SHOULD WE DO GEOTHERMAL?

By: DuBois & King

WHAT IS GEOTHERMAL?

From EPA.gov:

- Geothermal technology harnesses the Earth's heat.
- Just a few feet below the surface, the Earth maintains a near-constant temperature, in contrast to the summer and winter extremes of the ambient air above ground.
- Farther below the surface, the temperature increases at an average rate of approximately 1°F for every 70 feet in depth.

Translation:

There's a heat sink under your feet: if you run water through it, you can transfer heat:

…*to* your building in the winter for heating

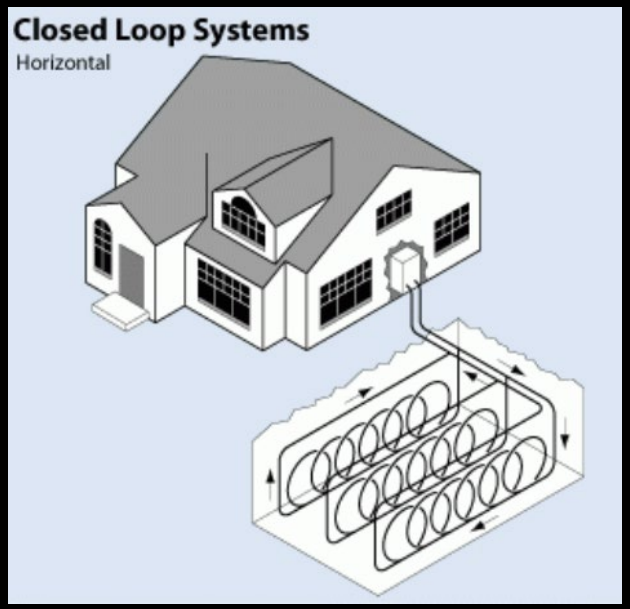
…and ***from*** your building in the summer for cooling

From experience with test wells in the area (Oyster River Middle School in Durham for instance) the temperature of the bedrock is approximately 50 deg. F which is also approximately the annual averaged air temperature.

HOW IS HEAT TAKEN FROM THE GROUND?

- Vertical bore holes
  - Closed loop piping in which heat is transferred to the water as it flows through the wells vertically

- Horizontal loops
  - Closed loop piping in which heat is transferred to the water as it flows through the loops
  - More common for residences
  - Not really practical in the northeast



INDOOR EQUIPMENT

Water is then pumped and directed to indoor units (water source heat pumps) with internal compressors to heat/cool the spaces.

Vertical stack

Typical horizontal/vertical ducted units

Console type

HOW EFFECTIVE ARE OPEN WELLS?

Open Wells = water is taken from wells similar to drinking water wells.

Aren't open wells more efficient? Well yes but..

- From our experience, open wellfields tend to clog pipes and heat pumps.
- Filters quickly get clogged causing maintenance headaches as flow rates are higher than drinking water wells.

HOW MANY WELLS ARE REQUIRED?

In discussions with area well drillers, a 500-ft well depth is optimal. Drilling deeper increases drilling expenses and complexity.

At 500 feet per well, how many wells are necessary?

First let's define a ton of cooling …

A TON OF HEATING OR COOLING (A DEFINITION)

- Is one ton of cooling equal to 2,000 lbs?
  - Not exactly. One ton of cooling is equal to the hourly rate of heat absorbed (or cooling effect) if 2,000 lbs of ice were melted in 24 hours, resulting in 12,000 BTU per hour: one ton of heating or cooling is equal to 12,000 BTU per hour.
- Heating and cooling loads from early plans indicate the building's estimated heating and cooling loads will be in the range of 500 tons of cooling and 400 tons of heating.
- While site conditions have not been tested at your site, a good rule of thumb is that 200 ft of well is necessary for each ton of cooling.
- Well data from nearby well sites appears to indicate the site may be a good location for geothermal though testing will be required to better understand the feasibility of geothermal at this site. DuBois & King utilizes GLHE-pro computer software for well design based on collected site data.
- Sizing a geothermal wellfield for 500 tons at 200 feet per ton would require 100,000 ft of vertical well.

WHAT IS REQUIRED TO CONSTRUCT 100,000 FT OF WELL?

- 100,000 foot of wells at 500 feet per well translates to 200 wells, or a wellfield grid that is 14 or 15 wells long by 14 wells wide..
- Your site may accommodate such a design.
- The design of the wellfield is very flexible and does not need to be rectangular or square in shape.

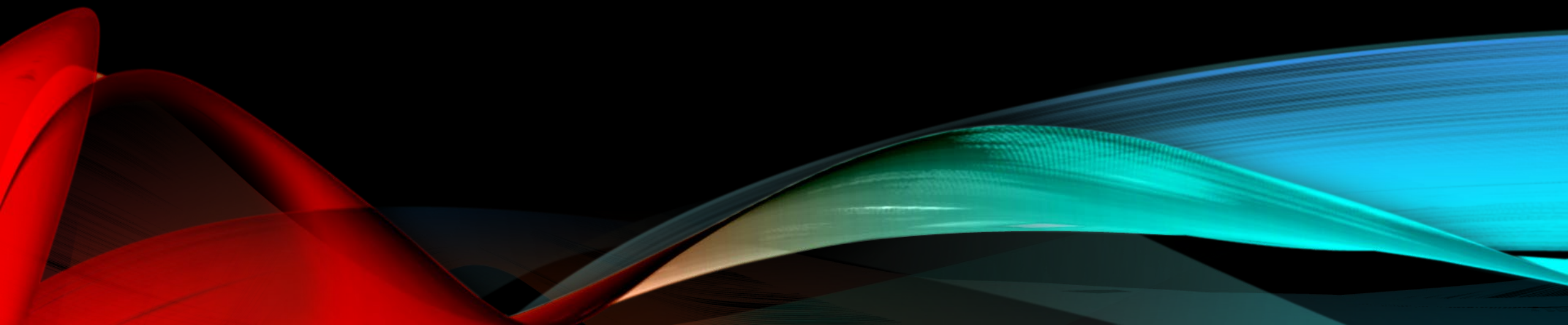
WOULD THIS PRESENT SIGNIFICANT COSTS?

Yes. We will address expenses later on.

WELL LOCATIONS

- Wellfields can go anywhere – under parking lots, driveways, etc. wherever is most convenient.
- Wells should be placed 25 feet apart. A 14x14 wellfield grid would be 400 feet x 400 feet

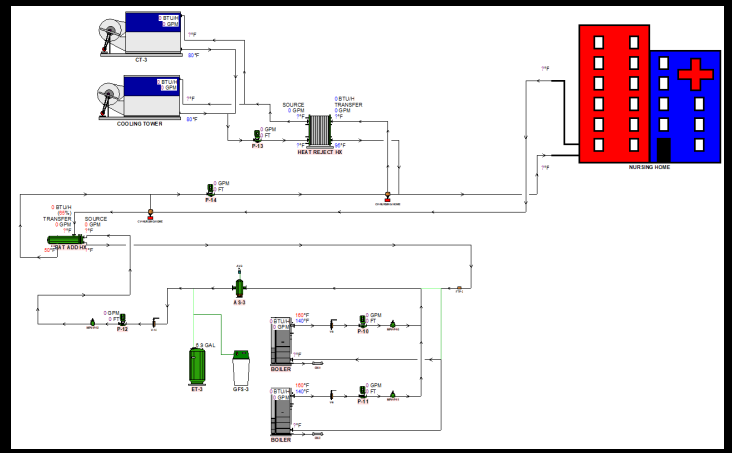
DOES GEOTHERMAL MAKE SENSE ECONOMICALLY?



THREE OPTIONS

Base System - Boiler/Tower Arrangement

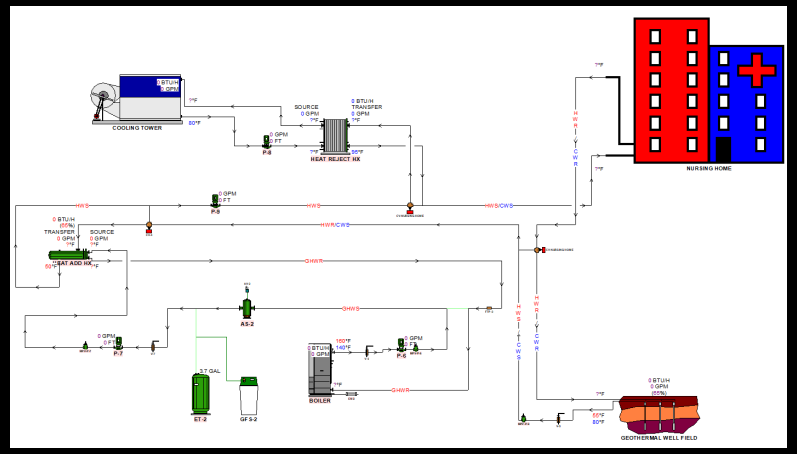
Water source heat pump system with boiler and cooling tower. This approach requires no geothermal well drilling. A boiler and cooling tower provide heating and cooling to the heat pump loop as necessary. Individual heat pumps take heat or reject heat to the heat pump loop as required to maintain space temperatures.



Option 1 - Geothermal wellfield designed for 100%

This option is similar to the boiler/tower option - the only exception being that instead of rejecting heat to a cooling tower or adding heat from a boiler, heat is rejected or added from the geothermal wellfield.

A cooling tower and boiler would still be required due to FGI guidelines and redundancy requirements.



Option 2 - Geothermal Wellfield designed for 60%

This is a hybrid approach that is the exact same option as the 100% wellfield option except sizing the wellfield for 60% of the cooling load instead of 100%. A boiler/tower arrangement would supplement heating and cooling as necessary. With this approach, the geothermal wellfield would be first stage heating and cooling and the tower/boiler would be second stage. This would allow the geothermal well to handle the building load the majority of the time.

CAPITAL AND OPERATING COSTS

Boiler/Tower

Lowest initial cost

- Opinion of probable cost (OPCC): $9,850,000*
- Energy use – highest energy use
- Operating cost – highest operating cost

100% wellfield

Highest initial cost

- OPCC: $15,000,000*
- Energy use – lowest energy use
- Operating cost – lowest operating cost

60% wellfield

Moderate initial cost

- OPCC: $13,140,000*
- Energy use – in between but closer to the 100% wellfield.
- Operating cost – in between but closer to the 100% wellfield.

* - Note that for reasons that will become clear in a later slide, this number only includes components that would be included for the heat pump system for comparison. This is NOT the entire cost of the HVAC for the project. Items not included in these costs include ductwork for code required ventilation, air handling equipment and related controls

RETURN ON INVESTMENT

CONCEPT-LEVEL ROI BASED ON CURRENT RATES

100% wellfield

OPCC Cost over base - $5,150,000

Annual Energy savings –

Electric – 41,178 KWH

Gas – 13,429 Therms

Annual cost savings - $24,105

Simple payback – 213 years

60% wellfield

OPCC Cost over base - $3,290,000

Annual Energy Savings –

Electric – 36,196 KWH

Gas – 10,813 Therms

Annual cost savings - $16,783

Simple payback – 196 years

CHEAP NATURAL GAS LENGTHENS THE ROI PERIOD

Natural gas is accessible at the site ($0.686 per therm). It is difficult to show an economical payback for geothermal.

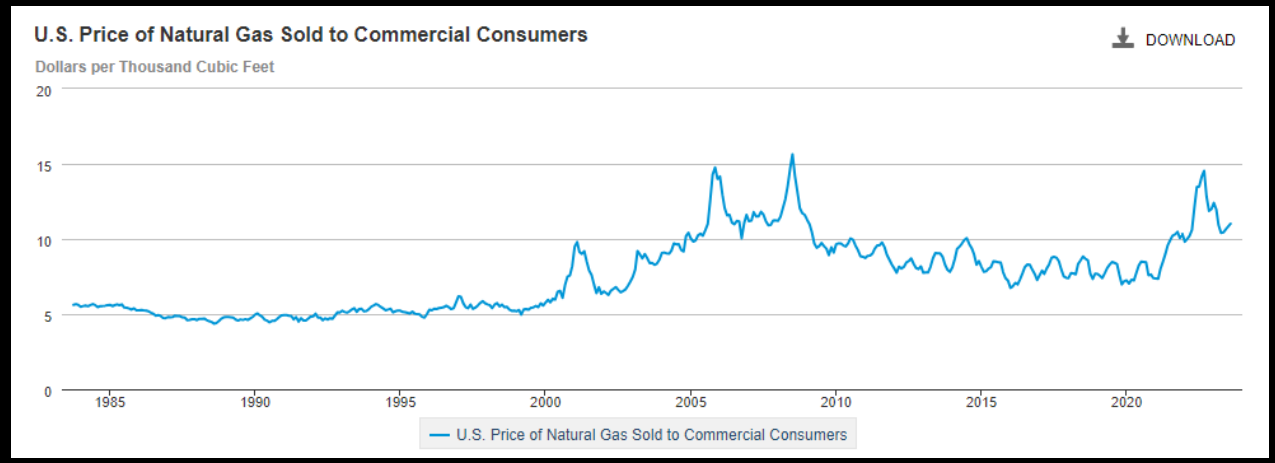
Where is the cost of operation in the geothermal?

- Geothermal systems still use pumps, compressors, and fans to move heat around. Pumping costs and compressor usage is slightly higher with geothermal systems when compared with boiler/tower heat pump systems.

It should be noted that energy is being saved, but the savings is not reflected in the payback because of the (current) low price of natural gas.

WILL THE COST OF GAS GO UP?

- Over the past several years, natural gas has generally been relatively inexpensive.
- Energy unit prices will continue to be a product of known and unforeseen global conditions.
- All choices regarding energy type involve some level of risk.



Average natural gas price over the past 25 years.

Source: https://www.eia.gov/dnav/ng/hist/n3020us3m.htm

IS THERE NO ECONOMIC PAYBACK TO GEOTHERMAL?

INFLATION REDUCTION ACT TAX CREDITS MAY RESULT IN PAYBACK

Does this apply to a municipality that doesn't pay taxes?

- It appears that it may be possible for municipalities to receive this money in the form of a check from the federal government under 26 U.S. Code § 48 - Energy credit
- For the purpose of easy interpretation, we will discuss this as if Strafford County pays taxes.
- DuBois & King is not an accountant or tax advisor, and does not provide legal counsel or financial advice. We recommend that the County discuss these matters with a legal and/or accounting professional regarding anything beyond this point

POTENTIALLY AVAILABLE FEDERAL TAX CREDITS

- Credit is offered at 6 percent times a multiplier of 5 for "projects meeting prevailing wages and registered apprenticeship requirements" (or a 30% total tax credit)
- Additional 10% tax credits for "domestic content minimums," which require a percentage of equipment to be made in America. Other credits and deductions may also be available.
- These credits appear to fall under the "investment tax credit"

WHAT IS INCLUDED IN THE 30% CREDIT?

Upon initial review, the following are included:

- All engineering, energy modeling, and soft costs associated with the design and implementation of the geothermal system and components.
- All exterior geothermal drilling excavation, borehole piping, pumps, geothermal horizontal piping, glycol, vaults, grouts, and anything associated with the exterior geothermal system into the building.
- All interior heat pump piping, pumps, controls, power, insulation, pipe hangers, thermostats, and plumbing up to and including the interior ground source heat pumps.
- Rooftop ERV with integral WSHP and associated power and controls for the unit. (ERVs without integral WSHP do not apply)
- All labor, materials, and equipment associated with the above is included.
- Anything downstream of this equipment, such as ductwork and VAV boxes, is ***NOT*** included.

REBATES FOR THE BOILER/ TOWER SYSTEM

- Based on discussions with NHSaves, rebates for the water source heat pumps (Boiler/Tower) would likely be:
  - $80 per ton - or for 500 tons - Rebates for the boiler/tower water source heat pumps would be $40,000.

What about taking the tax credit and taking the rebates for geothermal?

D&K discussed the possibility of taking both the rebate and the credit for geothermal heat pumps (which is also $80 per ton) with NHSaves. Taking both is not permitted.

SO WHAT'S THE PAYBACK IF WE TAKE INTO ACCOUNT THE 30% CREDIT & REBATES?

100% wellfield

- Cost difference now becomes $690,000
- Annual Cost savings is still $24,105
- Simple payback is now 28.6 years

60% wellfield

- Cost is now actually about $600,000 less than the base
- Annual energy savings is still $16,783
- Simple payback becomes negative because initial cost is less

Shorter paybacks can be achieved on 100% wellfield if bonus 10% or additional credits can be attained.

SO WHAT'S THE CONCLUSION?

Should we do geothermal or not??

ONE LAST ITEM TO CONSIDER - DOES A GEOTHERMAL SYSTEM EMIT CARBON?

- Like an electric car, a geothermal system (which uses electricity) does not produce "tailpipe emissions."

- If the electricity powering the geothermal system is generated using fossil fuels (such as natural gas or other fossil fuels), the system ***does*** indirectly emit carbon.

IS GEOTHERMAL A GOOD CHOICE?

It's really up to the delegation.

It appears a 60% wellfield design may make economic sense.

Opportunities for tax credits, utility incentives, and rebates will be investigated more as the project moves forward with design.