GSHP System Design Assistance

Otter Tail Power Company (OTPCO) has been promoting ground source heat pump (GSHP) systems for approximately 8 years with cash incentives (currently at $1,000 / ton of installed capacity). When their customers approached architectural and engineering firms about the feasibility of installing a GSHP in their commercial building project, they response was typically something like: "Well…your building is about 24,000 ft^2, so you'll need approximately 60 tons of equipment (400 ft^2 / ton) …and you'll need about 12,000' of borehole (200' of borehole / ton. And gas is cheap, so you'd be further ahead installing a gas boiler. Also, the ground heat exchanger will eventually heat up, so you'll have to replace it in 20 years."

Incentives alone weren't enough to convince building owners to move forward with a GSHP system. And some of the few that were installed didn't work as promised.

OTPCO has had a GSHP system in their head office and three additional buildings in Fergus Falls since 1998. Based on over 20 years experience, they knew GSHP systems could help the utility achieve with winter kWh growth for heating with heat pumps, while reducing summertime peak kW demand for cooling loads.

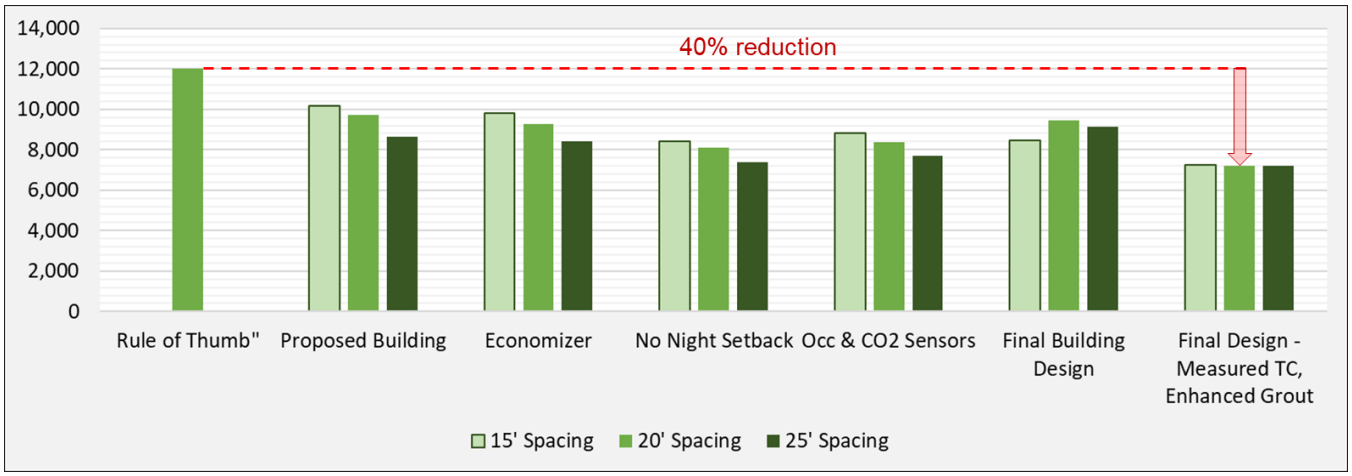
Providing training helped make mechanical system designers more comfortable with the design of commercial GSHP systems. They subsidized several Certified GeoExchange Designer courses between 2017 and 2021.

Training is supplemented with design assistance on real projects. Design assistance offers the design team assistance from a GSHP system design specialist early in the design process…at a time when changes to the building and / or mechanical system can have a significant impact on the amount of energy transferred to and from the ground. Assistance is tailored to the needs project and experience of the design team. There is no cost to the building owner or the design team for the design assistance. The cost of the GSHP system design specialist is covered by OTPCO, and may include:

- Review of hourly energy models developed by the design team, providing recommendations if needed that would potentially help balance energy loads to and from the ground, or, in some cases developing the energy model for the project. For most projects this included several iterations of the energy model to determine the impact of changes to the building or mechanical system such as glass or lighting specifications, ventilation strategy, heat pump equipment specifications.
- Review of the land area available for construction of the ground heat exchanger (GHX) and the geology it would be built in. Review of MN water well database and/or interviews with drilling and excavation contractors to estimate thermal properties of the ground at the site. This includes preliminary modeling of the GHX, the impact of changes to the layout of the borehole field, detailed borehole design, and in some cases, considering other GHX configurations such as a horizontal excavated or drilled GHX.
- Review and development of specifications for a test borehole and thermal conductivity test, or a horizontal GHX thermal properties testing procedure.
- Development of final system to ensure compatibility with the fluid temperatures available from a GHX and detailed GHX design, including fluid specifications, detailed construction drawings, pump selection
- Review and / or development of written specifications for the system and development of quality assurance / quality control program during construction.
- Development of operating and maintenance manual for building owner.

The purpose of design assistance is to demonstrate value of the process needed to optimize the size, cost, and long-term performance of the ground heat exchanger…beginning with the feasibility analysis and through to system commissioning.

A project for the Fergus Falls Library, in Fergus Falls, MN, illustrates the impact of iterative hourly energy modeling of the building, review of the geology and land area available to build the GHX, and iterative modeling of the GHX. Compared to commonly used “rules of thumb”, the amount of borehole required was reduced from 12,000’ to 7,200’…a 40% reduction. And by balancing the amount of energy rejected to the ground annually compared to the heat extracted, there was less likelihood of long-term temperature increase in the GHX.



Fifteen projects, ranging from a 12,000 ft^2 liquor store, to a 148,000 ft^2 high school. Ten of the fifteen projects have installed or have committed to installing a GSHP system. Discussions with building owners suggested that two of the projects would have installed a GSHP system without the help of the design assistance program. Eight additional projects that installed a GSHP system most likely would not have installed a GSHP system without the benefit of the design assistance program.

More interesting is the fact that three of the engineering firms that completed projects through the design assistance program have become confident enough in the technology that they have recommended a GSHP system to their clients outside of the OTPCO service area. The design assistance program has affected uptake of GHSP systems in the OTPCO service area…it has also increased the uptake of the technology outside of the OTPCO service area.

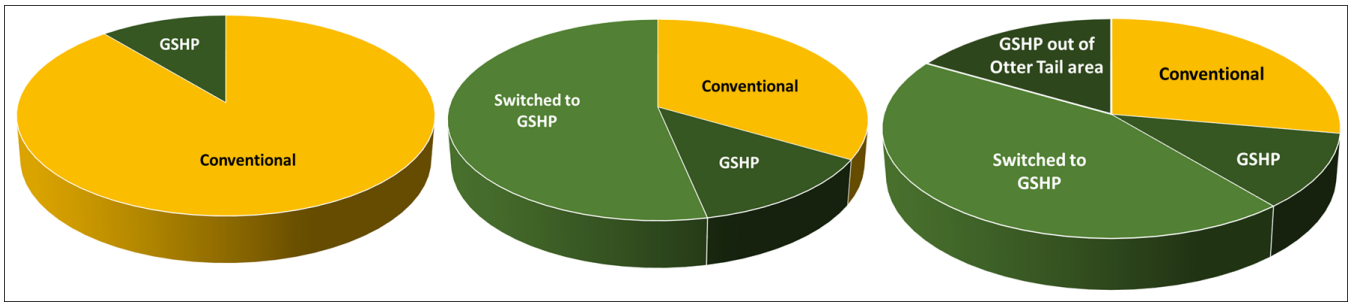


Figure 1: The design assistance program has quadrupled the uptake of GSHP systems in the OTPCO service area…and it has expanded the uptake of the technology to areas outside of their service area.