Preliminary Review of Geothermal Solar Assisted Heat Pumps

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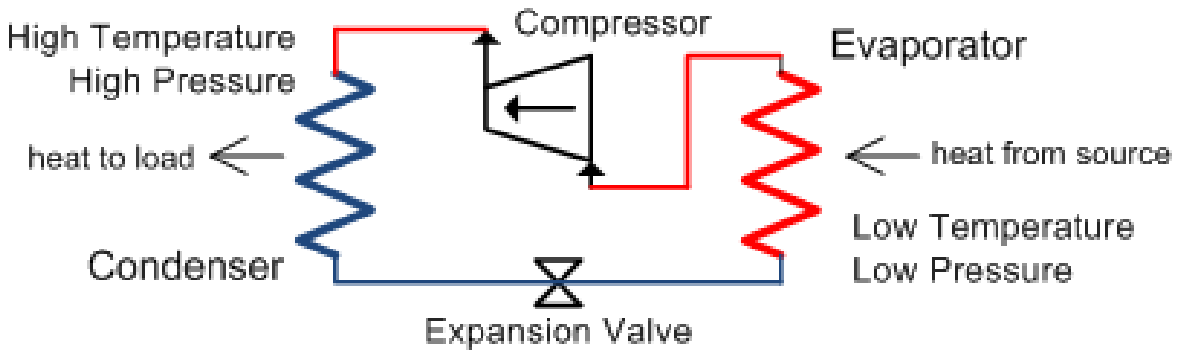
Presentation Outline

- Introduction
- Heat Pump Technology
- Ground-source/Geothermal Heat Pumps
- Solar Assisted Systems
- Current Status
- Future Work

img ref: Global English Keystone, “Green House”, http://gek.cl/school/, 2009

Heat Pump Technology

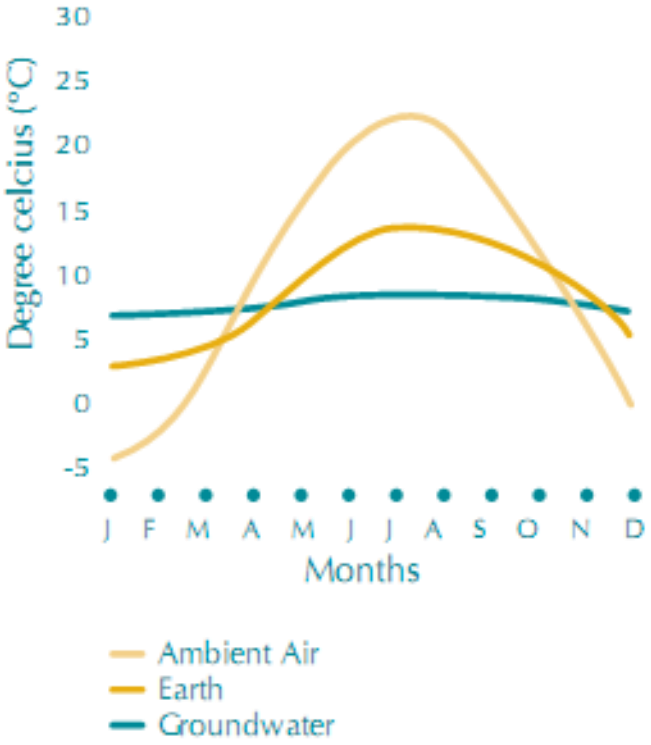
- Device that moves energy from a heat source to a heat sink using some for of work
- Modern heat pumps use a vapour-compression cycle



- Coefficient of performance or COP
- Ratio of the amount heat energy delivered/thermal cooling provided to the net work input

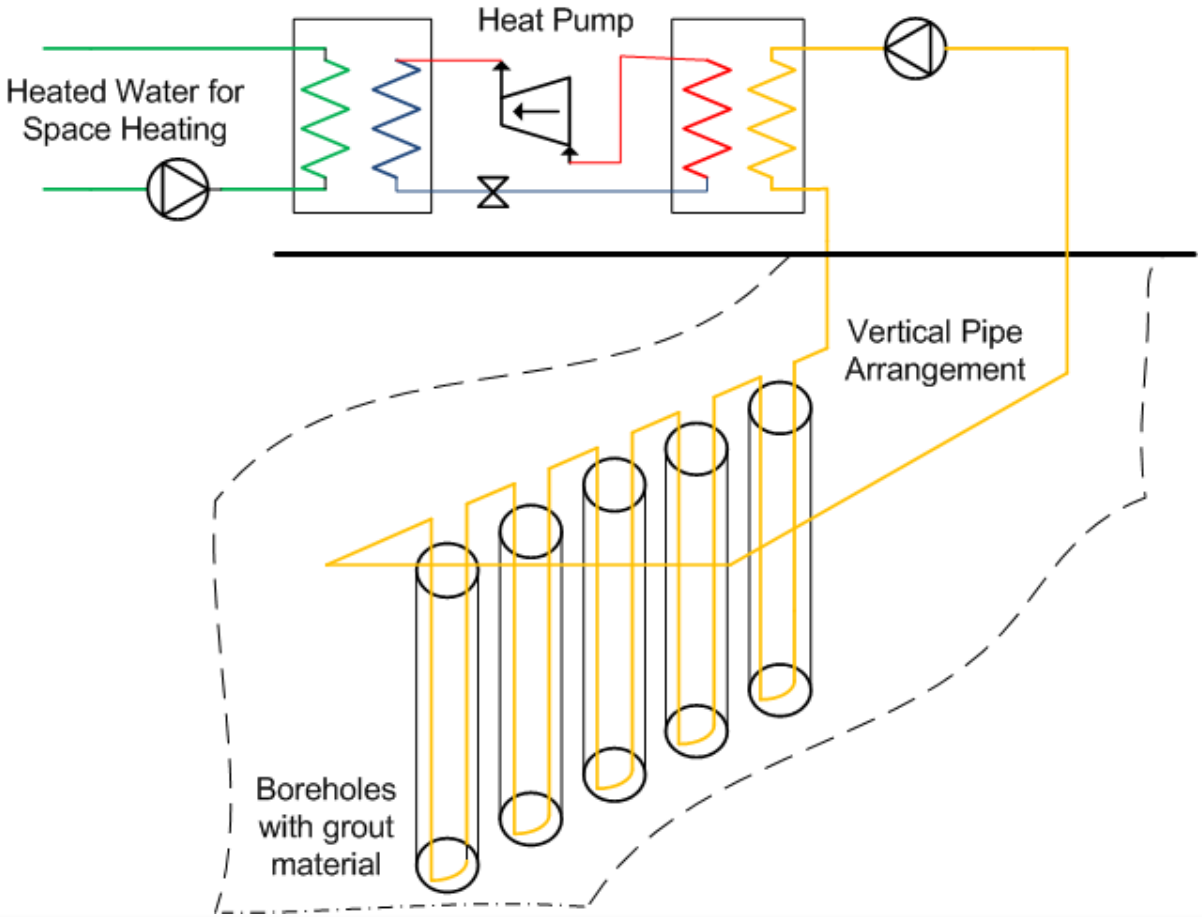
Ground-source/Geothermal Heat Pumps

- Heat pump system that utilizes the ground as a heat source/sink
- Three main configurations:
  - Closed Loop
  - Open Loop
  - Direct Exchange

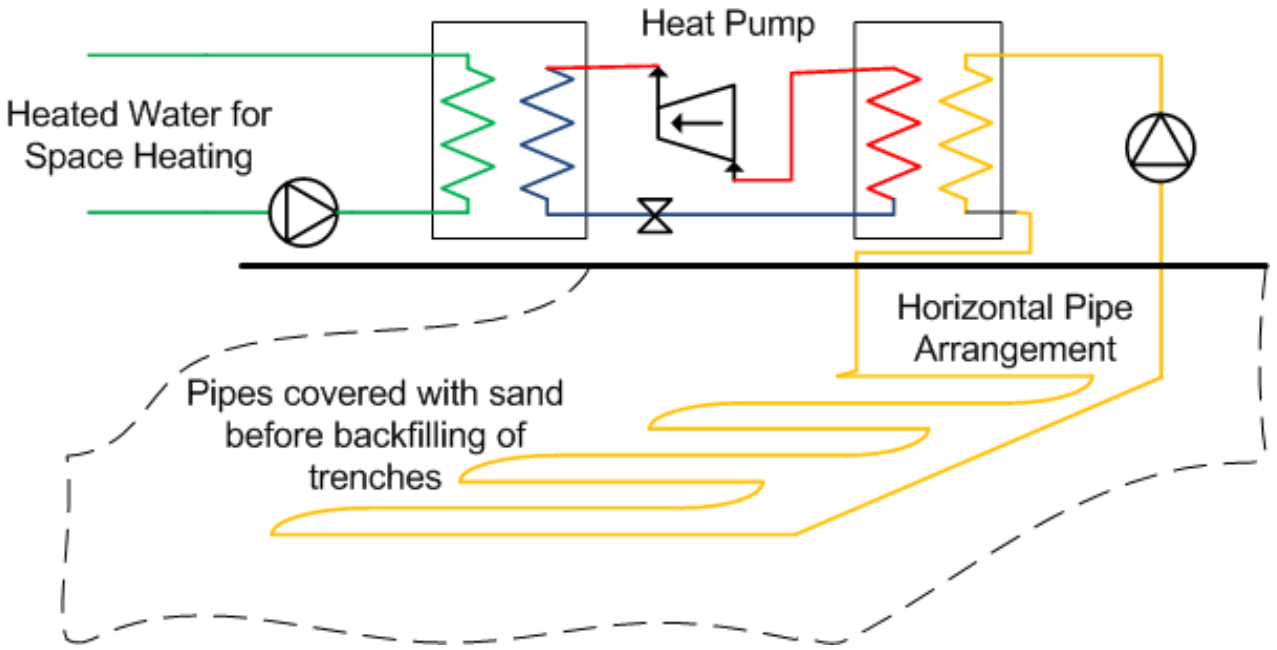


img ref: NRCAN, “Ground-Source Heat Pump Project Analysis”, pp. 6, 2005

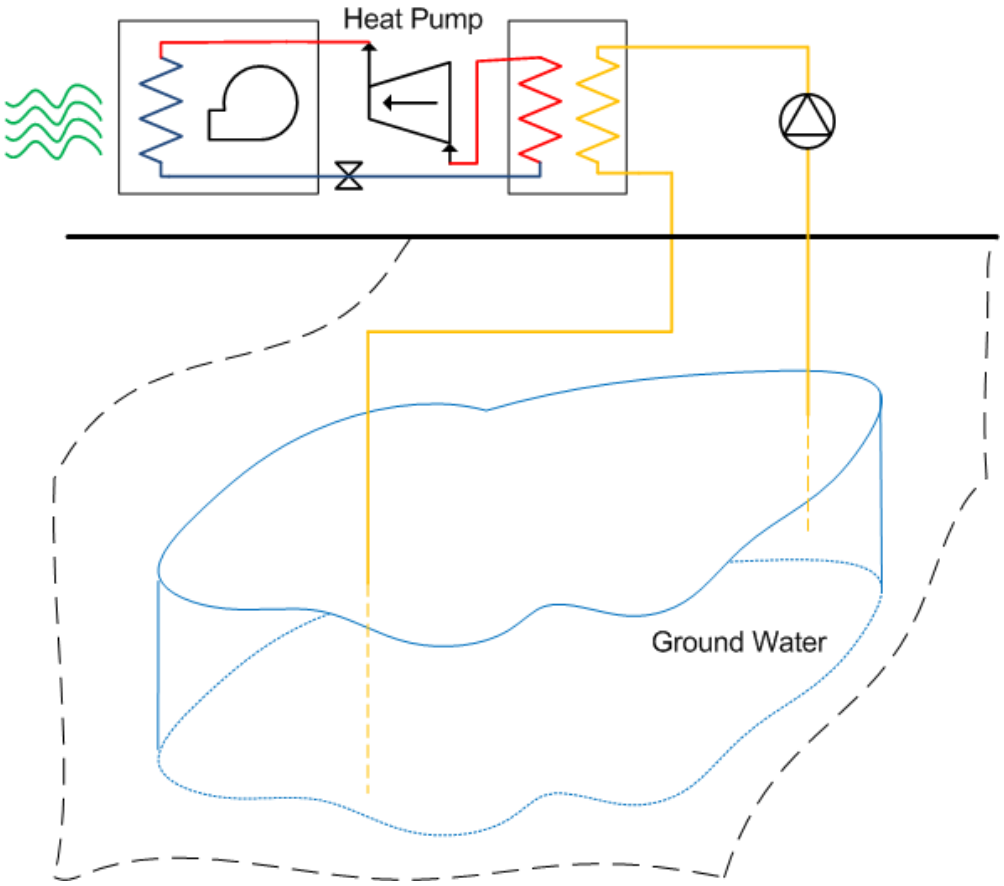
Vertical Closed Loop Configuration



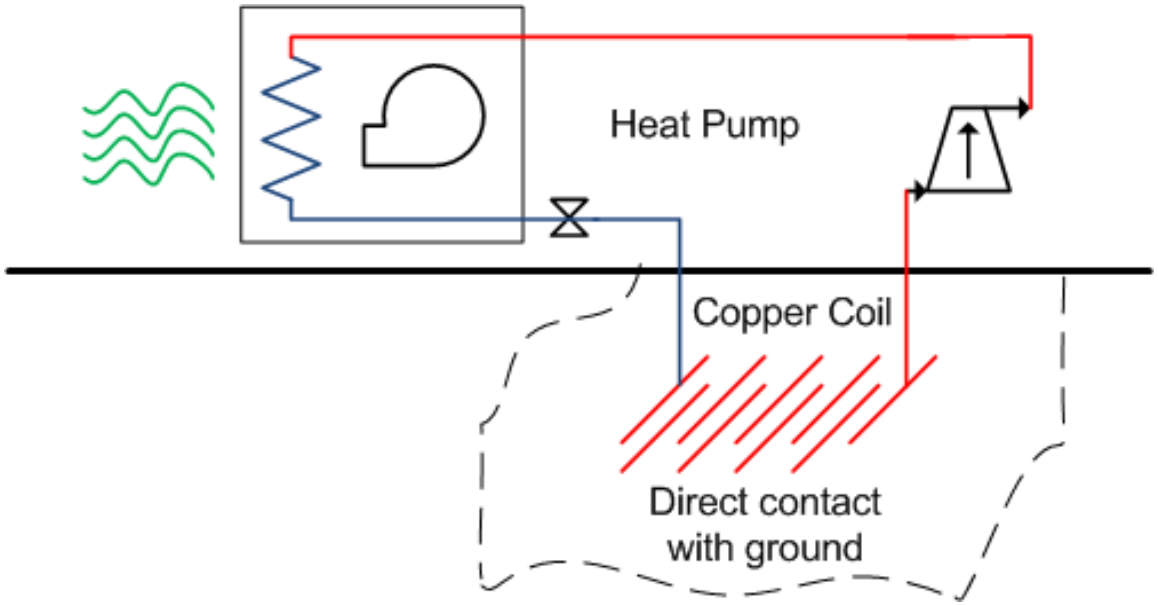
Horizontal Closed Loop Configuration



Open Loop Configuration

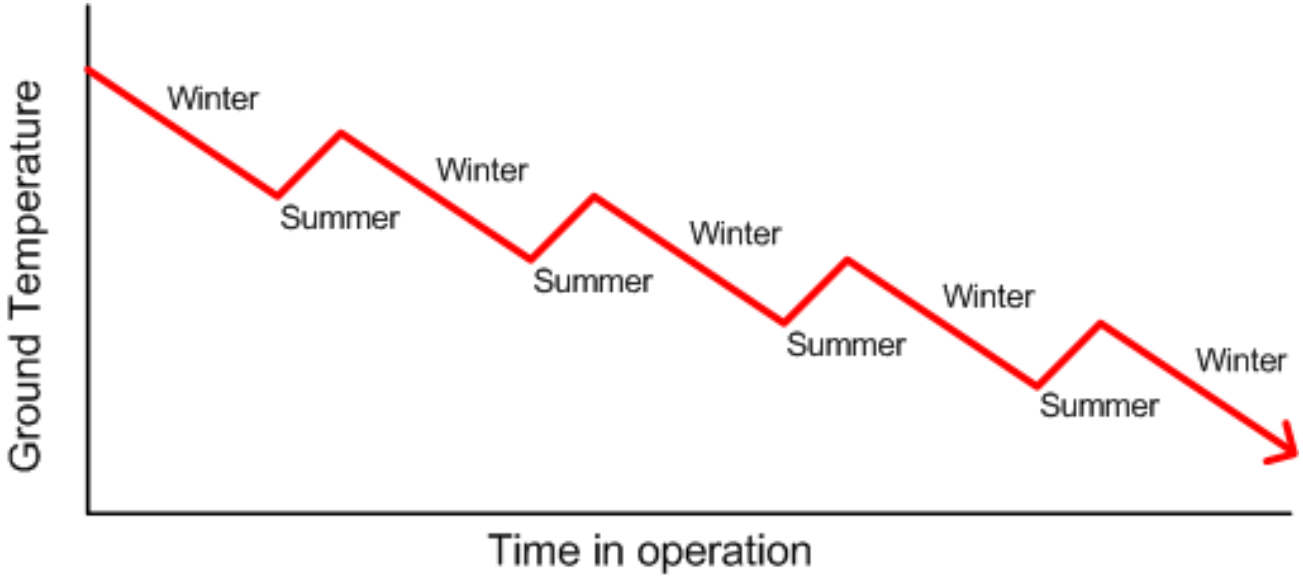


Direct Exchange Configuration



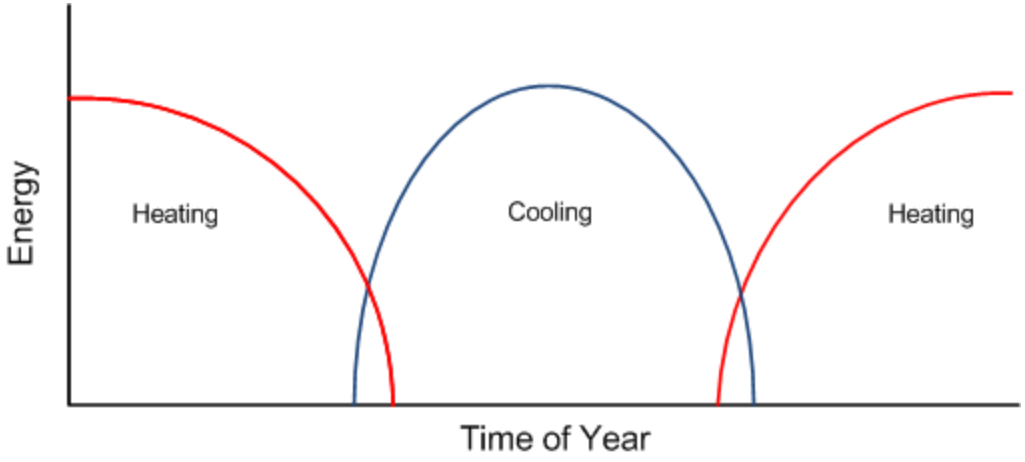
Problems with GSHP

- Over time ground temperatures may drop significantly
- Uneven heating and cooling loads
- Lowers system COP
- Solar provides a potential means to alleviate this problem

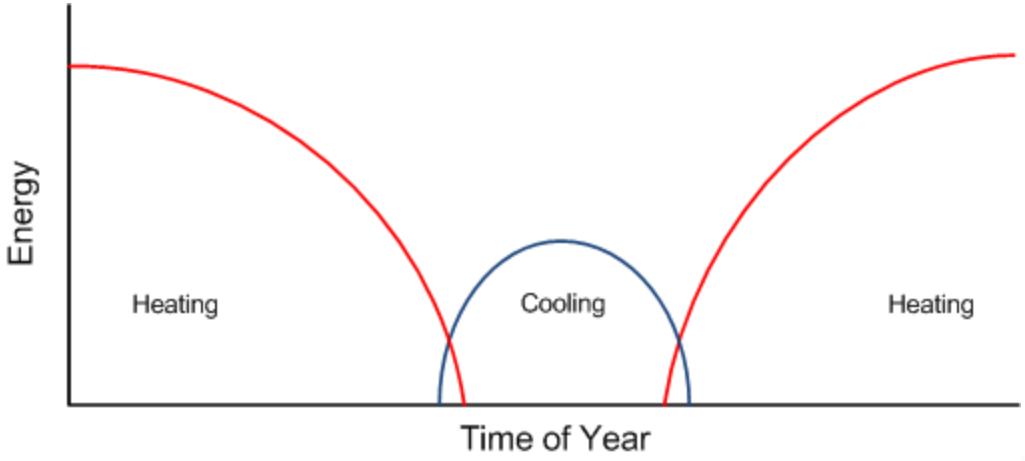


Solar Input: A Potential Solution

Toronto



Edmonton



Solar Input: A Potential Solution

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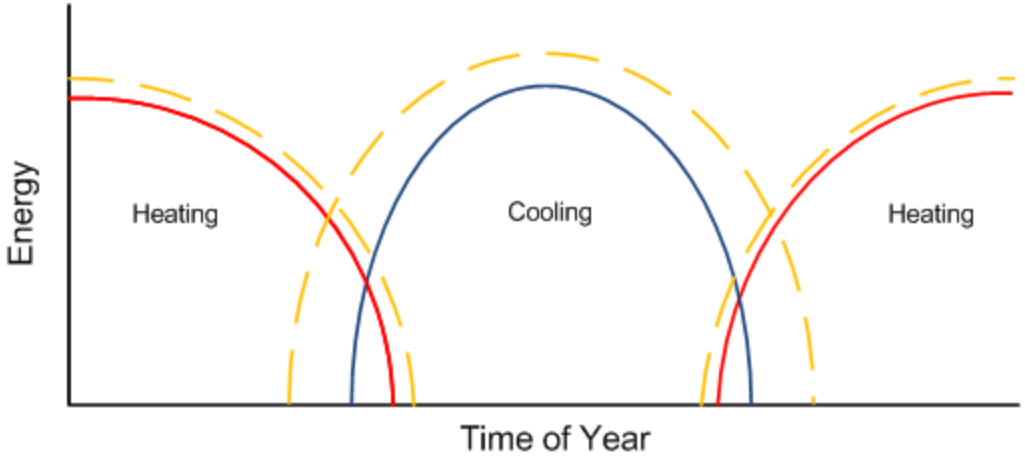

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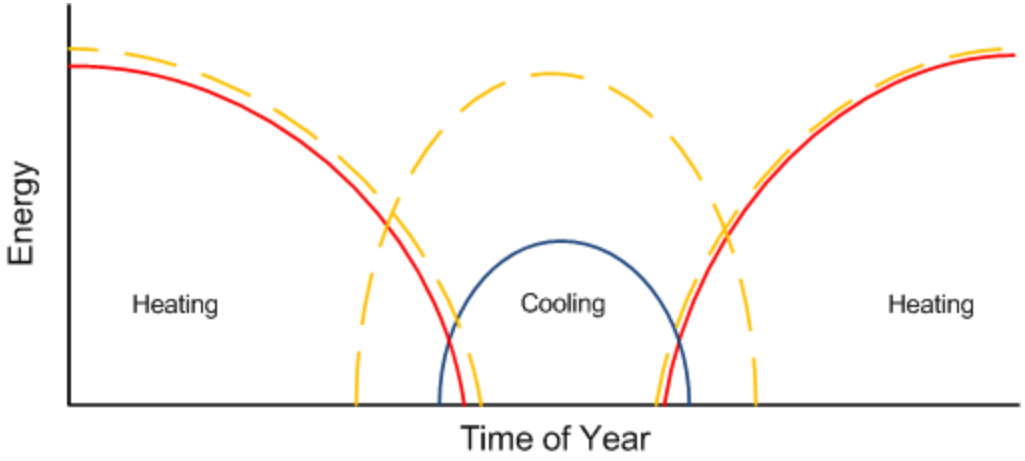
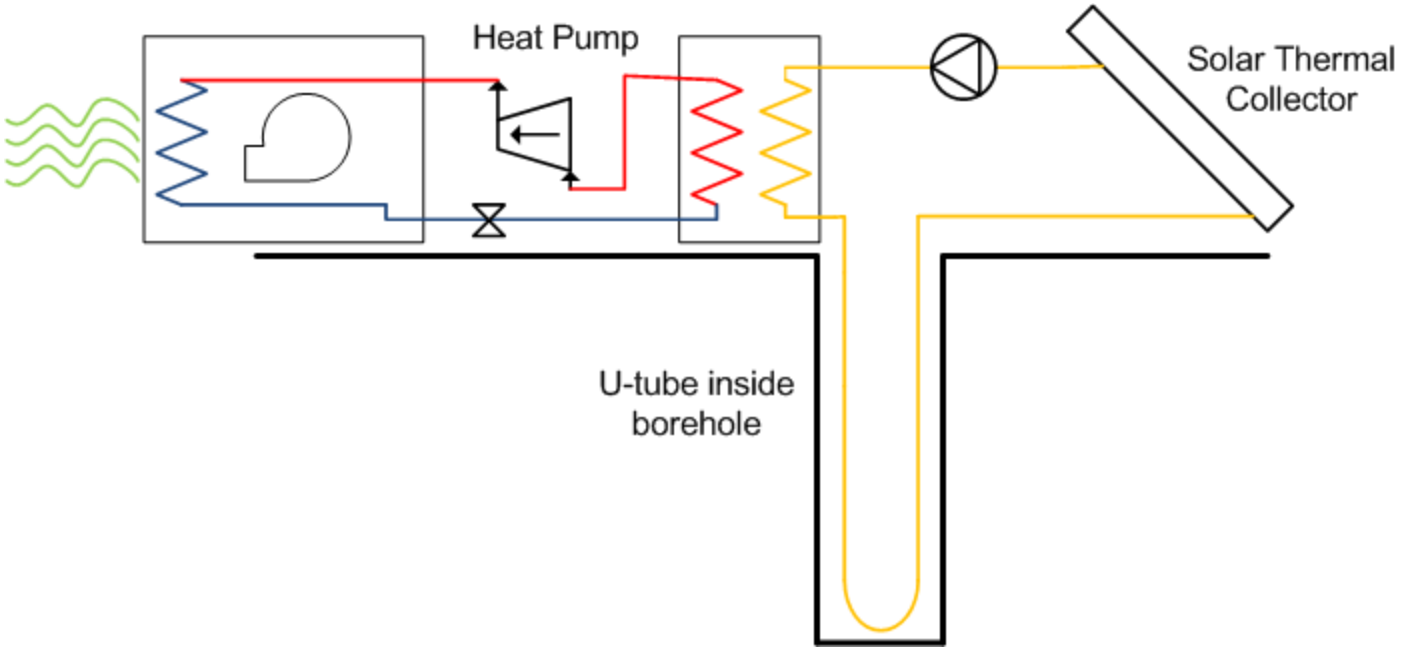


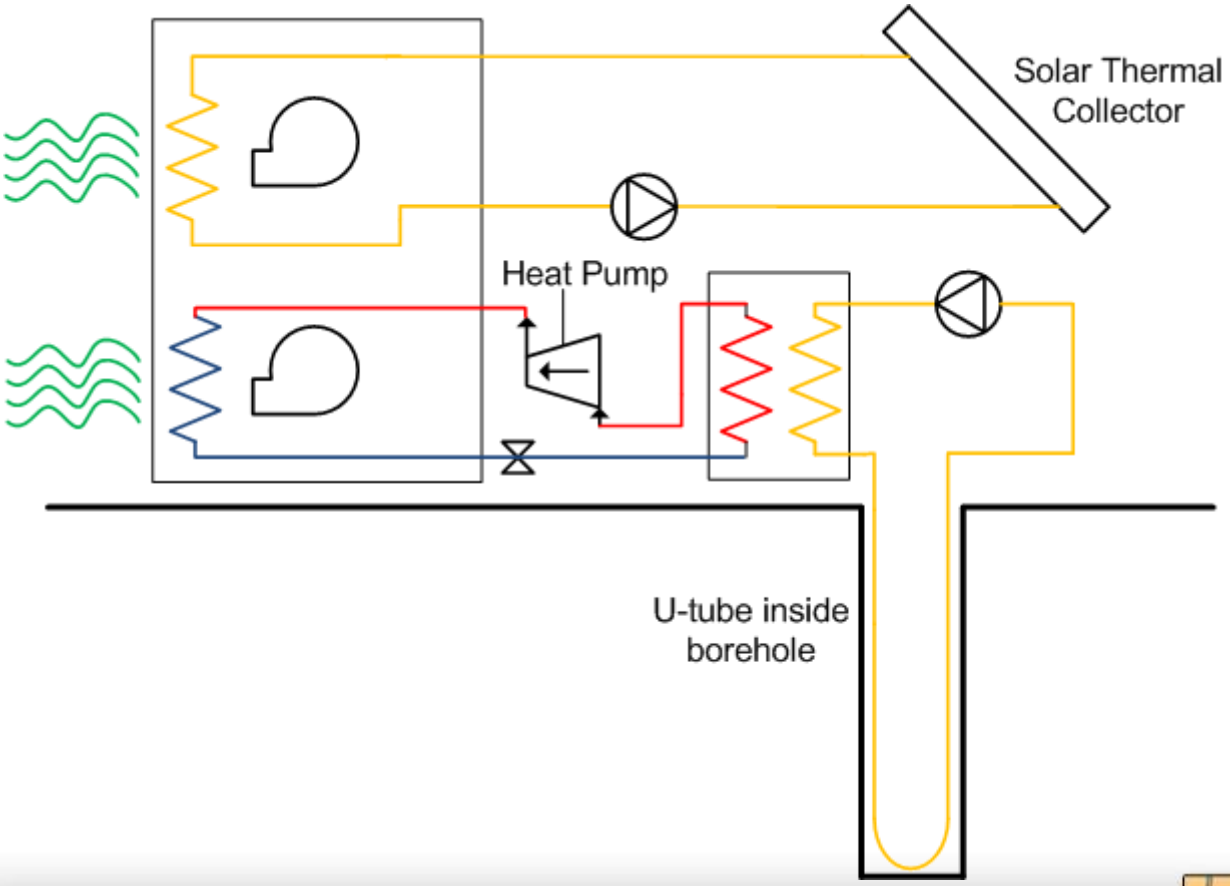
Solar Assisted Ground Source Heat Pump

- Series Arrangement



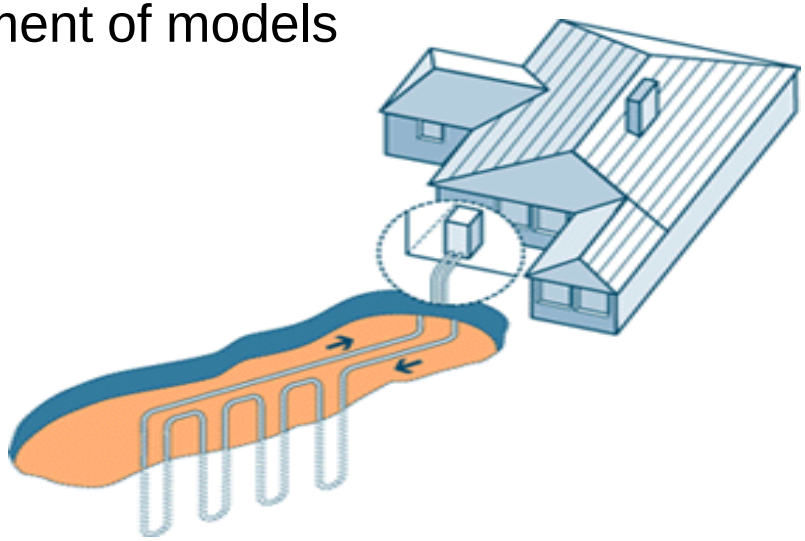
Solar Assisted Ground Source Heat Pump

- Parallel Arrangement



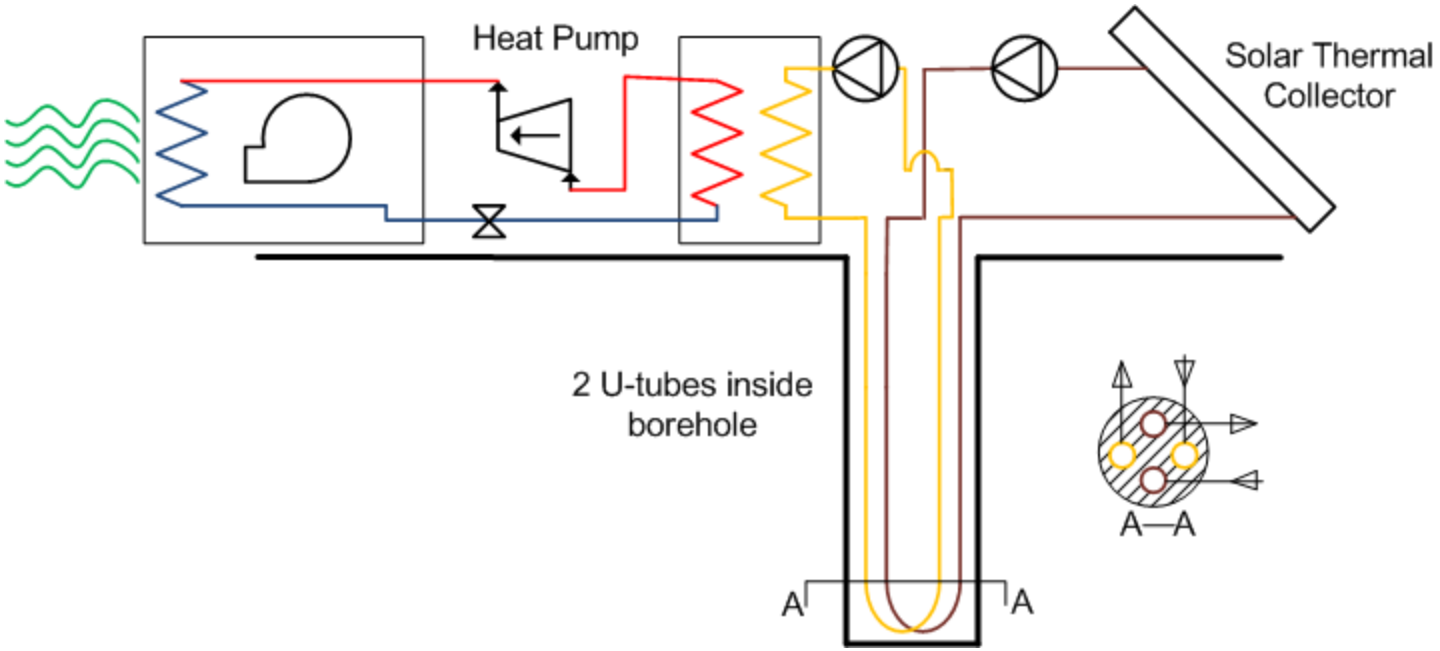
Current Status of SAGSHP

- Seasonal storage not suitable for horizontal arrangements
- Ground temperature recovery demonstrated experimentally
- Difficult to size ground loop
- A number of simulation models available
- Need for experimental data for refinement of models
- PVT adaptation
- Two U-tube configuration



img ref: NRCAN, “Heating and Cooling with a Heat Pump”, http://oee.nrcan.gc.ca/publications/infosource/pub/home/Heating_and_Cooling_with_a_Heat_Pump_Section4.cfm, 2009

Two U-tube Configuration



Looking Ahead …

- Need for integration of various models to create full system simulators
- Investigation into ground storage volume and capacity as a function of ground loop size and ground properties
- Marginal impact of adding solar to GSHP systems in unclear
- More experimental data required

Future Work

- Installation of a fully instrumented experimental rig utilizing vertical closed loop configuration at St. Lawrence Energy House
- Design of experimental procedure and control strategies
- System simulations in TRNSYS

Discussion