will be provided directly from the storage tank which is cooled at night directly from the PVT panels or augmented by the heat pump rejecting heat to the panels. The heating water temperature is delivered via the heat pump extracting from the storage tank and its temperature is recovered by solar heating from the PVT panels and the surrounding earth.

The assumed COP's of 4 for cooling and 5 for heating used in the Transsolar model may be achieved and possibly exceeded. As well, the heat pump electricity is only utilized in off peak hours. The cost of the PVT-coupled tank will yield a higher financial return than a conventional geothermal borehole system.