



Increasing Awareness of Geoexchange in Massachusetts – Part 5 of 5

Heat pumps are heat pumps are heat pumps, right? While most people seem to picture an air-source mini-split system when they hear 'heat pump' there actually are a variety of heat pump types. These include the common mini-splits and whole house air-to-air but there are also air-to-water heat pumps and my favorite: Ground Source Heat Pumps (GSHPs). GSHPs are used in Geoexchange Systems to efficiently heat and cool buildings and can also provide hot water.

Geoexchange systems offer significant advantages for both homeowners and businesses. In Massachusetts, where weather conditions can be extreme in both winter and summer, geoexchange systems provide distinct benefits over air-source heat pumps (ASHPs). There is some technical complexity in explaining the reasons for this. I have prepared 5 separate posts to explore some of the most compelling advantages of Geoexchange/GSHPs one at a time. The individual posts are written to stand on their own so you can pick and choose the order you read them or just focus on the topic(s) that are important to you right now.

In the Series, I provide information related to:

- 1 Efficiency and Peak Load Advantages
- 2 Aesthetic Advantages in Historic Districts
- 3 Longer Service Life and Lifecycle Cost Advantages of GSHPs
- 4 Risk from Refrigerant used in GSHPs and ASHPs
- 5 Potential for Networked Geothermal Systems.

I hope this Series can promote discussion of building electrification using either ASHPs and GSHPs. Here is Part 1 of 5 which considers Service Life and Lifecycle Costs:



Potential for Networked Geothermal Systems

Networked geothermal systems, also known as district geothermal or shared loop systems, offer a powerful solution for urban areas and historic districts where energy efficiency, aesthetics, and long-term sustainability are crucial. These systems involve a shared underground loop that connects multiple buildings to a single geothermal network, offering numerous environmental, economic, and logistical advantages. For towns with historic preservation concerns, networked geothermal systems represent an ideal balance between modern energy solutions and maintaining the aesthetic integrity of the area.

ENVIRONMENTAL BENEFITS

One of the most significant advantages of networked geothermal systems is the potential for large-scale decarbonization. By providing heating and cooling through geothermal energy, these systems reduce the need for fossil fuel-based heating systems, which are responsible for a significant portion of greenhouse gas emissions. Since networked geothermal systems rely on the Earth's stable underground temperature, they provide consistent heating and cooling with minimal energy consumption, making them a crucial component of climate change mitigation strategies in urban environments.

In dense urban areas, where space constraints make the installation of individual geothermal systems challenging, networked systems allow entire blocks or neighborhoods to share the same geothermal loop, reducing the overall carbon footprint of the community. For historic districts, this is particularly important as many of these buildings were built before modern heating technologies and often rely on inefficient, carbon-intensive systems.

ECONOMIC AND LOGISTICAL ADVANTAGES

Networked geothermal systems offer economies of scale that reduce the overall cost of installation and maintenance. Rather than each building installing its own geothermal system, the shared infrastructure distributes the cost across multiple users. This makes networked systems more affordable for property owners, particularly in urban areas where space and resources are limited.

From a logistical perspective, networked geothermal systems simplify the installation process. Instead of requiring each building to have its own well or loop, a single shared loop can be installed to serve multiple buildings. This not only reduces the amount of drilling required but also can reduce disruption to the community during installation.





AESTHETIC AND HISTORIC PRESERVATION BENEFITS

For historic districts, where the preservation of visual and architectural integrity is a priority, networked geothermal systems provide a discreet and visually unobtrusive solution. Unlike air-source heat pumps (ASHPs) that require visible outdoor units, networked geothermal systems involve underground installation, meaning that there is no impact on the exterior of historic buildings. This makes it easier to comply with preservation guidelines while modernizing the building's energy systems.

In towns where maintaining the character of the community is critical, networked geothermal systems can be a key tool in balancing sustainability with preservation. By eliminating the need for external HVAC equipment, these systems allow property owners to upgrade their heating and cooling systems without altering the appearance of their buildings or the streetscape.

RESILIENCE AND ENERGY INDEPENDENCE

Networked geothermal systems also contribute to energy resilience by providing a reliable and consistent source of heating and cooling. Unlike air-source systems that can lose efficiency during extreme weather, geothermal systems are not affected by outdoor temperature fluctuations. This makes them particularly valuable in areas where the grid may be strained during peak demand periods. In fact, geothermal systems use less than half the electricity that ASHPs do requiring less build-out of the electric grid to support moving to electrified systems.

Additionally, networked geothermal systems reduce dependence on external energy sources, such as natural gas or oil, allowing communities to move toward energy independence. As Massachusetts continues to pursue aggressive decarbonization goals, networked geothermal systems offer a pathway to achieving these targets while enhancing community resilience.

SCALABILITY AND COMMUNITY BENEFITS

One of the key advantages of networked geothermal systems is their scalability. These systems can be expanded over time to serve additional buildings or even entire neighborhoods, making them a flexible solution for growing urban areas. For example, a small network can initially serve a few municipal buildings or residential properties, and as the infrastructure expands, more buildings can be connected. Further, networked geothermal systems can be beneficially interconnected to improve overall efficiency.

From a community perspective, networked geothermal systems can also provide equitable access to clean energy. By spreading the cost of installation and maintenance across multiple users, these systems make it easier for low-income households to benefit from energy-efficient heating and cooling without bearing the full cost of an individual system. This contributes to greater energy equity and helps communities meet sustainability goals in an inclusive way.





Local Advantages

Adopting Networked Geothermal (Geoexchange) Systems in a Massachusetts towns and cities, presents a unique opportunity to achieve energy sustainability, reduce greenhouse gas emissions, and promote economic and social benefits for the entire community. This technology involves connecting multiple buildings to a shared underground loop that harnesses the Earth's stable temperature to provide efficient heating and cooling. The potential for the system to be owned and operated by the municipal utility or a community organization may add significant advantages, ranging from energy independence to increased local control.

Here's a detailed analysis of the potential benefits:

1. SIGNIFICANT CARBON EMISSIONS REDUCTIONS

- **Decarbonizing Heating and Cooling:** In Massachusetts, heating and cooling are among the largest contributors to carbon emissions, especially in a town where buildings rely heavily on oil and natural gas or propane for heating. Networked geothermal systems use the Earth's stable underground temperature to replace fossil fuels, significantly reducing the town's carbon footprint.
- **Meeting Climate Goals:** Massachusetts is aiming for net-zero carbon emissions by 2050, and towns and cities can play a crucial role in achieving this goal. By adopting networked geothermal, the town can take meaningful steps to decarbonize its built environment, contributing to both state and local climate action plans only 0.05 kg per year, resulting in just 23 kg of CO₂-equivalent emissions.

2. LOWER ENERGY COSTS AND PRICE STABILITY

- **Economies of Scale:** Networked geothermal systems provide economies of scale by distributing installation costs across multiple buildings or neighborhoods. Shared infrastructure like geothermal wells and underground piping systems lowers the cost per building, making geothermal more affordable than individual installations.
- **Stable Energy Costs:** Unlike fossil fuels, which are subject to global price fluctuations, geothermal systems provide stable heating and cooling costs. Since the Earth's temperature is constant, geothermal energy is unaffected by fuel price volatility, offering long-term price stability for homeowners and businesses.





3. PEAK LOAD REDUCTION AND GRID STABILITY

- **Reducing Peak Demand:** In towns and cities in New England, extreme weather—especially during cold winters—leads to spikes in energy demand for heating. Networked geothermal systems maintain high efficiency regardless of outdoor temperature, helping to reduce peak load on the electric grid. This reduces the risk of power outages and the need for costly grid upgrades.
- **Supporting Renewable Energy Integration:** By lowering peak demand, networked geothermal systems make it easier to integrate renewable energy sources such as wind and solar into the local grid. This helps Marblehead's grid transition to cleaner energy sources while maintaining reliability.

4. IMPROVED AESTHETIC AND ZONING FLEXIBILITY

- **No Visible Equipment:** In our historic towns and cities, preserving the visual character of buildings is a priority. Air-source heat pumps (ASHPs) and traditional HVAC systems often require outdoor units that can detract from the aesthetic of homes and buildings. Networked geothermal systems have no visible external components, making them ideal for historic districts.
- **Flexibility for Various Building Types:** Networked geothermal systems can serve a variety of building types—residential, commercial, and institutional—without requiring zoning changes or major renovations. This flexibility is particularly advantageous in mixed-use areas where maintaining architectural integrity is important. In fact, a networked system that connects mixed-use buildings can be even more efficient.

5. LONGEVITY AND DURABILITY

- **Longer System Lifespan:** The underground loop of a geothermal system can last 50-100+ years, and the heat pump units typically last 25 years. This longer lifespan compared to traditional heating systems means fewer replacements and lower long-term capital costs.
- **Lower Maintenance Costs:** Because the majority of the geothermal system's components are protected underground and indoors, there is less wear and tear compared to systems exposed to outdoor conditions. This results in lower maintenance costs and fewer disruptions for homeowners and businesses.





6. COMMUNITY OWNERSHIP AND LOCAL CONTROL

If a municipal electric company or a community organization were to own and operate the networked geothermal system, it would create significant additional benefits:

- **Local Energy Control:** Community ownership of geothermal infrastructure would provide greater local control over energy pricing and service. Local entity could set rates to ensure affordable heating and cooling, free from the volatility of global energy markets.
- **Revenue Generation:** By operating the geothermal system, the local light company or community organization could generate revenue by charging residents and businesses for heating and cooling services. These revenues could be reinvested in maintaining the system or used to support other local energy efficiency projects.
- **Energy Equity:** A municipally owned system could ensure fair and equitable access to clean energy for all residents, including lower-income households. By spreading costs across the entire community, networked geothermal systems could help reduce energy costs for everyone, not just those who can afford individual installations.
- **Public Accountability:** A community-run geothermal network would be accountable to local residents, ensuring that the system is managed transparently and that service decisions are made in the best interest of the community.

7. INCENTIVES AND FINANCING OPPORTUNITIES

- **Federal and State Incentives:** Networked geothermal projects are eligible for federal tax credits (though the regulations on this need modification to ease implementation) and state incentives like rebates through Mass Save. Community ownership could maximize these incentives to lower installation costs and provide additional financial support for the project.
- **Low-Cost Financing:** A municipally owned utility or community organization may have access to low-interest loans or grants for renewable energy projects, further reducing the cost of implementing a networked geothermal system. This financing could make geothermal infrastructure more affordable for the entire community.
- **Public-Private Partnerships:** Municipalities and community organizations could explore public-private partnerships to fund and operate the geothermal system. These partnerships could attract private investment while keeping the system under local control, ensuring both financial feasibility and community benefit.





8. ENERGY INDEPENDENCE AND RESILIENCE

- **Reduced Dependence on Fossil Fuels:** By adopting a networked geothermal system, our cities and towns would reduce its dependence on imported natural gas, oil, and propane for heating. This transition would enhance the town's energy independence, making it less vulnerable to global energy market fluctuations or supply chain disruptions.
- **Resilience to Climate Change:** As climate change leads to more extreme weather events, our cities and towns need resilient energy systems. Geothermal systems, which operate efficiently regardless of outdoor temperature, provide a reliable source of heating and cooling that can withstand the challenges of a changing climate.

9. JOB CREATION AND ECONOMIC DEVELOPMENT

- **Local Jobs:** Installing and maintaining a networked geothermal system would create local jobs in geothermal drilling, system design, installation, and long-term maintenance. This workforce development could provide economic benefits to the community, particularly as the clean energy sector continues to grow.
- **Economic Attractiveness:** A town with a municipally owned geothermal system would be more attractive to businesses and new residents who value sustainability and clean energy. This could help attract environmentally conscious companies and new homeowners, boosting the local economy.

10. SCALABILITY AND FUTURE EXPANSION

- **Scalable Infrastructure:** Once the core infrastructure for a networked geothermal system is in place, it can be expanded to serve more homes and businesses over time. Municipalities or community organizations could start by connecting municipal buildings, schools, and key residential areas, then gradually expand the system to include additional neighborhoods.
- **Flexible to Growth:** As Marblehead grows or as new technologies emerge, the geothermal network can be adapted and expanded to accommodate more buildings or more efficient heat pump technologies, ensuring the system remains viable for decades to come.





Conclusion: A Path to a Sustainable Future

Adopting networked geothermal systems offers a clear path toward achieving environmental goals while delivering economic and social benefits to residents. The potential for local ownership by a municipal utility or a community organization further enhances these advantages by ensuring local control, revenue generation, and energy equity. As Massachusetts pursues ambitious climate goals, networked geothermal represents a transformative opportunity for Massachusetts cities and towns to lead by example, creating a sustainable, resilient, and forward-thinking energy system for its residents and businesses.

