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CanmetENERGY: Activities on Ground Source Heat Pumps and recent advancements.

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2018 OGA conference

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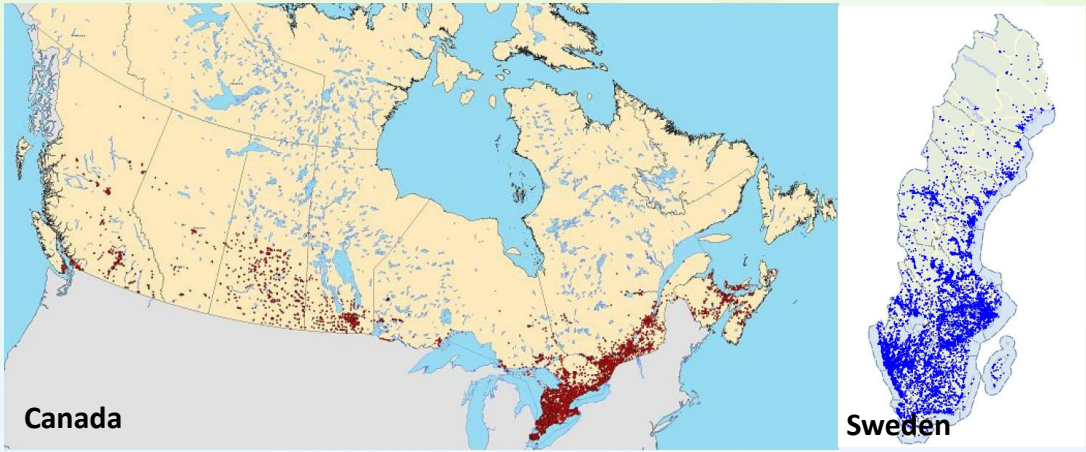
Presentation outline

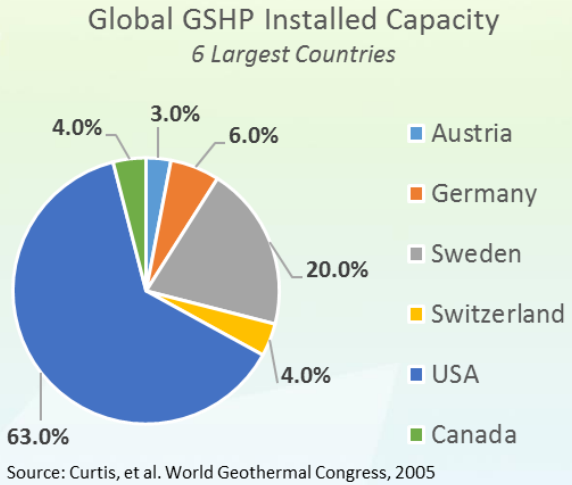
- GSHP status
- Barriers
- Activities at CanmetENERGY
- Recent advancements
- Perspectives

Ground Source Heat Pumps

Shallow Geothermal Landscape



Shallow geothermal landscape (D. Tangauy, 1st Canadian German conference 2014)

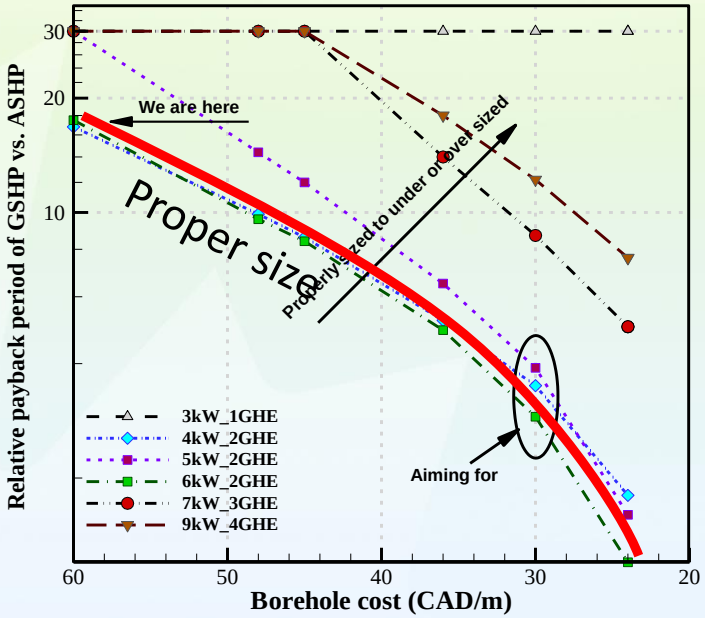


Source: Curtis, et al. World Geothermal Congress, 2005

- Approximately 95% of heat pumps used in the Austrian housing market are ground-source.
- Switzerland is estimated to have the highest installed density in world, with an average of more than one unit per 2 km^2

Market and Technical Barriers

1. High initial cost
2. Use of synthetic refrigerants
3. Lack of knowledge and good tools for design



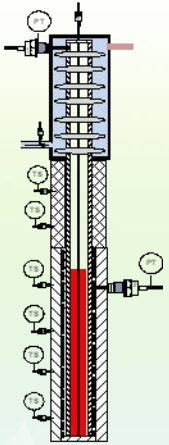
Activities

CO_2 SL-GSHP

CO_2 DX-GSHP test bench

Borehole with PCM

Ground Source Thermosiphon



Showcase CO_2 DX-GSHP

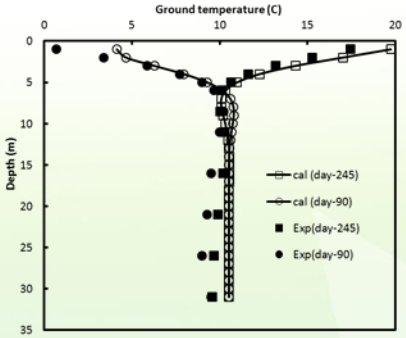
2008 — 2012 — 2014 — 2016 — 2018

CO_2 DX-GSHP Combined Heating, Cooling & DHW

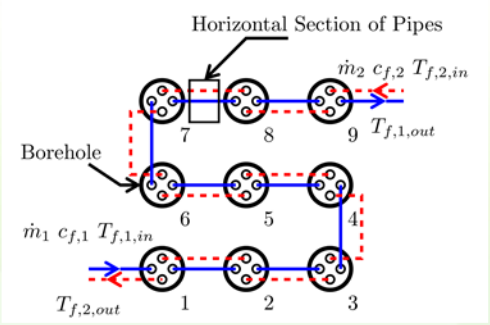
coming soon

Activities

Soil temperature profile



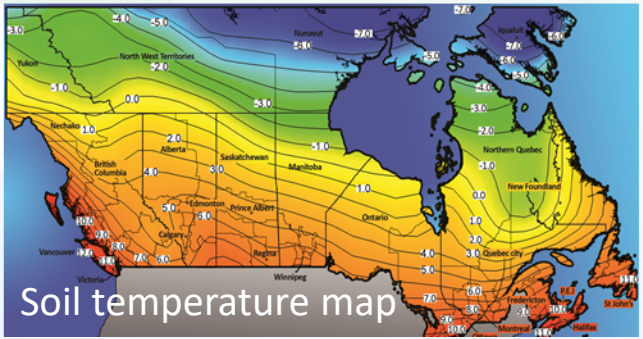
New SL-GHE model

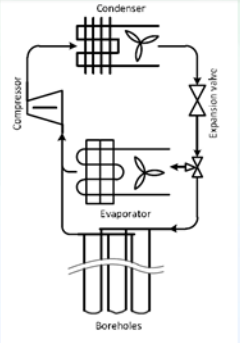


Refrigerant comparison for DX-GHE

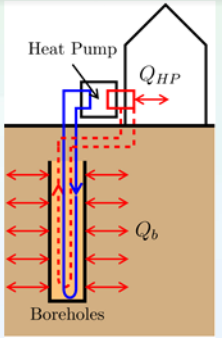
2011 **2013** **2016** **2017**

Grout permeability





Hybrid DX-GSHP



Self-assisted SL-GSHP

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Virtual Borehole

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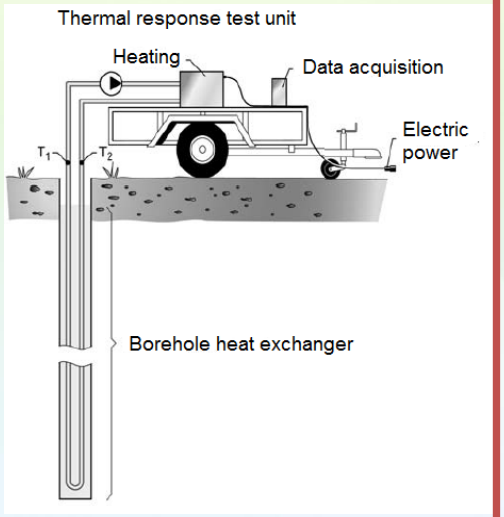
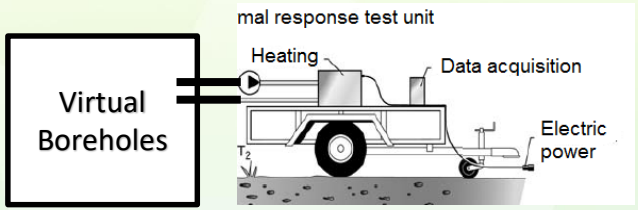
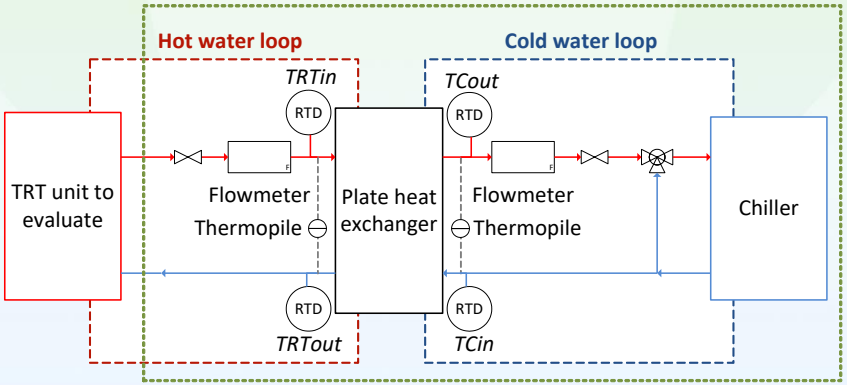
Thermal Response Test (TRT) unit



TRT





Virtual Borehole

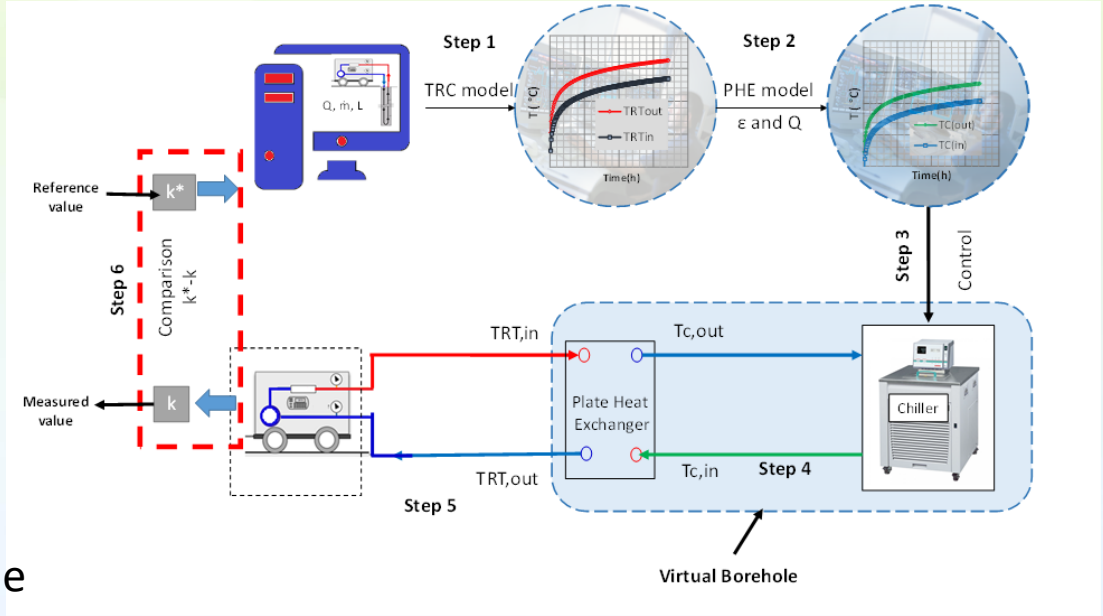
A test setup to calibrate TRT units.

Thermal conductivity is the most important data required for a precise ground loop design.

Virtual borehole

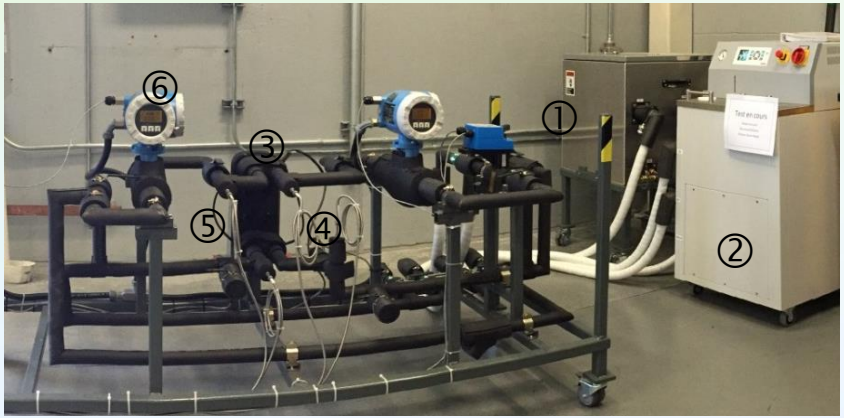
How it works?

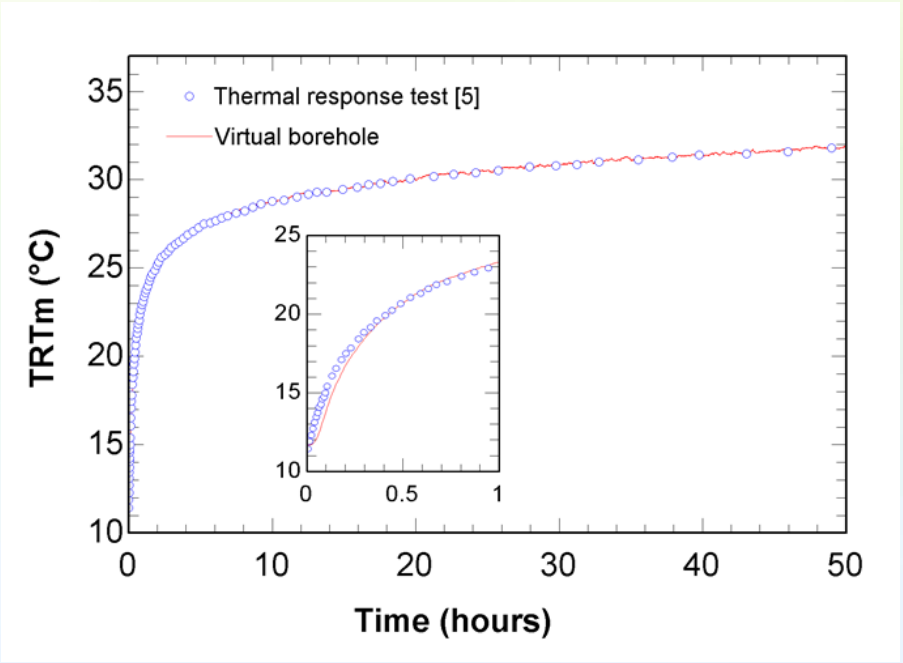
- Hypothetical borehole dimensions and characteristics
- Heat injection rate
- Thermal conductivity value for which the TRT is calibrated
- Heat exchanger's performance curve
- Validated RC model for borehole



Test sample!

The concept is able to reproduce the soil thermal conductivity with the uncertainty of 0.5%.





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Why CO_2 for DX-GHE!

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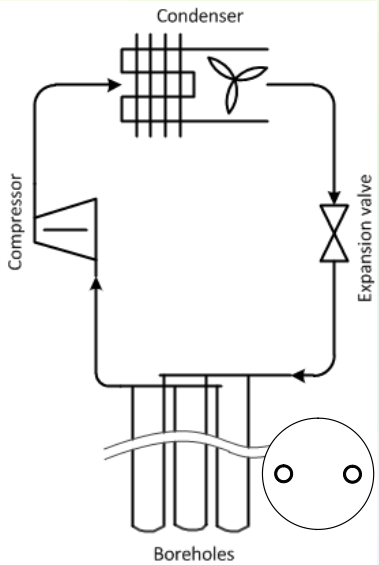
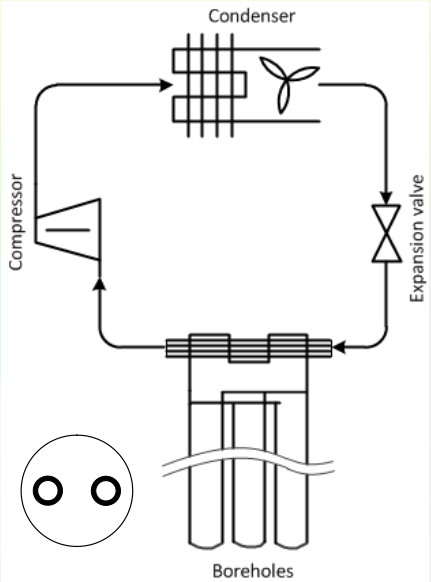
GSHP types

- DX GSHPs provide noticeably greater energy performance
- DX GSHPs are more complicated to design and to control



Direct Expansion



Secondary Loop

Carbon Dioxide (CO_2) as refrigerant

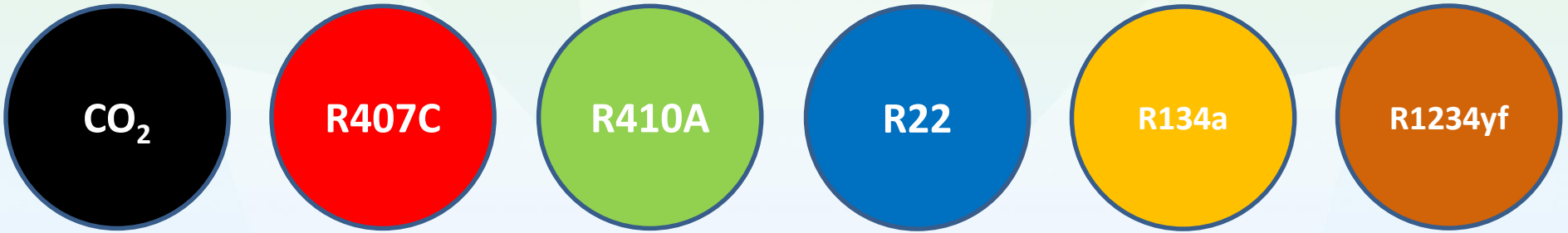
- Non toxic, Non flammable, Non corrosive
- ODP=0
- GWP=1
- Large carbon footprint reductions

- Low critical temperature
- Good heat transfer characteristics
- Less energy required for circulation
- Higher cooling capacity
- Higher energy density

- Less expensive
- No Phase-out Potential and unaffected by future legislation
- Smaller heat pump components

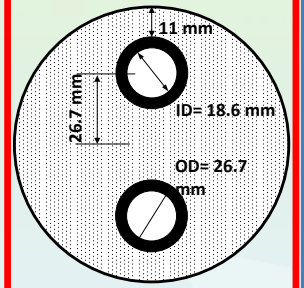
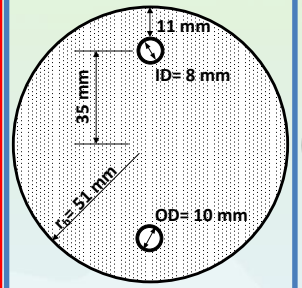
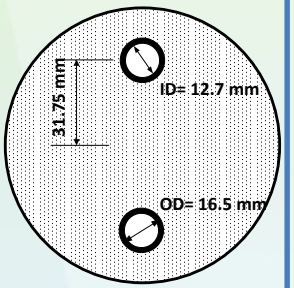
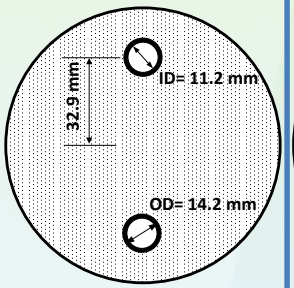
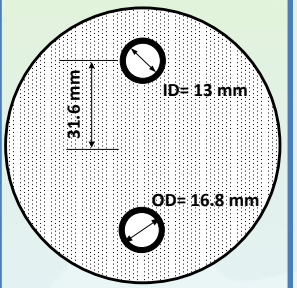
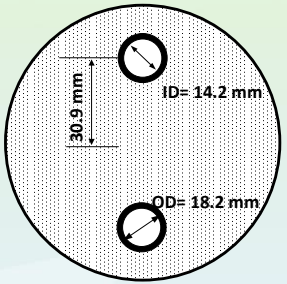
Refrigerant comparison

Comparing numerically the performance of the direct expansion ground heat exchangers as evaporator under using 6 different refrigerants



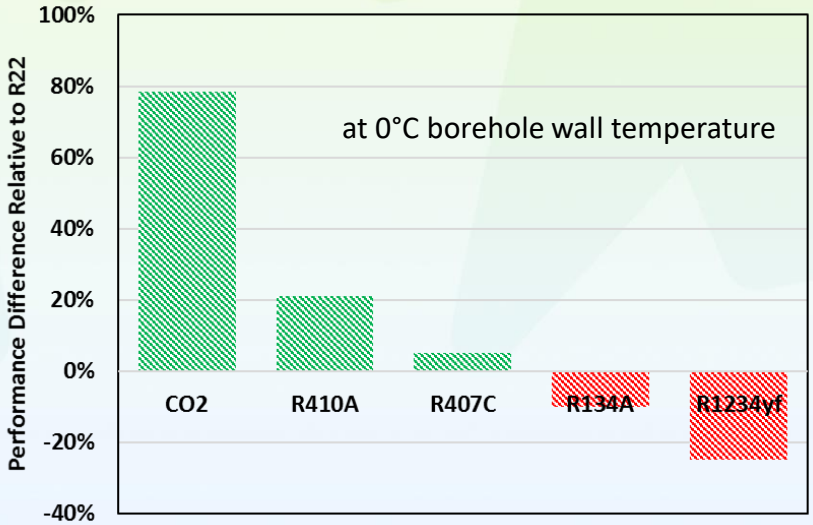
Pipe size reduction!

Pipe sizes under equal pressure drop!

Water+antifreeze	CO2	R22	R410A	R407C	R1234yf R134a
					
↑60%	↓37%	0	↓12%	↑2%	↑12%

Performance improvement

Heat extraction rate per pipe surface area per temperature difference and per required mass flow rate.



Perspectives

- CO_2 is a promising candidate (environmental, technical and financial benefits) for the replacement of synthetic refrigerants!
- Innovative borehole configurations using CO_2 is leading to significant reduction in borehole costs by up to 50%!
- Promising COP is anticipated for integrated CO_2 DX-GSHP solutions!
- New standard for TRT can improve the accuracy of units!

Thank you!

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