

Prototyping Geothermal Energy Recovery for Space Heating and Cooling

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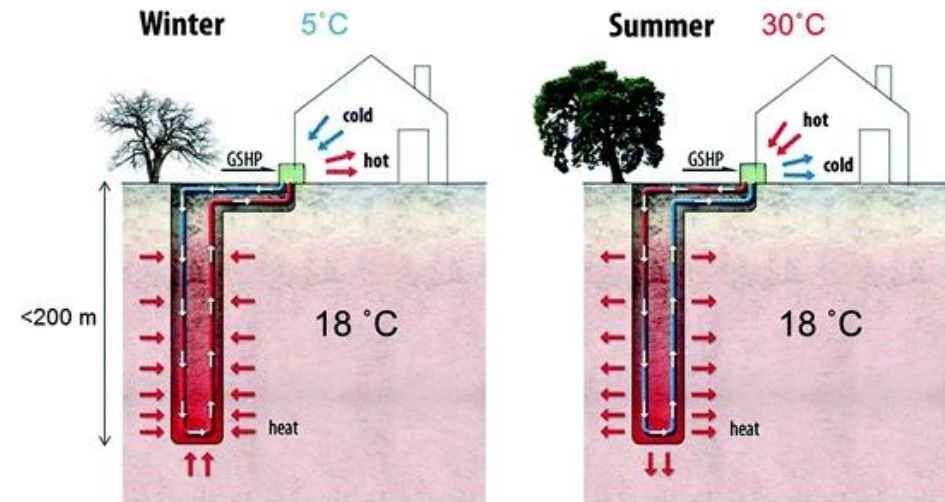
Introduction

- Why geothermal

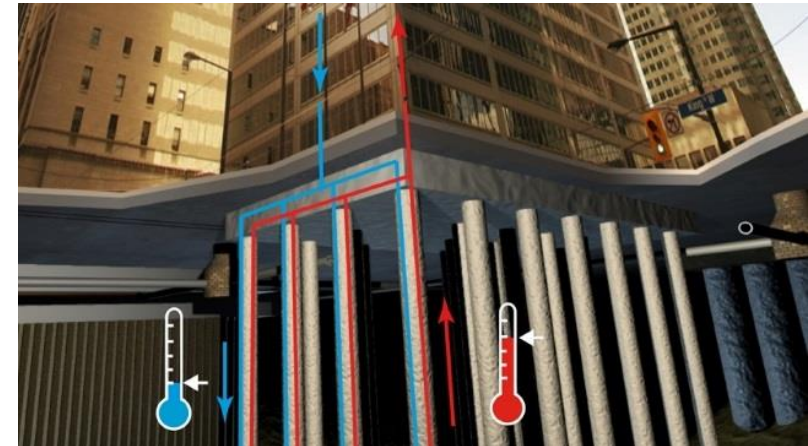
- Geothermal energy: heat from the earth
- An alternative energy of fossil fuels
- Can be cheaper
- More environmentally friendly
- Renewable

- Use cases

- Space heating and cooling
- De-icing (for bridges)
- Hot water production
- Thermal energy storage
-



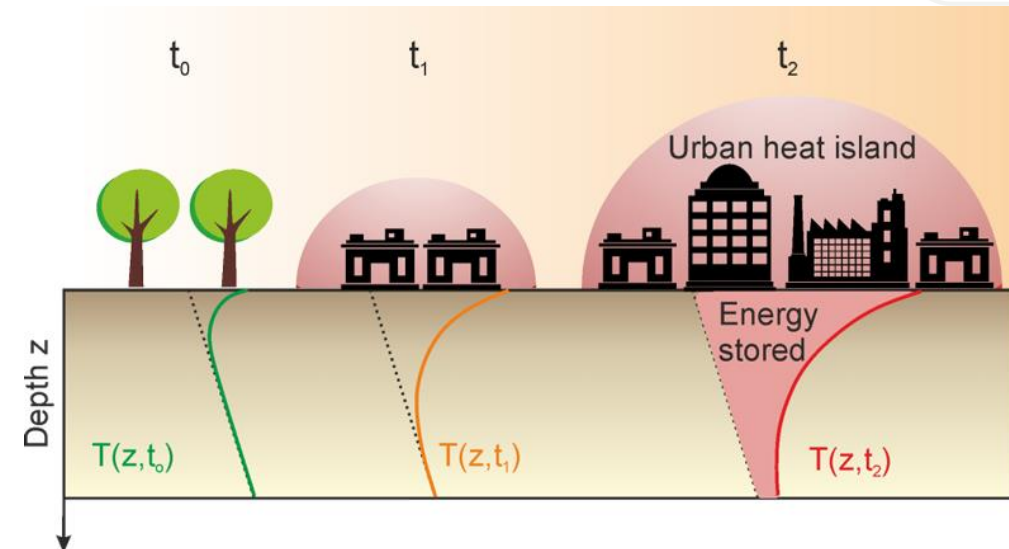
https://link.springer.com/chapter/10.1007/978-981-10-7326-7_18



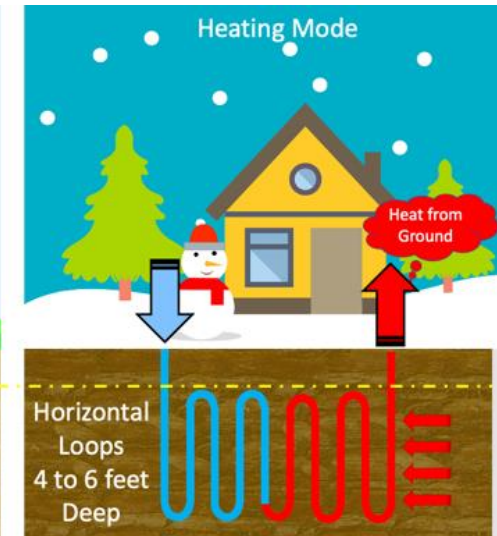
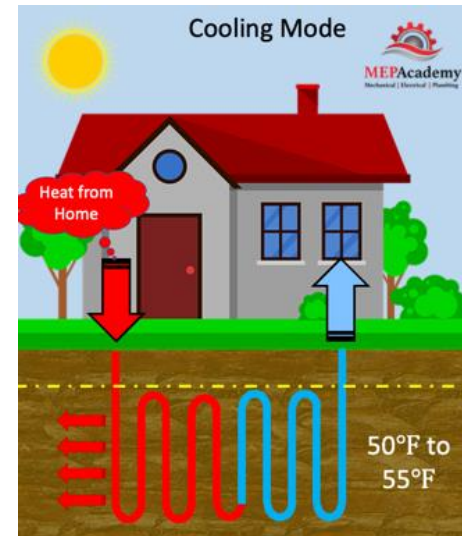
actu.epfl.ch/news/a-new-research-project-on-the-performance-of-energy/

Challenge

- Underground heat island
 - Constantly injecting heat into underground
 - Negative effects in tarnishing groundwater and increased energy use
- Ground heat depletion
 - Average subsurface temperatures decrease (increase), as a result of constantly removing (injecting) heat from (into) the soil
 - The geothermal system gradually become less efficient



<https://ethz.ch/en/news-and-events/eth-news/news/2017/02/tapping-into-underground-urban-heat-islands.html>



Solution to Ground Heat Depletion – EPCM

- EPCM: Encapsulated phase change materials (paraffin)
 - High melting heat that can be released or stored via solidification and melting processes
 - Chemically stable, low subcooling, nontoxicity
 - To alleviate temperature fluctuations and provide temperature regulation for the soil during extended periods of heat movement



Experiments: Sand + EPCM

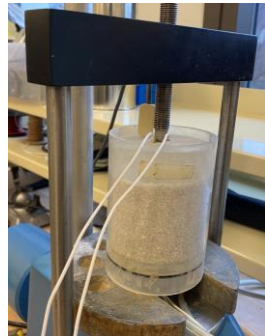
Specimen:

- Ottawa 20/30 sands (Pure Quartz)
- EPCM with melting temp of 18°C
- Vol fraction of EPCM:
 - 0%
 - 2.5%
 - 5%
 - 10%

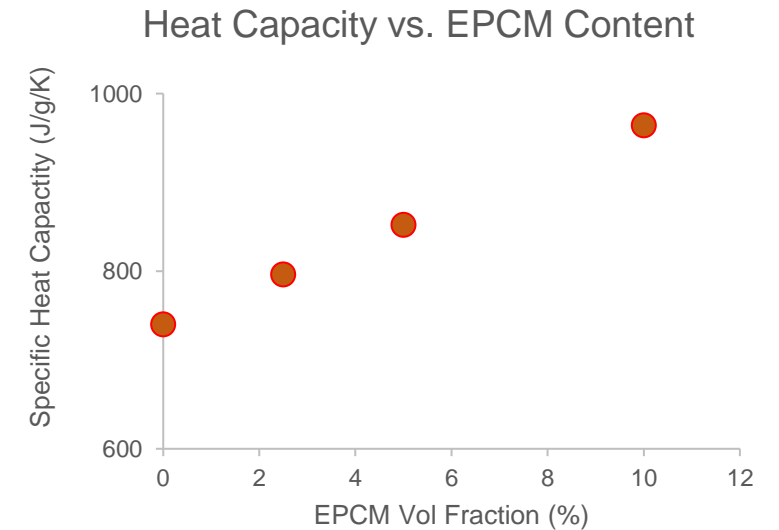
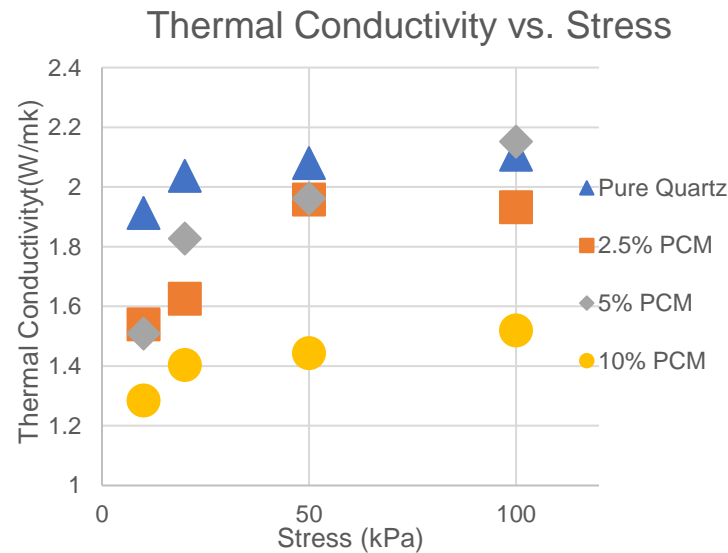
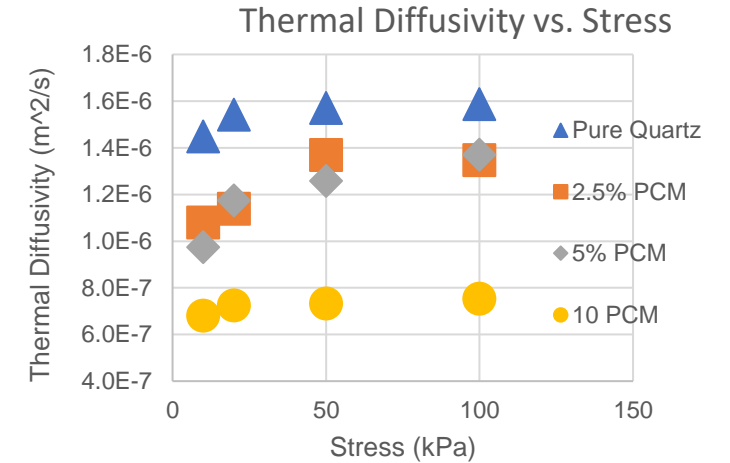
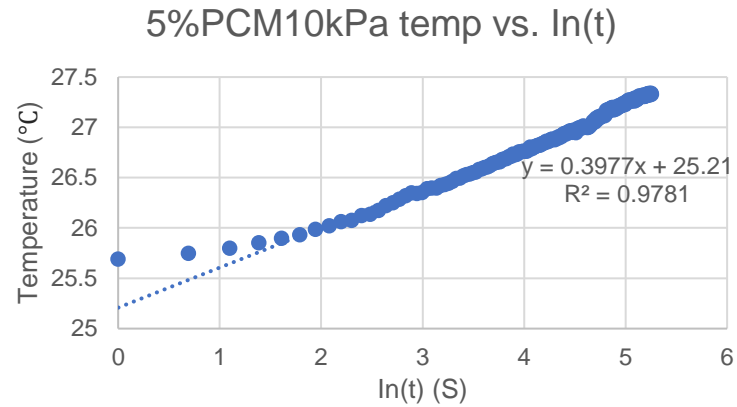
Methods:



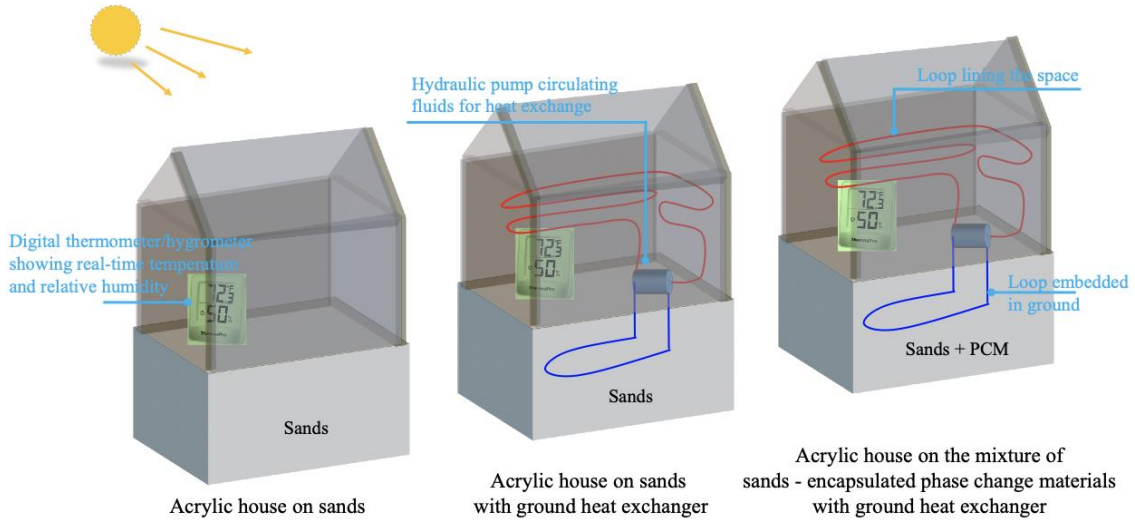
CMT
EQUIPMENT
Construction Materials Testing Equipment



Results:



Prototype Model

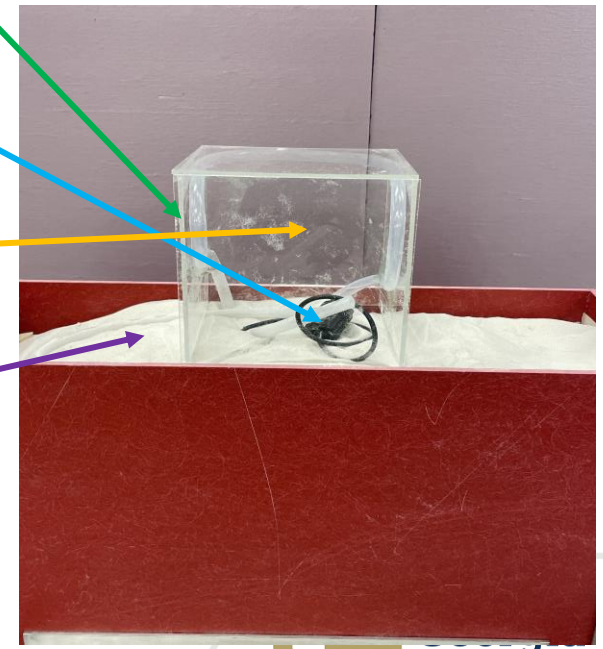
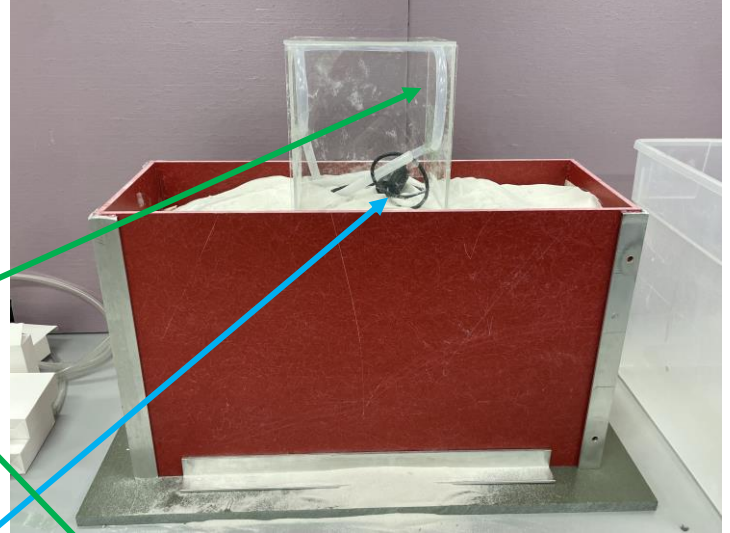


Tygon tubes

Mini-pumps for fluid circulation

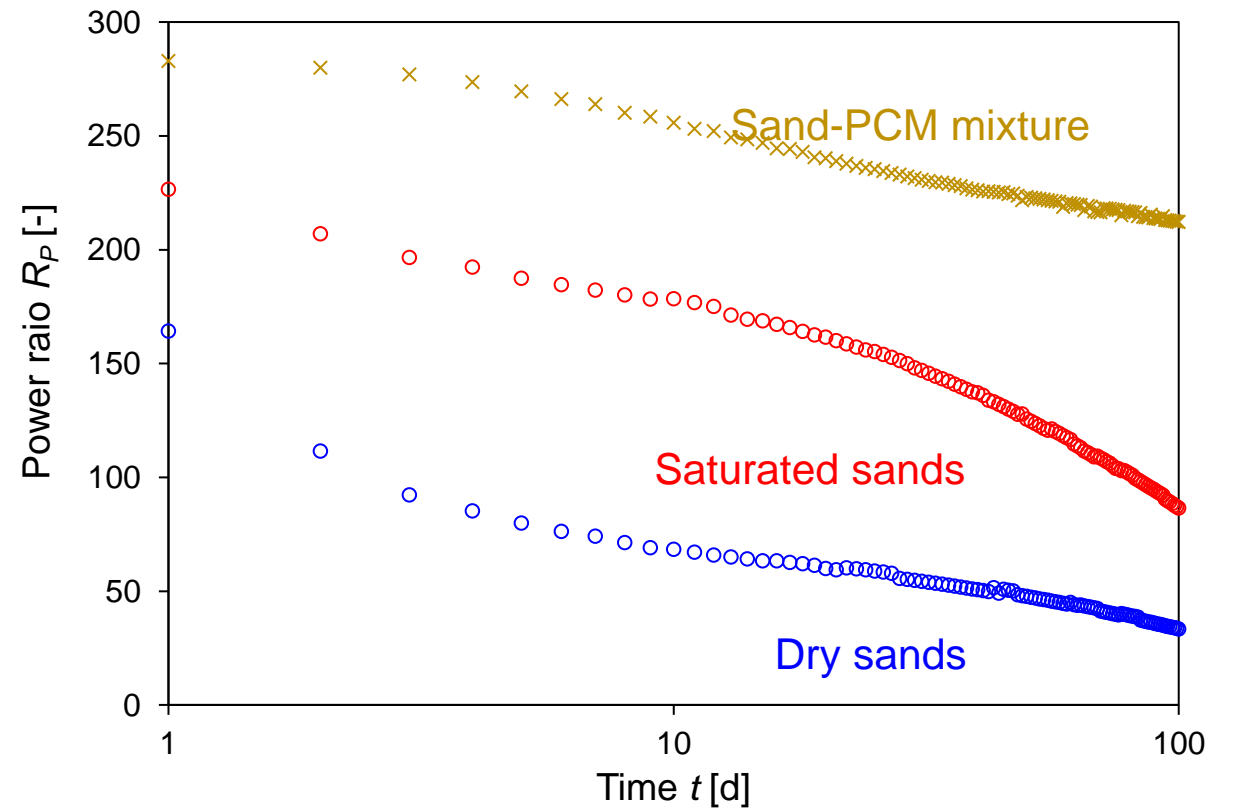
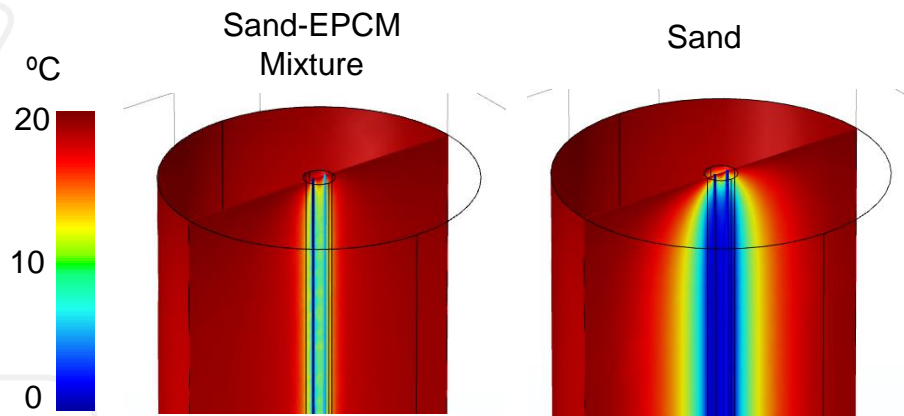
Acrylic house

Sandy ground



Numerical Results

Ground temperature distribution after 100 days of a heat pump operation



Conclusions

- Geothermal is the heat energy from the earth. It can be used for space heating and cooling. It's a sustainable, greener and efficient energy resource.
- Long-term utilization of geothermal energy can lead to ground heat depletion that will lower the geothermal recovery efficiency and impose subsurface heat island effects.
- Using encapsulated phase change materials to improve the thermal properties of the ground can address the ground heat depletion issue.