What to Expect from Your Geothermal Heating System: The Potential Savings, Benefits, and More

As New York State navigates an exciting time in its plans for a clean energy future, geothermal heat pump systems, also known as ground-source heat pump (GSHP) systems, have risen to the top of the list as one of the most efficient and effective technologies to help accelerate the transition to clean energy across the State. This is particularly true for businesses and commercial facilities statewide, all of which play a significant role in helping New York meet the ambitious goals set in motion by the Climate Leadership and Community Protection Act (CLCPA) of 2019.

Whether you've just begun some high-level research or are seriously considering a GSHP system, you may be wondering how the technology may potentially benefit your business or facility from both a cost and energy-savings and an environmental benefits standpoint.

If you are feeling at all overwhelmed by the sheer scope of information and research currently available on the topic, we've compiled a comprehensive overview of what you can expect from your GSHP system.

Overall Savings and Benefits

While geothermal heating systems have the potential to offer significant operations and maintenance (O&M) cost and energy savings for nearly all commercial facilities, in general, certain factors can lead to greater benefits. For example, the 2019 Geothermal Clean Energy Challenge (the "Challenge"), jointly developed by NYSERDA and NYPA, assessed the potential savings and environmental benefits of GSHP systems for 91 participating buildings and facilities across several different industries (including universities, k-12 schools, healthcare organizations and government entities). Of those assessed, the participating sites that had the potential to maximize savings and benefits encompassed one or more of the following variables:

- They were replacing the highest-cost, highest-carbon energy sources like fuel oil and propane (although sites replacing conventional natural gas boilers also had the potential to recognize significant savings especially if they had had low electricity costs).
- Sites that encountered high operations and maintenance costs, or those that were able to retire cooling towers during the time of the Challenge, were estimated to have greater annual O&M savings potential.
- Sites considering larger GSHP systems saw greater greenhouse gas (GHG) emissions reductions as a result of the displacement of the largest amount of conventional energy consumption.

A Closer Look at What You Can Expect

With all of the above in mind, here's a closer look at how you can expect geothermal heating systems to impact nearly every aspect of your building and your business. Expectations are derived from a high-level assessment of the 91 participating Geothermal Clean Energy Challenge sites, 30 of which went on

for further analysis (Stage 2 of the Challenge) after being ranked higher for both economic and technical viability of implementing a GSHP system at their location.

You can expect…. energy bill savings.

GSHP systems can generate energy bill savings in two ways: by more efficiently converting inputs (fuels) into outputs (space conditioning), and/or by substituting a less expensive fuel for a more expensive fuel. In almost all instances, geothermal systems were found to be more energy efficient than traditional HVAC systems. Additional savings or costs from *fuel switching* is dependent on the fuel currently used and the rate currently being paid for that fuel compared to electricity costs associated with a GSHP system.

Energy bill savings did vary depending on the square footage of the sites assessed. A range of square footage was accounted for in the assessment, as summarized in the table below.

Estimated Annual Energy Bill Savings from GSHP Systems per Square Foot

	All Sites (n=91)	Stage 2 Sites (n=30)
Mean	$0.412	$0.445
High	$1.516	$1.516
80th Percentile	$0.890	$1.063
Median	$0.277	$0.333
Low	-$0.138	$0.011

You can expect… operations and maintenance cost savings.

One benefit of GSHP systems that is often overlooked is the amount of O&M cost savings that they can potentially generate. Given their long life (some models of GSHPs can efficiently remain in service for up to 50 years), the amount saved on operations and maintenance costs can be a significant incentive to invest in a geothermal heating system.

Of the participating sites, the annual O&M savings were roughly $0.35/sf, or $62,000 per year for the average-sized (177,379 sf) site. Facilities with higher than average savings tended to either have very high current O&M costs or were able to retire a cooling tower if they implemented a GSHP system.

Estimated Annual O&M Savings from GSHP Systems per Square Foot

	All Sites (n=91)	Stage 2 Sites (n=30)
Mean	$0.367	$0.423
High	$1.960	$1.960
80th Percentile	$0.488	$0.628
Median	$0.343	$0.349
Low	$0	$0

And when combining both energy cost savings *and* O&M savings, you can expect the implementation of a geothermal heating system to decrease operating costs even further. The modeled GSHP projects assessed within the Geothermal Clean Energy Challenge were expected, on average, to decrease sites' operating costs for heating and cooling by more than 50%.

Annual Operating Cost Savings *(energy bill and O&M savings combined)* ***as a % of Pre-GSHP Annual Operating Costs***

	All Sites (n=91)	Stage 2 Sites (n=30)
Mean	52%	57%
High	78%	78%
80th Percentile	69%	72%
Median	52%	52%
Low	-5%	28%

You can expect…. to avoid significant HVAC capital costs.

Of the sites assessed, those with the highest avoided HVAC capital costs tended to be new construction where a geothermal system is installed from the beginning. At such sites, the entire cost of the traditional HVAC system that would be installed in the absence of a GSHP system is avoided.

Net Present Value of Avoided HVAC Capital Costs with GSHP Systems per Square Foot

	All Sites (n=91)	Stage 2 Sites (n=30)
Mean	$4	$6
High	$16	$16
80th Percentile	$5	$7
Median	$4	$5
Low	$1	$1

You can expect… a lower carbon footprint.

In addition to significant cost savings, with geothermal heating systems you can also expect to have a positive impact on the environment.

For all 91 sites assessed, the implementation of a GSHP system would reduce energy use, lowering a facility's carbon footprint by creating improvements in HVAC energy use intensity (EUI) of at least 25%.

Additionally, GSHP systems have the potential to substantially reduce a building or facility's GHG emissions, with the highest emissions reductions possible among both larger installed geothermal

systems, which displace a larger amount of conventional energy traditionally consumed, and among sites that used fuel oil for heating.

Annual GHG Emissions Reductions from GSHP Systems *(metric tons of CO_2 equivalent)*

	All Sites (n=91)	Stage 2 Sites (n=30)
Mean	790	774
High	9,800	9,800
80th Percentile	1,003	971
Median	324	233
Low	48	48

To take an even deeper dive into the potential savings and benefits you can expect with a geothermal heating system. Learn More