

PON 3519 – Attachment E2 Ground Source Heat Pump Cost Compression

Introduction

Ground source heat pumps (GSHPs), also referred to as geothermal heat pumps, use an indoor heat pump unit and a heat exchange loop buried underground to transfer heat between the ground and building and provide both heating and cooling to indoor spaces. GSHPs, along with other renewable HVAC technologies, have the potential to contribute significantly to the reduction in energy use and decarbonization of the HVAC sector in New York State (NYS).

The GSHP industry utilizes several types of ground heat exchange (GHEX) systems external to the building, including: closed-loop systems using a ground loop (typically made of high density polyethylene (HDPE) or polyvinyl chloride (PVC)) that circulate water or antifreeze to exchange heat with the ground; open-loop systems, which circulate water to exchange heat directly from a local groundwater source; and direct exchange systems that circulate a refrigerant through copper pipe in the ground instead of using HDPE or PVC piping with water or antifreeze. Loop configurations can be horizontal or vertical. The four major drilling technologies used today in vertical GHEX drilling are mud or wet rotary, air rotary, air hammer, and sonic. The technical potential (resource availability) as a percentage of the total estimated statewide annual HVAC load for horizontal loop and vertical loop GSHP is 15% and 58%, respectively.¹ Closed-loop, vertical bore, ground heat exchanger coupled with a heat pump internal to the building has the highest technical potential in NYS.

Due to the drilling requirements and GHEX components, the installed cost of vertical loop GSHP systems is significantly higher than traditional HVAC systems. The estimated costs of a system and potential cost reductions for a typically small installation are shown below.

GSHP Cost Components	Est. percentage of total cost for residential and small commercial/multifamily	Max. potential direct cost reduction
Drilling	32%	40%-50%
Equipment – heat pump	24%	15%-20%
Equipment – balance of system	6%	35%-40%
Labor (excl. drilling labor)	13%	35%-40%
Other non-equipment	25%	~10%
Total	100%	~30%

Table 1 - Source: NYSERDA Renewable Heating and Cooling Policy Framework: Options to Advance Industry Growth and Markets in New York February, 7, 2017

Design Challenges

NYSERDA seeks to support the research, development, and demonstration of the next generation of GSHP systems that offer a 20% or greater reduction of the overall installed cost of a GSHP system for residential and/or commercial applications. For this subchallenge, the GSHP system installed cost includes all hardware, labor, materials, and soft costs for installing the vertical ground loop, bringing the loop connection into the building, site restoration, heat pump equipment, balance of system, and other non-equipment costs.

For reference, Figures 1 and 2 illustrate a borehole and a closed-loop, vertical bore, ground heat exchanger.

¹ NYSERDA Renewable Heating and Cooling Policy Framework: Options to Advance Industry Growth and Markets in New York February, 7, 2017.

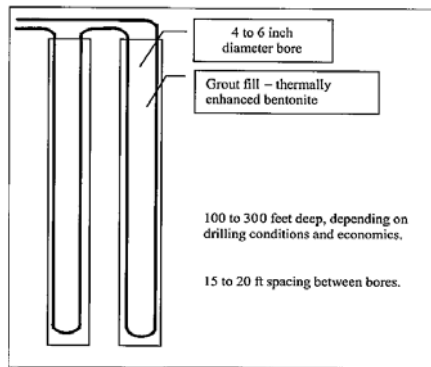


Figure 1 - Example of a Borehole

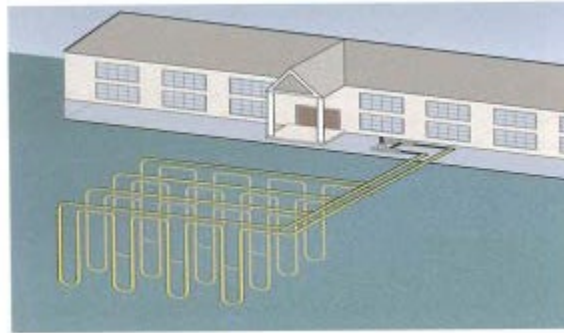


Figure 2 - Closed-Loop Vertical Bore Ground Heat Exchanger

Potential solutions may include one or more of the following:

- Hybrid GSHP systems, including but not limited to:
 - multi-source heat pumps, and/or
 - air source and geothermal heat pump hybrids.
- Improved installation quality,
- Innovative business models, including those that can turn CapEx into OpEx,
- Loop installation improvements, including, but not limited to:
 - improved or novel bore hole drilling techniques,
 - non trenching alternatives
 - novel heat exchangers or fluids,
 - innovative casing solutions,
 - piping connection/fusion, and
 - grouting materials and techniques.

All proposals are required to:

- 1) baseline the cost elements for the typical application the proposer's solution addresses, and
- 2) provide estimates of the cost change for each element (continued or new).

Subchallenge Requirements:

1. Proposers will be required to use Attachment E2a - GSHP System Cost Breakdown to baseline and provide an estimate of the cost change for each element. The identified reductions must be clearly linked to the proposed project activities.
2. Installations should conform with "Closed-Loop/Geothermal Heat Pump Systems - Design and Installation Standards" 2017 Edition published by the International Ground Source Heat Pump Association²; or ANSI/CSA C448 Series-16 Bi-National American-Canadian Standard: Design and installation of ground source heat pump systems for commercial and residential buildings.³ Any deviations from these standards, in order to achieve the desired cost reduction, must be documented and justified.
3. Projects must adhere to all relevant local and NYS laws and ordinances as they pertain to safety, drilling, buried pipe systems, and working fluids, or a statement must be made noting the requirement for a variance.
4. Proposal must include an independent 3rd party contractor to validate cost reductions and performance of the installed GSHP system. Examples of validation activities include: time & motion evaluations, bill of materials, quantification of soft costs, and business model evaluations. Recommended American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) and the International Ground Source Heat Pump Association (IGSHPA) specifications for testing the performance of an installed GSHP system.

² <https://igshpa.org/manuals>

³ <https://igshpa.org/manuals#ansicsa-c448-series-16-bi-national-american-canadian-standard-21036>

Subchallenge Targets:

1. Demonstration of a solution that is repeatable, sustainable, and scalable in attaining a 20% or greater cost reduction in the installation of a ground source heat pump system.

Any questions regarding eligible proposals for this Innovation Challenge Area should be directed to Scott Smith at (518) 862-1090 ext. 3344 or by email (ScottNextGen@nyserda.ny.gov).