



Geothermal Heating and Cooling

Part 2: Step-by-Step

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Key issue: More sustainable heating and
cooling

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This document continues the geothermal primer for houses of worship interested in exploring and implementing sustainable heating and cooling solutions for their buildings. It expands on *Geothermal Heating and Cooling Part 1: Introduction* by comparing geothermal systems with air source heat pumps, outlining practical steps for getting started, examining financing options in greater detail, identifying potential challenges, introducing thermal energy networks, and pointing to additional resources.

Comparing Ground Source Heat Pumps to Air Source Heat Pumps

Ground source heat pumps (GSHPs), also called geothermal heat pumps, are generally more efficient than air source heat pumps (ASHPs) because they exchange heat with the ground, which holds a much more stable temperature year-round than the outside air. As a result, they use less electricity than ASHPs and so are less expensive to operate

1. More consistent performance

Because ground temperature changes very little across the seasons (staying at roughly 50 - 55 degrees Fahrenheit), GSHPs maintain relatively steady efficiency all year. Air source systems lose efficiency in extreme cold or heat, when they have to work against

harsher outdoor conditions. Simply put, it is easier to extract heat from 50-degree ground than 20-degree air so geothermal equipment works less hard and uses less electricity.

2. System durability

The underground piping (ground loop) is protected from the weather and can often last 50 years or more, while the indoor heat pump unit typically lasts around 20 to 25 years. Air source systems have outdoor units exposed to rain, snow, UV radiation, and temperature extremes, which generally shortens their lifespan to 15 years or less.

3. Environmental advantages

Ground source heat pumps generally deliver greater long-term carbon reductions because they use less electricity for the same heating and cooling, helping congregations meet any decarbonization goals they may have. If the congregations use renewable electricity – either generated by solar panels on the building or by purchasing renewable electricity – the system can have zero carbon emissions.

4. Cost

While a geothermal system has higher upfront costs, federal and state incentives can make the initial costs comparable to an air source heat pump option. Over time, its higher efficiency lowers operational costs significantly.

5. Networking capabilities

Air source heat pumps are isolated units specific to a single building. An emerging trend in geothermal is to connect many buildings to a network of pipes and boreholes, making sustainability more communal. This is discussed in more detail toward the end of this paper. While geothermal systems today are generally limited to one building, they can be built to enable connection to a future network. MassIPL also believes houses of worship can be leaders in collective efforts to build these geothermal networks in their communities.

Incentives make geothermal comparable in cost

While the initial gross cost of a geothermal system will be higher, strong federal and state incentives can help bring the net installation cost essentially in line with conventional options. **Under federal incentives, nonprofit houses of worship are eligible for a 30% direct payment on the project, with an additional 10% if materials are sourced domestically and another 10%**

if the building sits in an "energy community"¹. Further rebates are available through Mass Save, a statewide program that incentivizes energy efficiency. These two incentives can be combined to eliminate most, if not all, of the difference in cost between the geothermal system and an air source heat pump system.

Getting Started

Transitioning from a traditional heating system to geothermal will take more time, planning and design work than simply replacing the existing system with newer, similar equipment. A successful geothermal project will unfold in three phases:

Sealing the building envelope

Before transitioning to any new heating and cooling system, it is important to ensure the building is properly insulated. Sealing the building envelope, or weatherizing, is the process of identifying and addressing unintended leaks where conditioned air escapes and unconditioned air enters. Weatherizing a house of worship makes it more comfortable and safer for congregants while increasing energy efficiency, which lowers heating and cooling costs. MassIPL has partnered with Mass Save's weatherization assessment program, available to houses of worship interested in weatherizing their buildings.

Site assessment and initial design

If a house of worship has an end-of-life or failing HVAC system, replacing it will cost a significant amount of money whether they choose geothermal or an updated gas or oil system. MassIPL always recommends that any HVAC replacement project undertakes an initial building evaluation to ensure the new system is designed to accurately meet the building's heating and cooling needs. The cost of this evaluation is a modest investment to ensure that the new system is designed appropriately to deliver comfort and efficiency.

A house of worship interested in geothermal will need to hire an external company to assess whether their property is suitable for geothermal heating and cooling. This study will examine factors that impact geothermal suitability such as the property size, terrain and geology, as well as existing HVAC infrastructure.

Once the site has been determined to be viable for geothermal, the same company or a different one can create a schematic design for the building's system that will be the basis for soliciting proposals from contractors. Unlike a gas or oil system, where you replace specific components such as just the boiler, geothermal installation requires a full system overhaul and a complete design, including borehole locations and other specifics. This design will carry some upfront

¹ The term "energy community" covers areas with closed coal mines or coal-fired power plants, brownfield sites, and places with significant employment or local tax revenue tied to fossil fuels alongside higher-than-average unemployment.

cost of its own but is a modest investment that pays back by ensuring that the system is sized and designed correctly for the unique characteristics of your building and to ensure you receive comparable, “apples-to-apples” proposals from contractors.

Get quotes on different systems from different contractors

Because updating a building's HVAC system is a major logistical and financial decision, congregants will likely want to understand and compare the options for their community, assuming they have decision-making power. Once initial evaluation and schematic designs are complete, a congregation should reach out to the contractors they are interested in working with to get quotes on the cost of installing their geothermal design, and on how those costs, in both the short and long term, compare to other HVAC systems. Consider MassIPL's partner, GreenerU, for these evaluations, as they were a great help to Wellesley Village (see the Success Story at <https://www.massipl.org/success-stories/wellesley-village-church>)

What potential challenges may arise?

As with any major construction project, houses of worship can anticipate some challenges and bumps along the road. Geothermal is a serious undertaking: it took Wellesley Village Church 10 years to go from initial idea to completed project. While it might not take a decade, a congregation should be prepared for a disciplined process that requires significant time and money. They should also expect that construction may disrupt building use, and that unforeseen costs can arise along the way.

Wellesley Village Church took two additional steps to manage these potential challenges. As is a best practice for any major construction project, the church included a contingency budget to cover any unexpected, extra expenses. They took the further step on investing in a more detailed design which allowed them to negotiate a fixed-price contract. Your congregation should consider the tradeoff of investing more in this additional upfront design vs the congregation's ability and willingness to handle problems that will otherwise only surface during construction. The more thoroughly the building is evaluated before construction begins, the lower the likelihood of unanticipated problems and increased costs.

Thermal Energy Network Systems

Networked geothermal (also known as a thermal energy network) is an emerging approach that provides geothermal heating and cooling to several buildings at once. Unlike an individual system, where a property might have several boreholes that exchange thermal energy only for itself, a networked system uses a designated site or sites for boreholes that serve the entire network. In addition, when some buildings on the network have excess heat, the system can share it with others without drawing on the heat stored in the ground. The thermal energy travels as water through a network of underground pipes to each building, which has its own heat pump.

Networked geothermal can be thought of like a gas utility, except that instead of gas moving to various properties, the pipes move heated or cooled water. For an explanation of networked geothermal and how it is being implemented in a pilot program in Framingham [see this video](#). The success of the Framingham pilot increases the likelihood of networked geothermal systems becoming more common in the future.

While a house of worship installs a geothermal system to heat their building, they should consider designing it with the possibility to connect to a network in the future.

A note about thermal energy more broadly

Ground source and air source heat pumps are not the only way to access thermal energy. Thermal energy exists in bodies of water like rivers, lakes, and the ocean, as well as in other buildings, from factories to grocery stores to schools. It is a huge resource that can be tapped to sustainably meet a community's needs. A networked thermal energy system can harness the differences in heat generation and heating and cooling needs among buildings to distribute that energy more efficiently. Thermal energy in all its forms has the potential to be the next step in sustainable heating and cooling.

To discuss the information in this article and to learn more about how geothermal heating and cooling might be appropriate for your house of worship, contact MassIPL on our [website](#) or email info@massipl.org

Additional Resources

- Geothermal Explainers
 - Short video on how geothermal heat pumps work: <https://www.youtube.com/watch?v=XxITnBukweI>
 - Short video from HEET explaining geothermal, networked geothermal, and the Framingham networked geothermal pilot program: <https://www.youtube.com/watch?v=Ncs7Sy-CCG0&t=132s>
 - Explainer page on HEET's mission to change gas utilities to thermal energy utilities, with 2 minute illustrated video: <https://heet.org/what-is-gas-to-geo>

- Wellesley Village Church
 - MassIPL Success Story about this church's project:
<https://www.massipl.org/success-stories/wellesley-village-church>
 - Overview site with short explanatory videos documenting the installation process: <https://wellesleyvillagechurch.org/empoweringthefuture/>
 - 1 hour webinar with King's Chapel explaining the entire process from start to finish: <https://www.youtube.com/watch?v=ZD5Vb-S0xW8>
- Incentives
 - Mass Save state incentives for non profits:
<https://www.masssave.com/business/solutions-by-sector/non-profits>
 - Short pdf explaining federal incentives for nonprofits:
https://www.energy.gov/sites/default/files/2024-08/Elective_Pay_Fact_Sheet_Territories_073124.pdf
 - Longer slideshow explaining federal incentives for nonprofits:
<https://www.energy.gov/sites/default/files/2024-05/Getting%20Cashback%20for%20Clean%20Energy%20-%20Renew%20America%27s%20Nonprofits%20-%2005.21.2024%20%281%29.pdf>