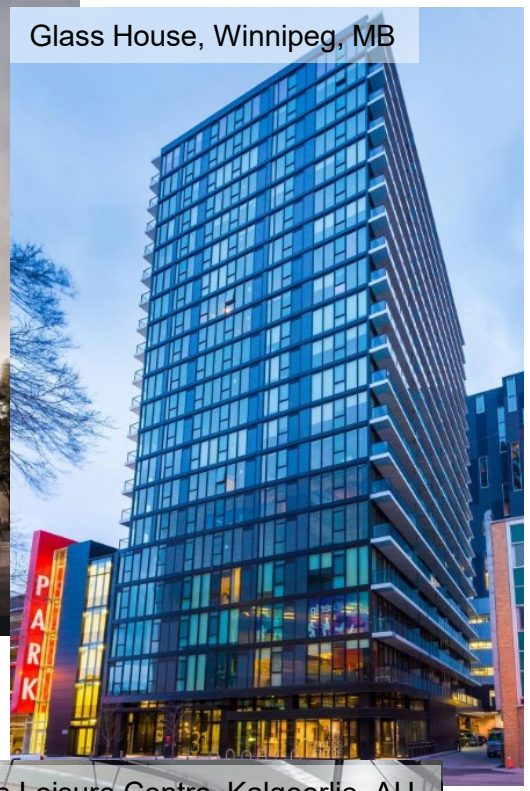
IKEA, Denver, CO


Obama Library, Chicago, IL

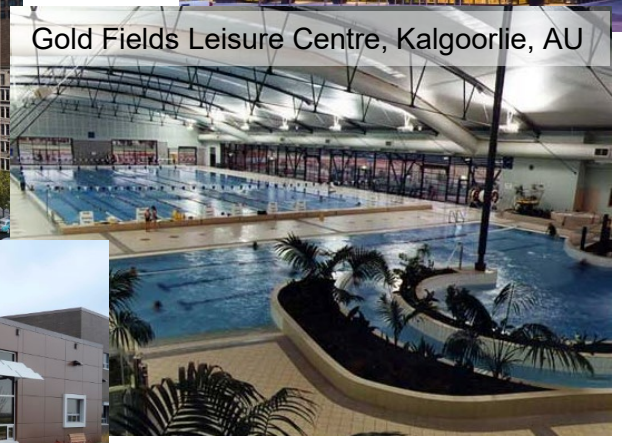


Glass House, Winnipeg, MB


Steinbach Credit Union, Winnipeg, MB


561 Greenwich, NYC, NY


Nurses Pavilion, College Universite St. Boniface, Winnipeg, MB


Gold Fields Leisure Centre, Kalgoorlie, AU

Hopkins Correctional Centre, Ararat, AU

Prairie Dale School, Winkler, MB

CERTs

Feasible Geothermal Heat Pump Systems

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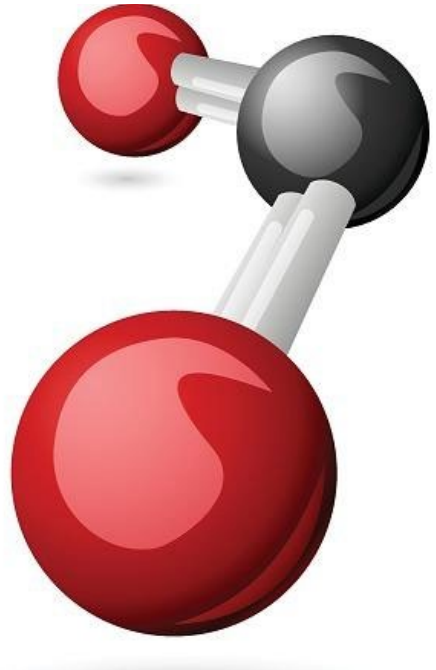
204-318-2156
ed@geoptimize.ca

GEOptimize.ca

Geothermal heat pump system perceptions

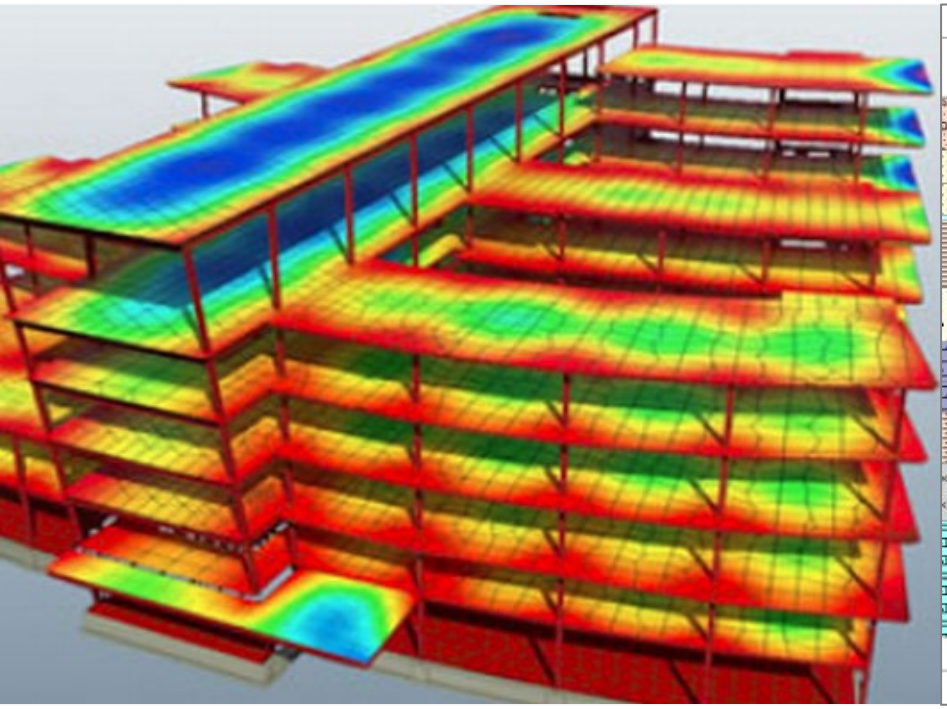
- Perceived high cost: Design methodology creates cost certainty
- Perceived risk: Design methodology creates performance certainty
- Environmental benefit: Reduces CO_2 emissions

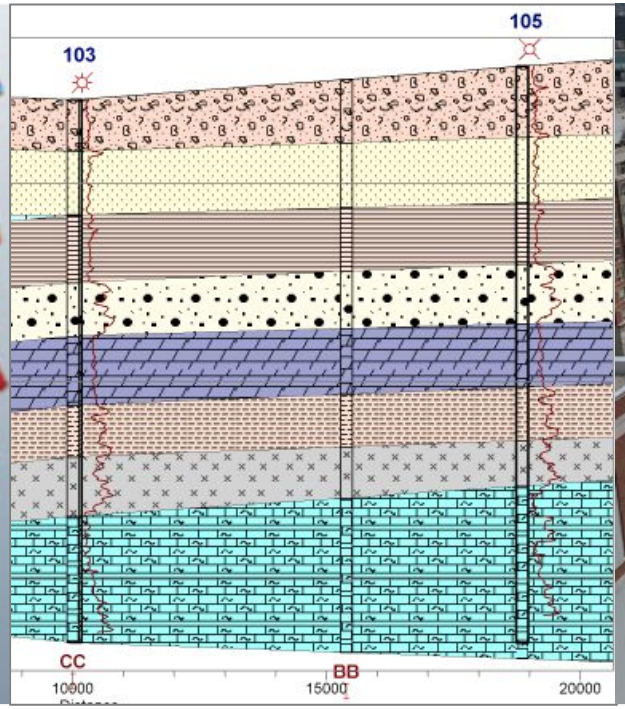


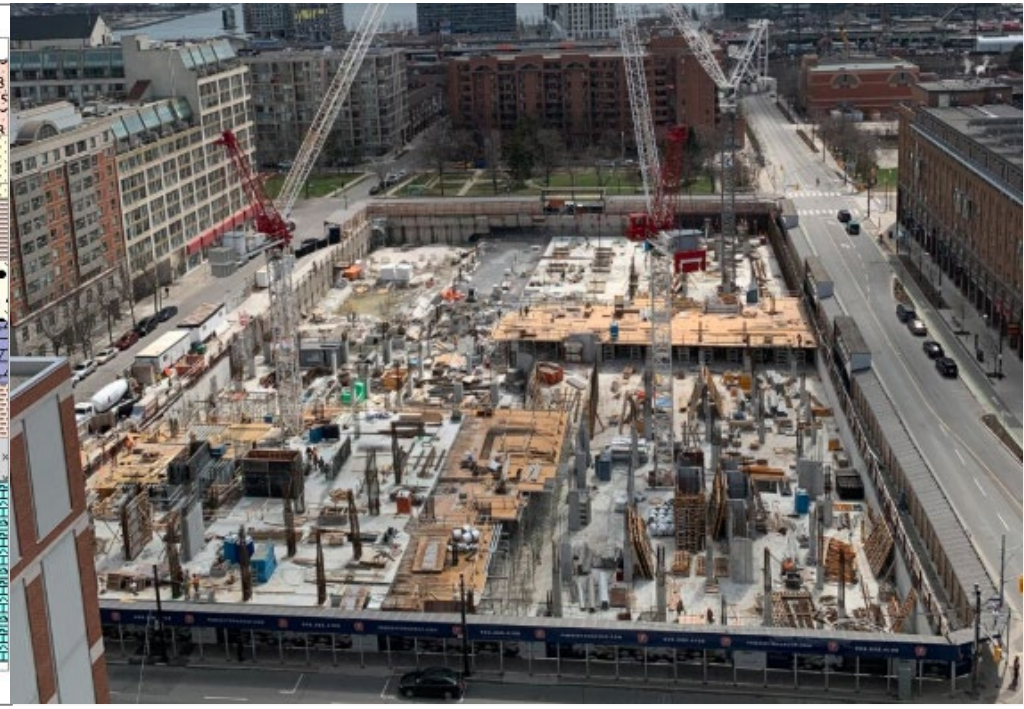
Avoid discarding the GSHP system option

The cost of a GHX is sensitive to:

- Energy loads
- Geology
- Land area available for construction







Importance of integrated design process

Detailed hourly energy modeling is used to inform architectural and mechanical system design of the building to optimize the size, cost and performance of a geothermal heat pump system

Rules of thumb

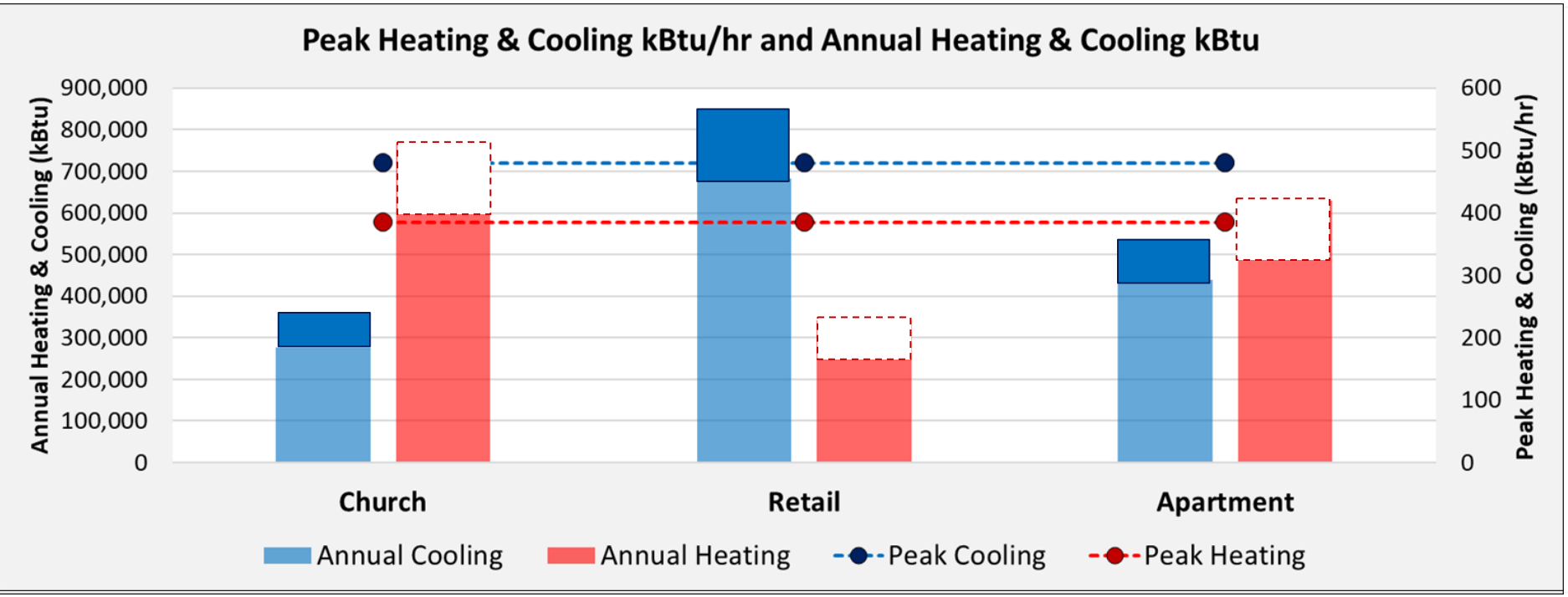
- Rules of thumb often used to provide quick answers to clients
- Rules of thumb are dangerous - cost and design of a GHX is sensitive to many factors

Peak loads don’t determine size of GHX

- Peak cooling loads for 3 buildings are identical – 480 kBtu/hr (40 tons)
- Peak heating loads are identical – 385 kBtu/hr

Energy rejected to ground versus energy extracted from ground

- Peak heating and cooling loads are identical for each building
- Total annual heating and cooling requirements are very different
- Compressor energy changes the amount of energy to and from ground

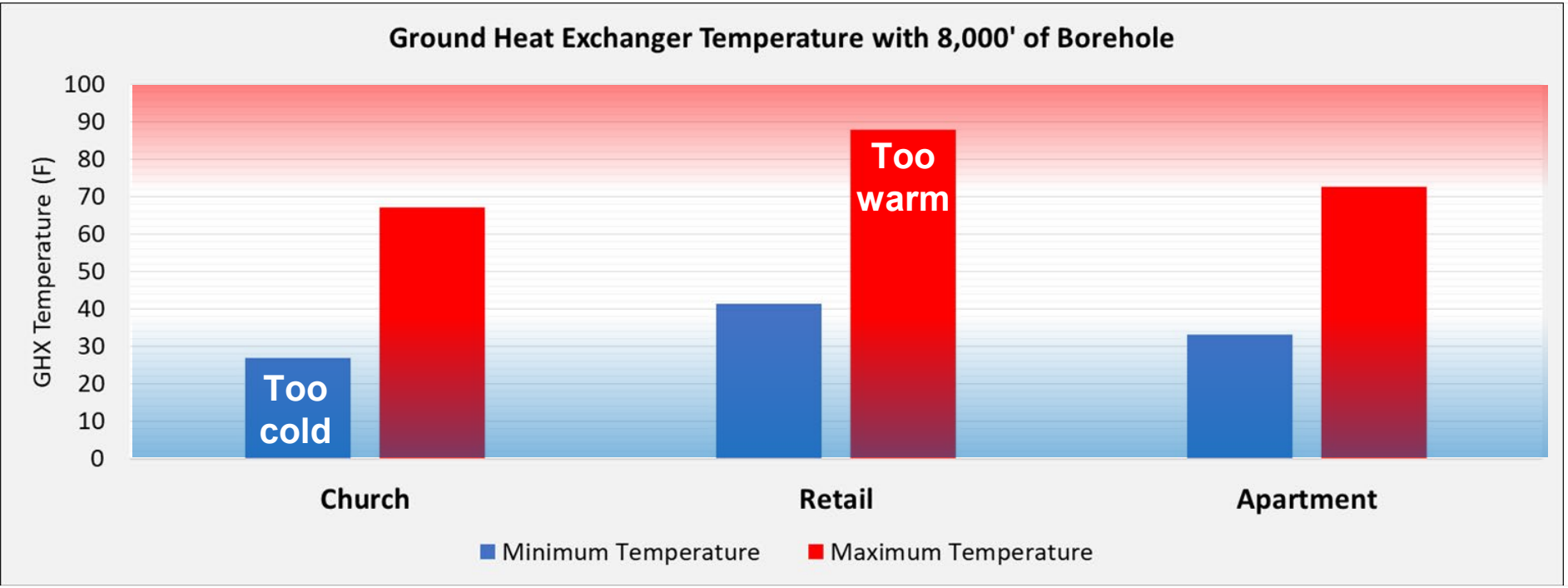


Compressor energy added to GHX

Compressor energy not taken from GHX

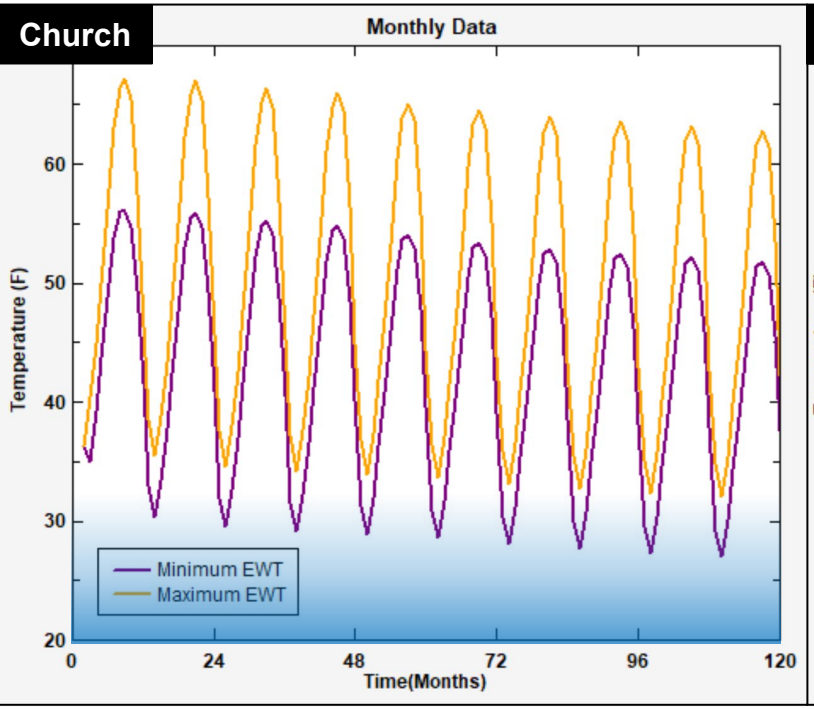
Rules of thumb suggests these buildings need 8,000’ of borehole

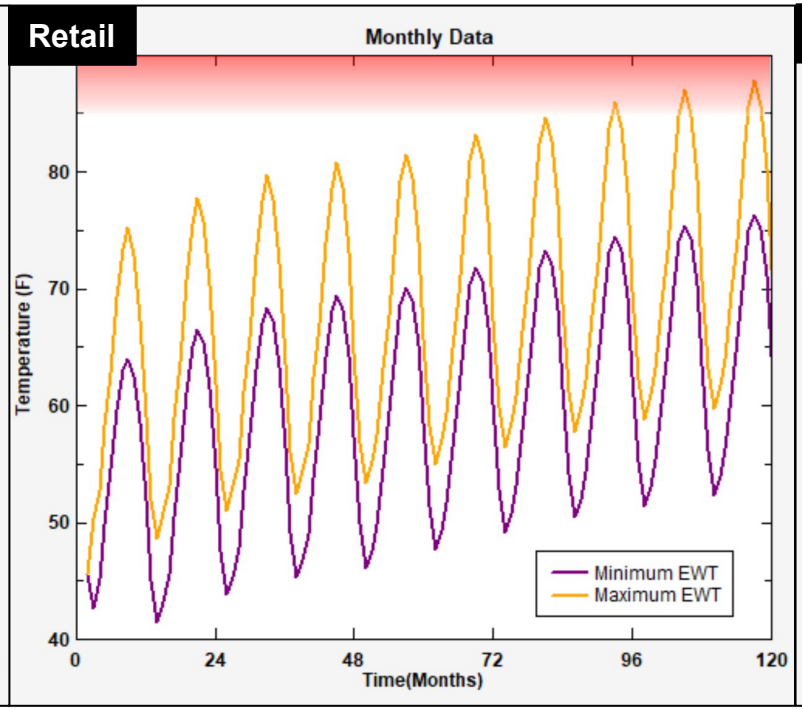
- Max / min temperatures should be 30-35°F / 85-90°F for efficient heat pump operation
- Potential for heat pumps to quit working

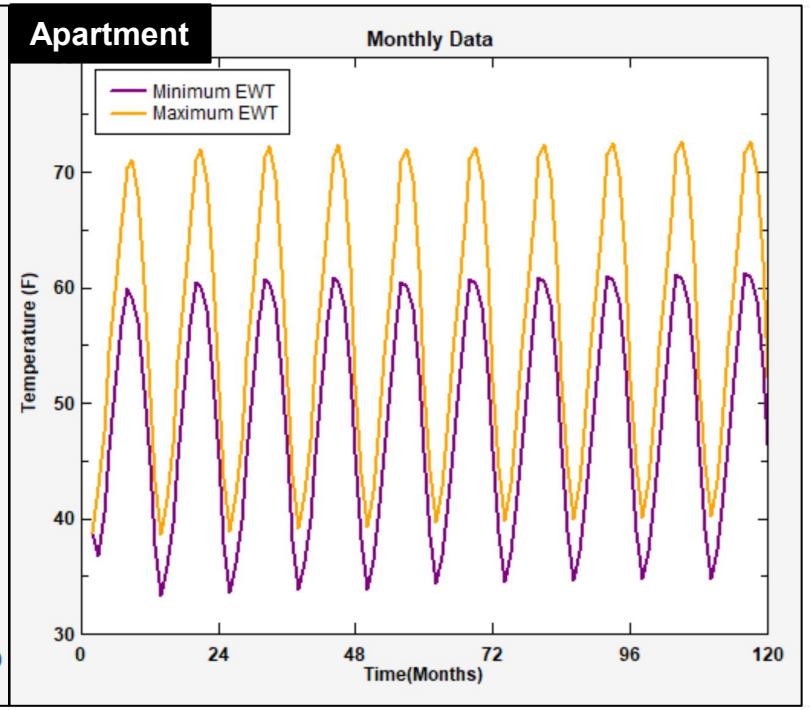


Rules of thumb don't consider all the variables

- After 10 years GHX temperature for church and retail store fall outside efficient operating parameters
- Balanced loads of apartment building maintains efficient operating temperatures over time

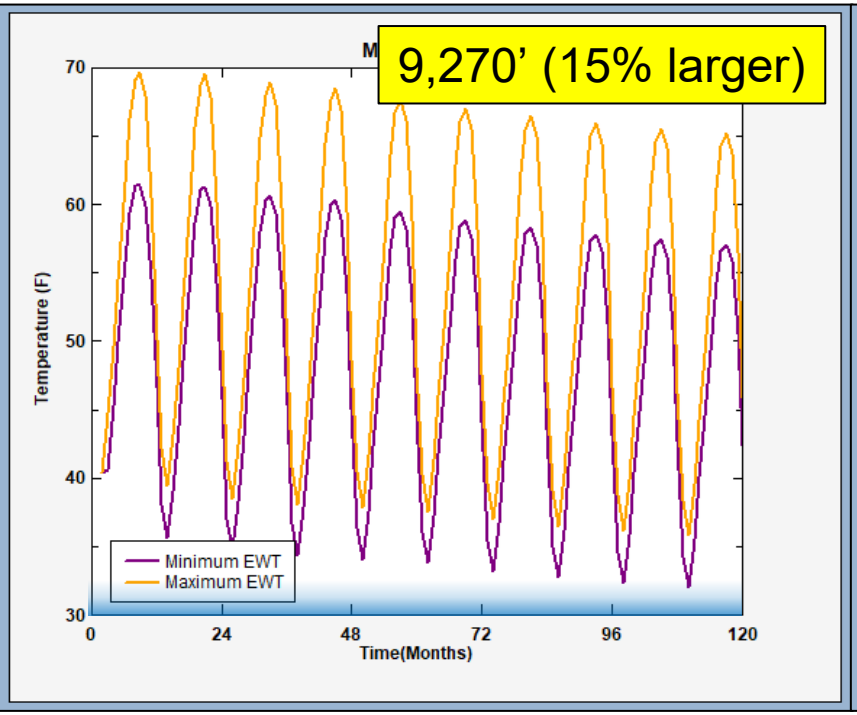


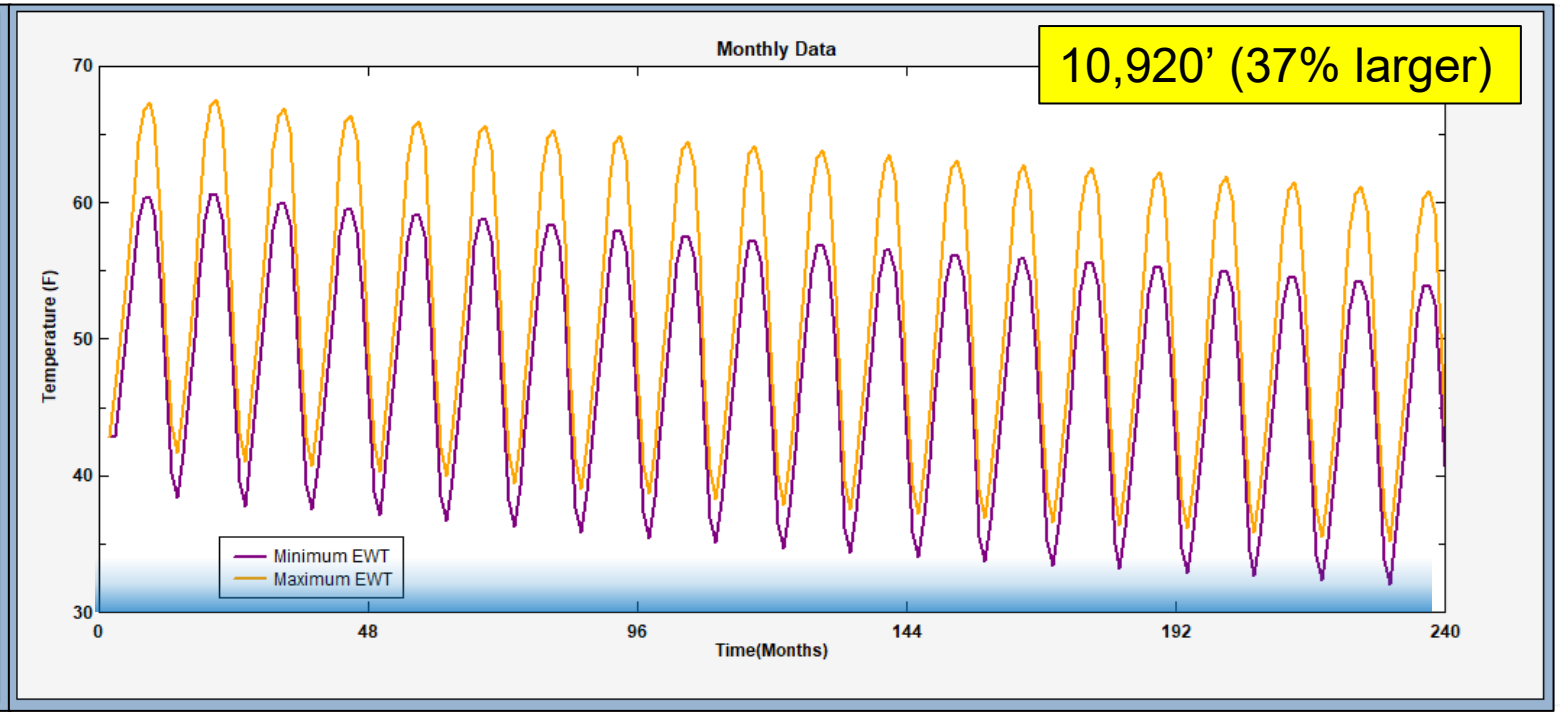




Increasing size of the GHX for the church

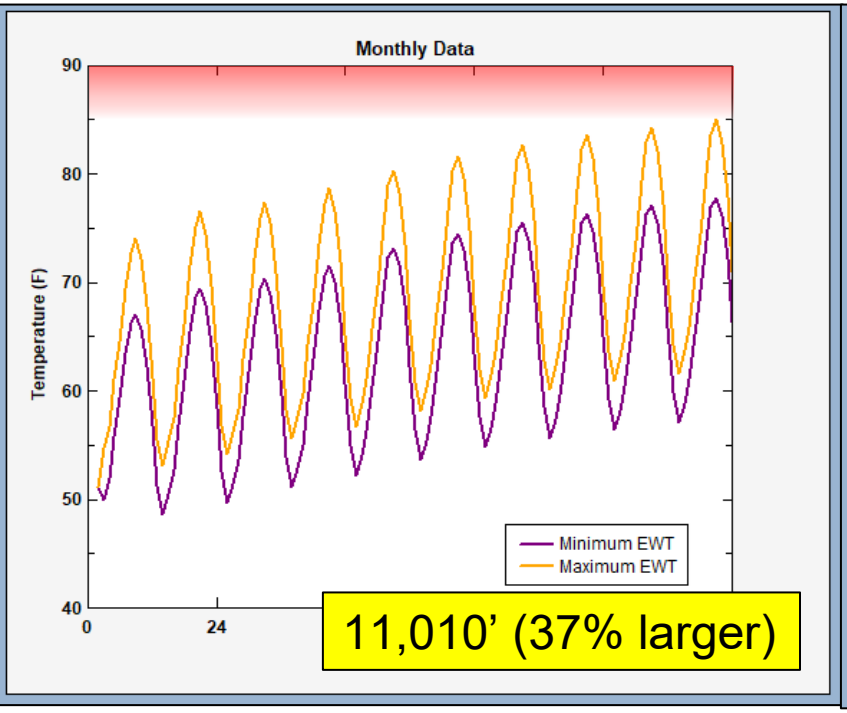
- A larger GHX extends the time until the temperature of the GHX drops below efficient operating parameters…but only delays the inevitable!



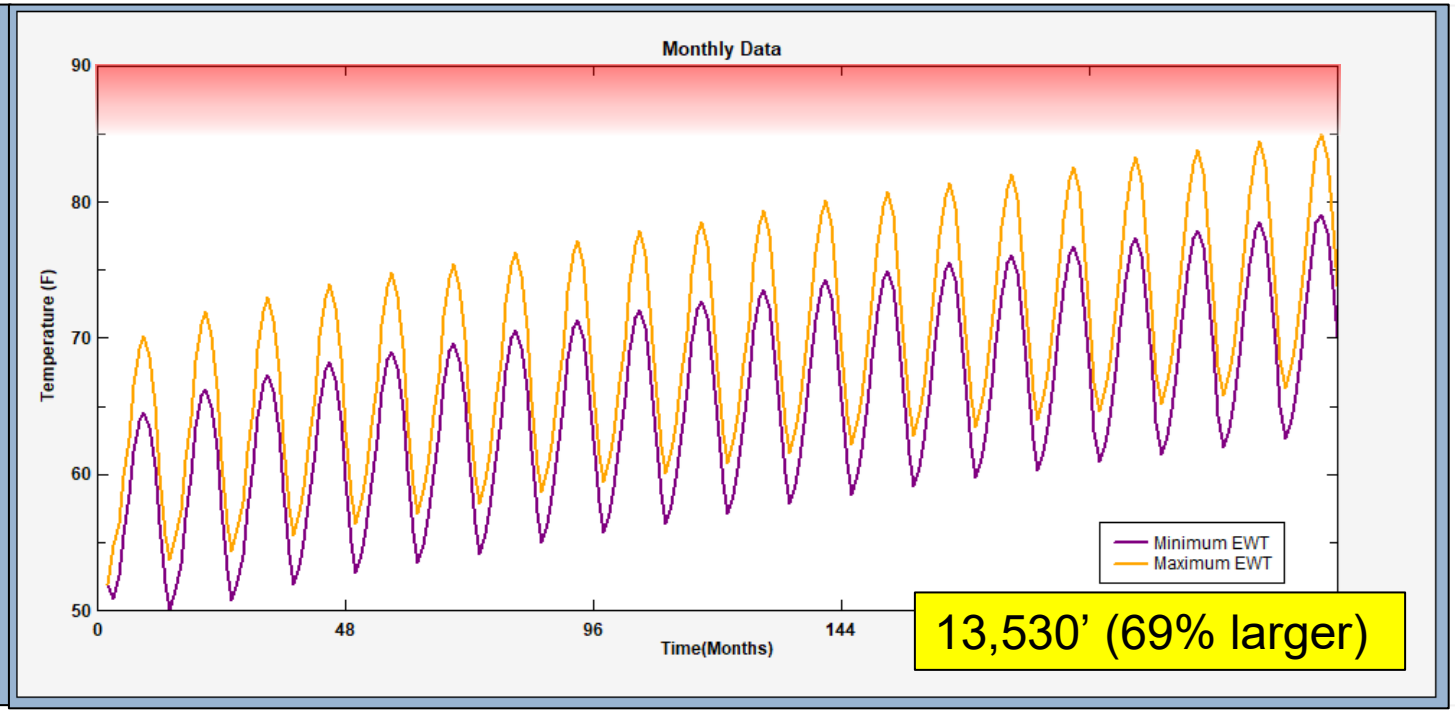


Increasing the size of the GHX for retail

- Increasing the size of the GHX extends the time until the temperature increases outside of efficient operating parameters…but doesn't prevent long term temperature degradation



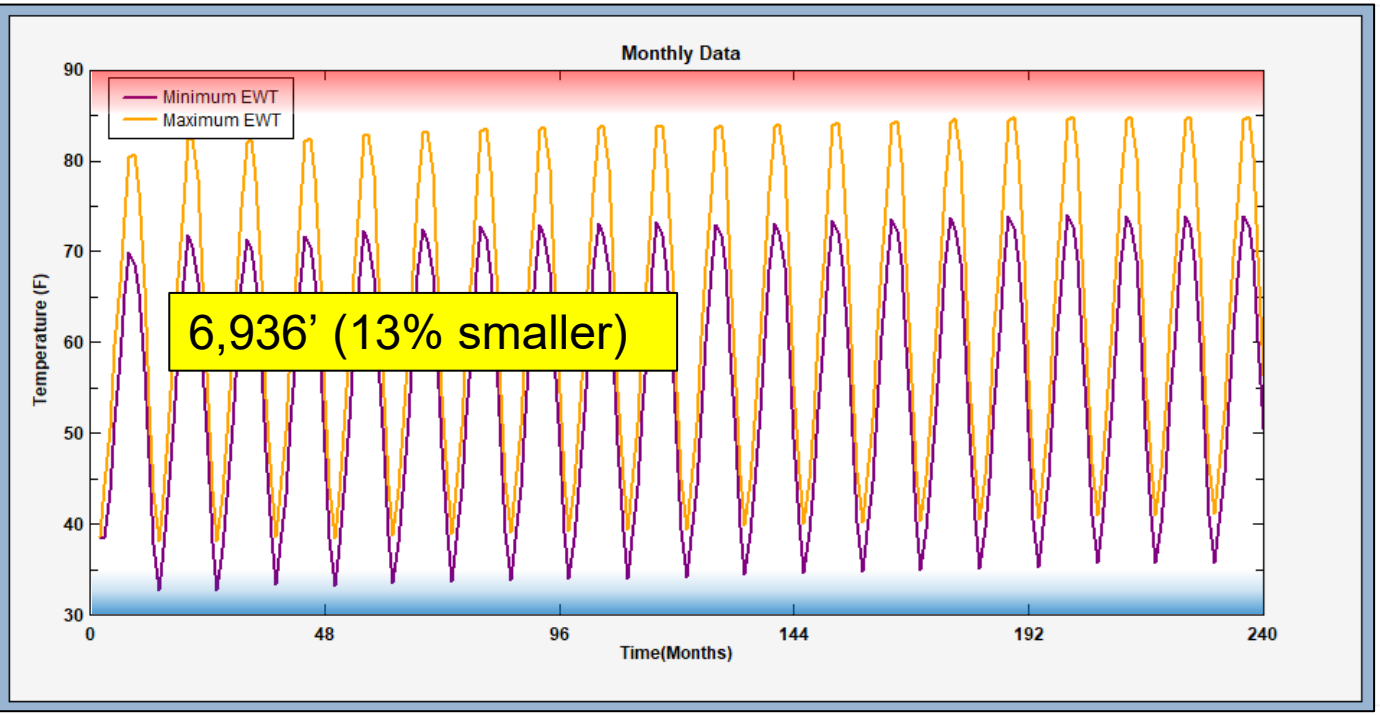
11,010' (37% larger)



13,530' (69% larger)

Reduced upfront costs for apartment

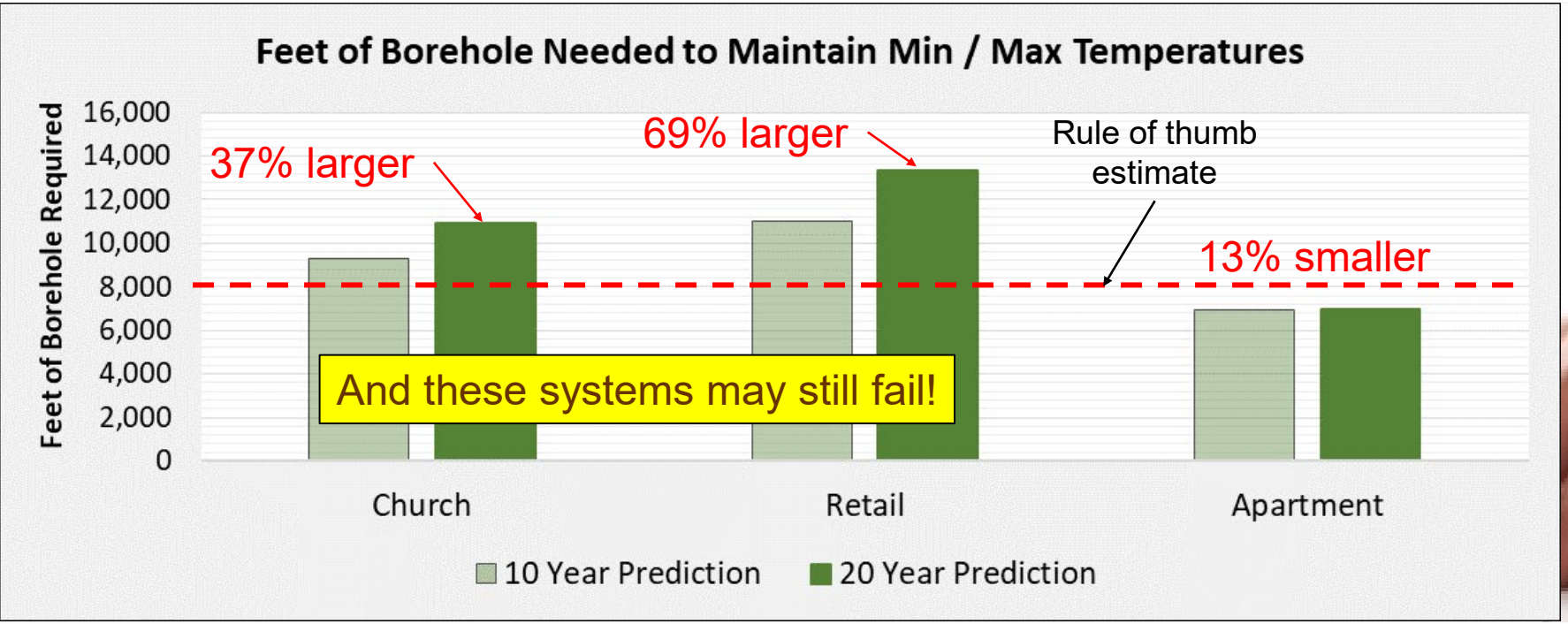
- Proper design reduces the amount of drilling required from 8,000 ft to less than 7,000 ft (13% cost savings)
- Balancing energy loads allows the system to operate efficiently for the life of the building



Challenging the “Rules of Thumb”

Rules of thumb can result in projects that either:

- Fail because of long term temperature degradation, or
- Are not built because they are too expensive to build



Environment and economics

- Clients want to see a reasonable rate of return on their investments
- Holistic design approach and geothermal design expertise reduces capital cost while improving operating cost
- GeoFease provides better answers for clients

Vertical GHX

- Vertical boreholes are common on large commercial buildings.
- Boreholes can be built adjacent to the building and it is not uncommon to drill boreholes under the building.

Horizontal GHX

- A horizontal GHX can be built more cost-effectively than a vertical GHX on larger properties.
- Horizontal directional drilling can be very cost-effective depending on the geological conditions.

Surface water HX

- Lakes, storm retention water ponds, the ocean or other bodies of water can provide an energy source / heat sink for a geo system

Energy pile GHX

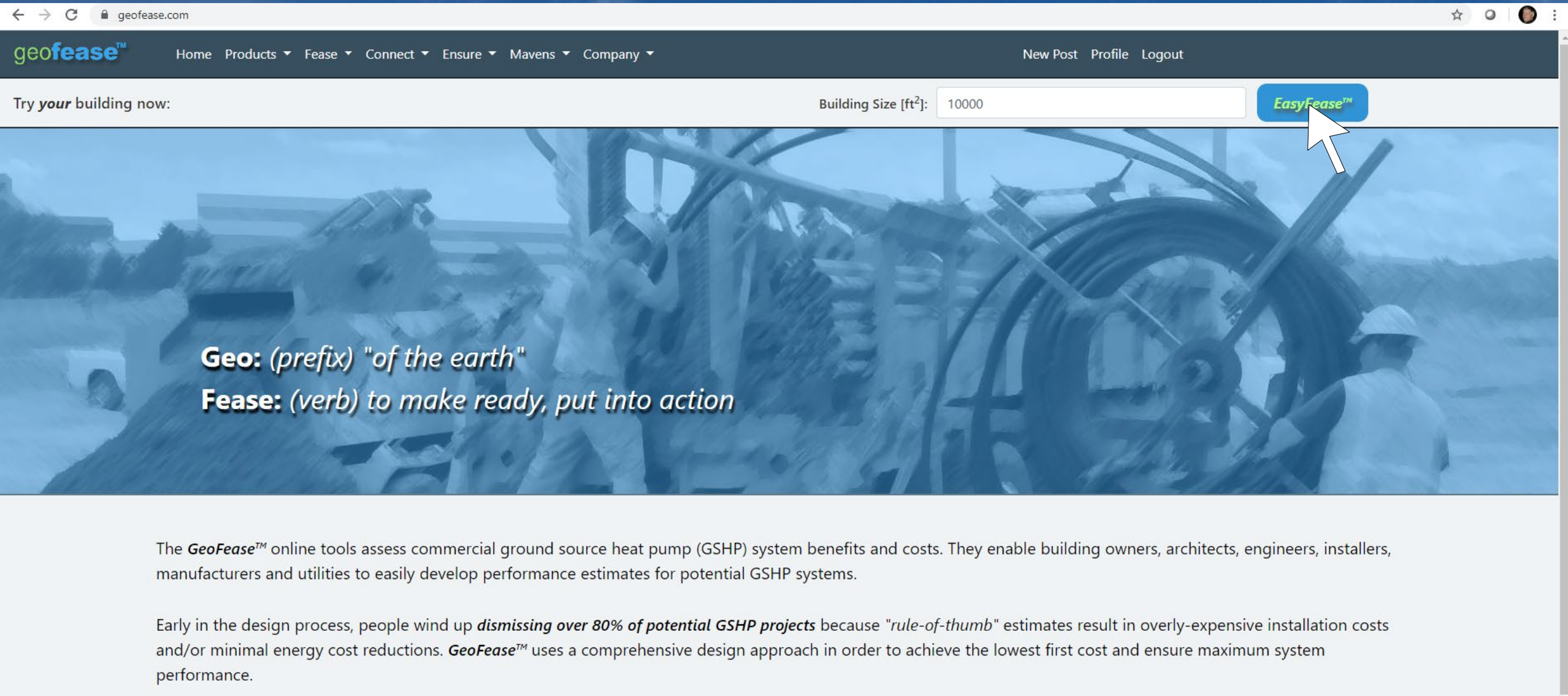
- Inserting plastic heat exchangers in the piles as they are built connects the heat exchanger to the ground cost-effectively and eliminates the cost of drilling.




Tunnel GHX

- The City of Stuttgart embedded a heat exchanger built with plastic piping in the tunnel walls of the recently completed subway tunnel.
- Buildings near the subway line can take advantage of energy extracted from or rejected to the earth around the tunnels.

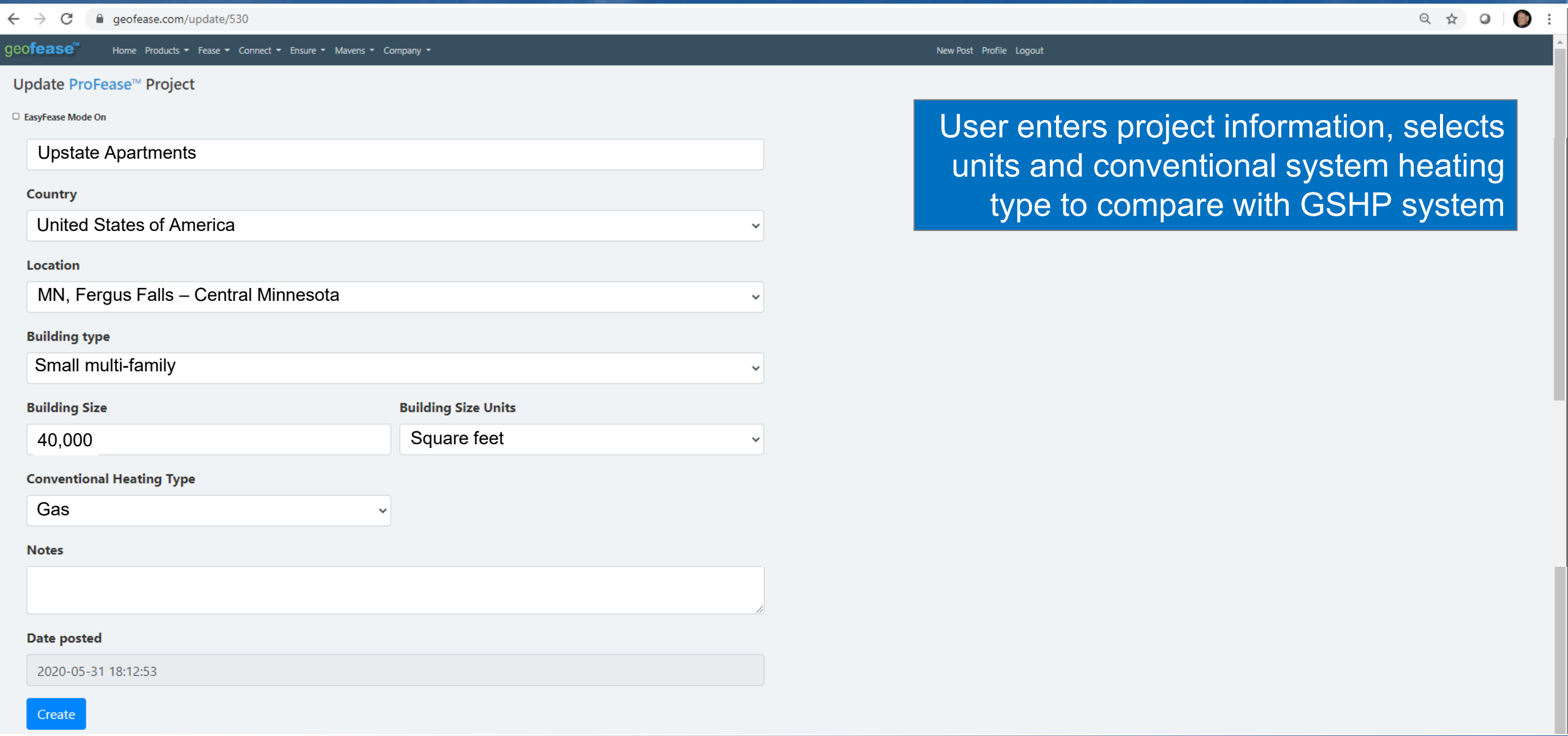
GeoFease – more accurate than rules of thumb



The ***GeoFease***™ online tools assess commercial ground source heat pump (GSHP) system benefits and costs. They enable building owners, architects, engineers, installers, manufacturers and utilities to easily develop performance estimates for potential GSHP systems.

Early in the design process, people wind up ***dismissing over 80% of potential GSHP projects*** because *"rule-of-thumb"* estimates result in overly-expensive installation costs and/or minimal energy cost reductions. ***GeoFease***™ uses a comprehensive design approach in order to achieve the lowest first cost and ensure maximum system performance.

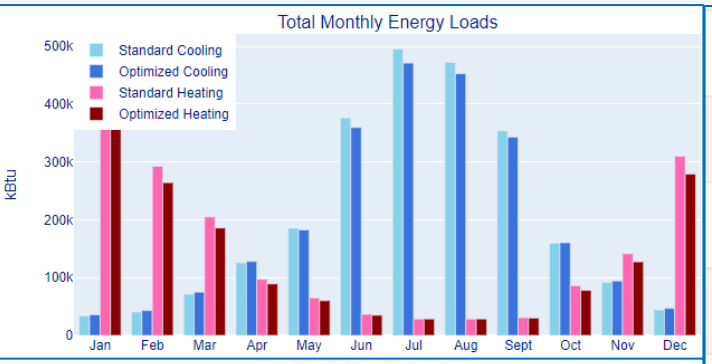
GeoFease can be run by anyone with minimal geo design experience

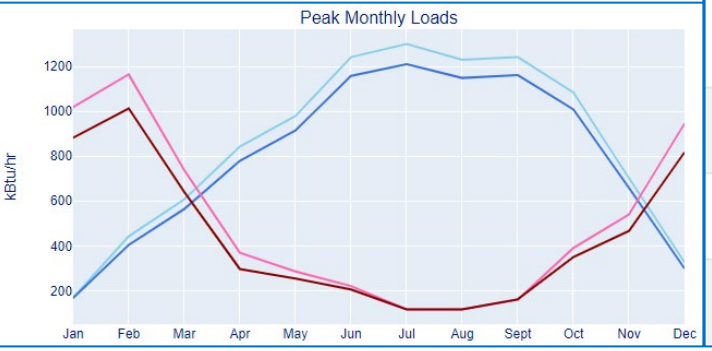


User enters project information, selects units and conventional system heating type to compare with GSHP system

Changing the building – glass specifications

Changing glass specifications reduces cooling and heating loads, reduces size of GHX by 8%

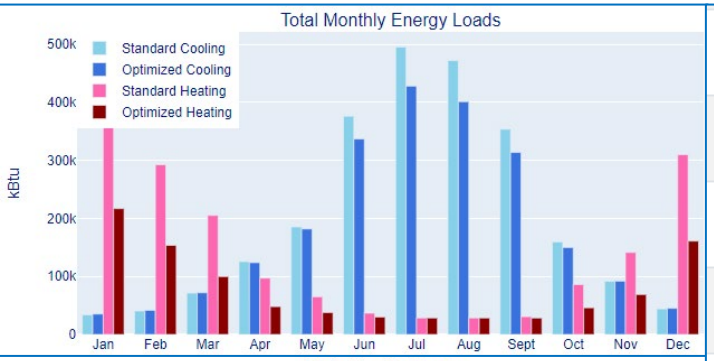


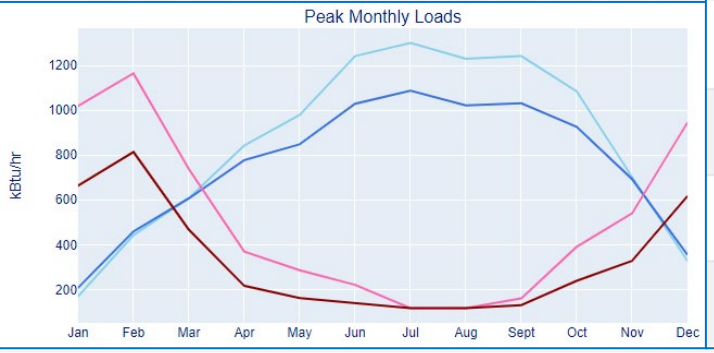


Description	Optimized	Optimized
Total Borehole Length	**24,000 ft**	**22,000 ft**
Number of Boreholes	48	44
Approximate Land Area Required (square feet)	26,775	24,525
Max. Expected Fluid Temp (°F) to Heat Pumps	**85.8**	**88.2**
Min. Expected Fluid Temp (°F) to Heat Pumps	**40.9**	**41.6**
Estimated GHX Construction Cost	**$480,000**	**$440,000**
Estimated cost of GHX / square foot of building	$6.40	$5.87

Changing the mechanical system – exhaust air energy recovery

Recovering energy from exhaust air changes heating and cooling loads…reducing size of the GHX by 8%.

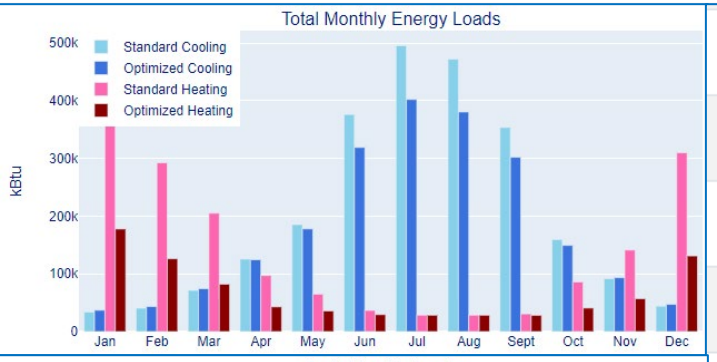


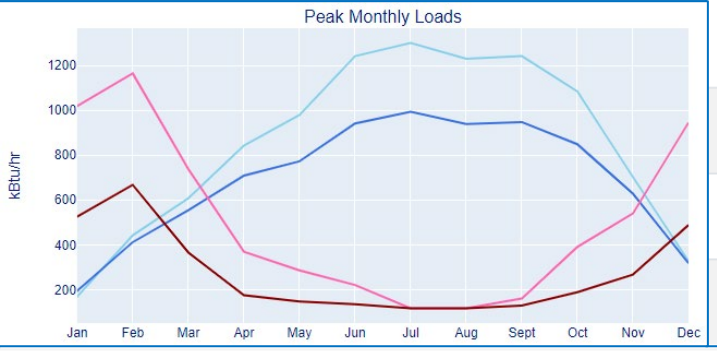


Description	Optimized	Optimized
Total Borehole Length	**24,000 ft**	**22,000 ft**
Number of Boreholes	48	44
Approximate Land Area Required (square feet)	26,775	24,525
Max. Expected Fluid Temp (°F) to Heat Pumps	**85.8**	**88.7**
Min. Expected Fluid Temp (°F) to Heat Pumps	**40.9**	**45.6**
Estimated GHX Construction Cost	**$480,000**	**$440,000**
Estimated cost of GHX / square foot of building	$6.40	$5.87

Changing building & mechanical system – ERV and glass specifications

Combination of glass and ERV reduces GHX size by 8% for this building

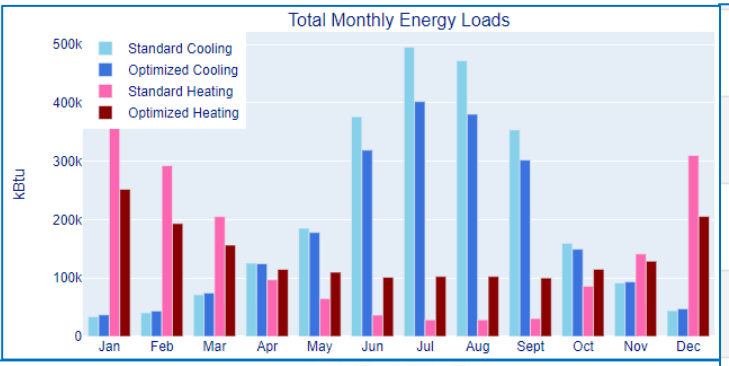


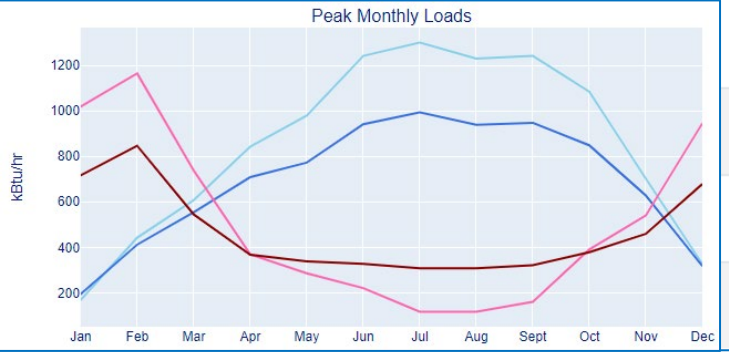


Description	Optimized	Optimized
Total Borehole Length	**22,000 ft**	**22,000 ft**
Number of Boreholes	44	44
Approximate Land Area Required (square feet)	24,525	24,525
Max. Expected Fluid Temp (°F) to Heat Pumps	**88.7**	**87.3**
Min. Expected Fluid Temp (°F) to Heat Pumps	**45.6**	**46.9**
Estimated GHX Construction Cost	**$440,000**	**$440,000**
Estimated cost of GHX / square foot of building	$5.87	$5.87

Changing building loads – adding DHW loads to geo system

Adding DHW loads to the geo system improves energy balance to and from the ground…reduces size of GHX by 23%



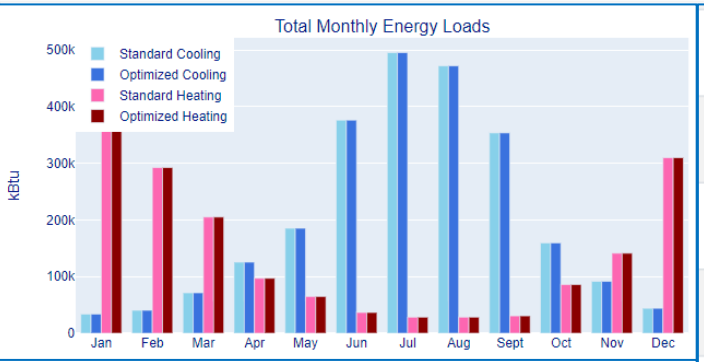


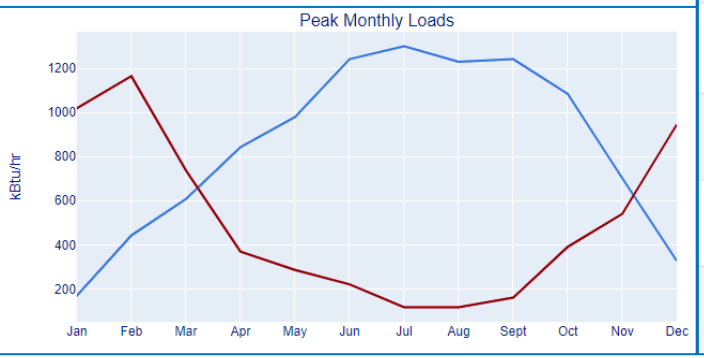
Description	Optimized	Optimized
Total Borehole Length	**22,000 ft**	**17,000 ft**
Number of Boreholes	44	34
Approximate Land Area Required (square feet)	24,525	18,900
Max. Expected Fluid Temp (°F) to Heat Pumps	**87.3**	**87.0**
Min. Expected Fluid Temp (°F) to Heat Pumps	**46.9**	**42.4**
Estimated GHX Construction Cost	**$440,000**	**$340,000**
Estimated cost of GHX / square foot of building	$5.87	$4.53

Changing the GHX design

The size and cost of the GHX is directly impacted by the GHX design. Size of GHX reduced by 67%

Standard sq 15’ spacing, s	Rectar spacing,	sp	F	Rectangular grid, 25’ spacing, high-conductivity grout, high-eff heat pumps





Description	Optimized	Optimized	Optimized	Optimized	Optimized
Total Borehole Length	**72,000 ft**	**31,000 ft**	**31,000 ft**	**27,000 ft**	**24,000 ft**
Number of Boreholes	144	62	62	54	48
Approximate Land Area Required (square feet)	34,225	16,450	34,650	30,150	26,775
Max. Expected Fluid Temp (°F) to Heat Pumps	**86.3**	**94.3**	**86.9**	**86.6**	**85.8**
Min. Expected Fluid Temp (°F) to Heat Pumps	**47.9**	**42.9**	**42.2**	**43.1**	**40.9**
Estimated GHX Construction Cost	**$1,440,000**	**$620,000**	**$620,000**	**$540,000**	**$480,000**
Estimated cost of GHX / square foot of building	$19.20	$8.27	$8.27	$7.20	$6.40

Automatically-generated, customized client report

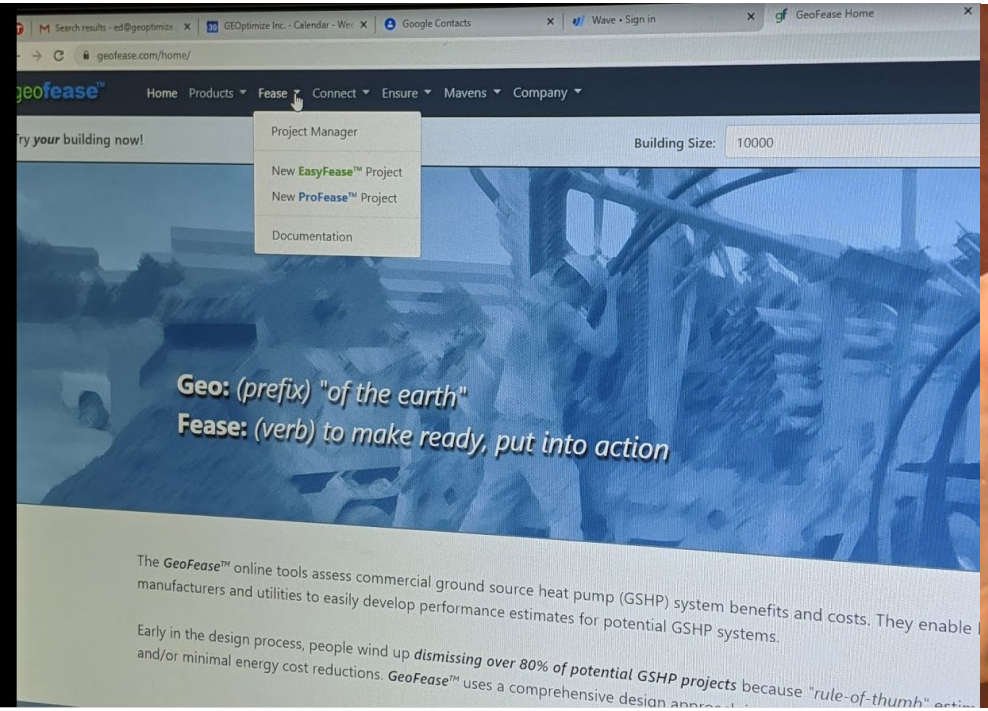
Feasibility assessment automatically generated in GeoFease.

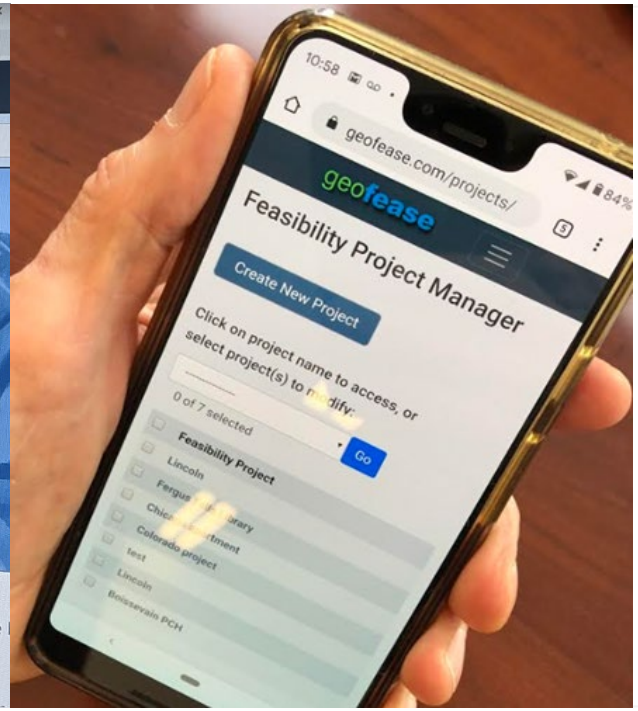
Detailed report estimates:

- Construction cost
- Land area needed for GHX
- Operating cost
- Energy consumption
- Economic analysis
- CO_2 emissions

Geofease – online feasibility assessment tool

- GeoFease report can be run in a few minutes
- PDF emailed to colleagues and clients



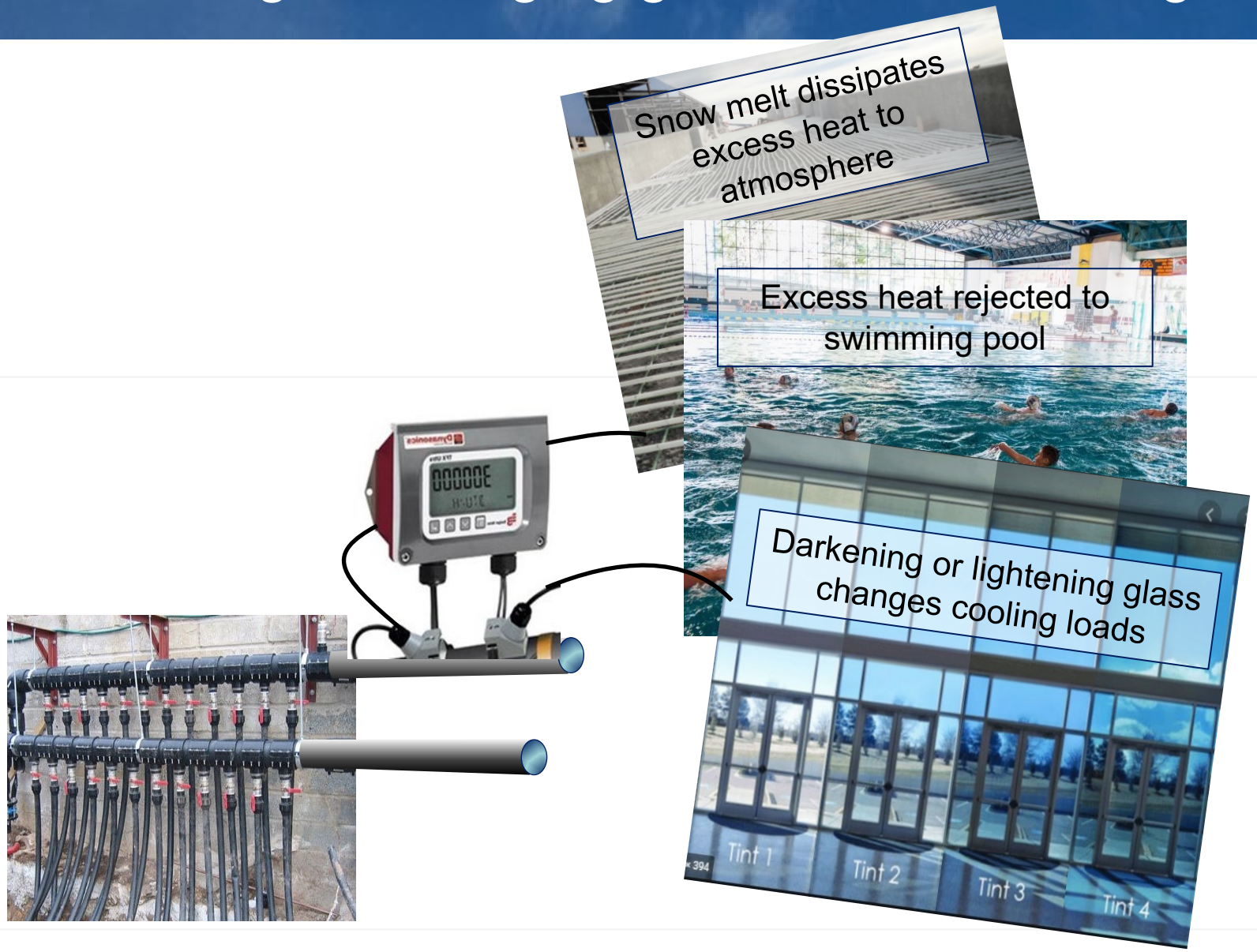


What's happening in the industry

- Monitoring & managing performance of the ground heat exchanger

- District geothermal heat pump systems that facilitate energy sharing between buildings and improve overall system efficiency

Monitoring & managing ground heat exchanger



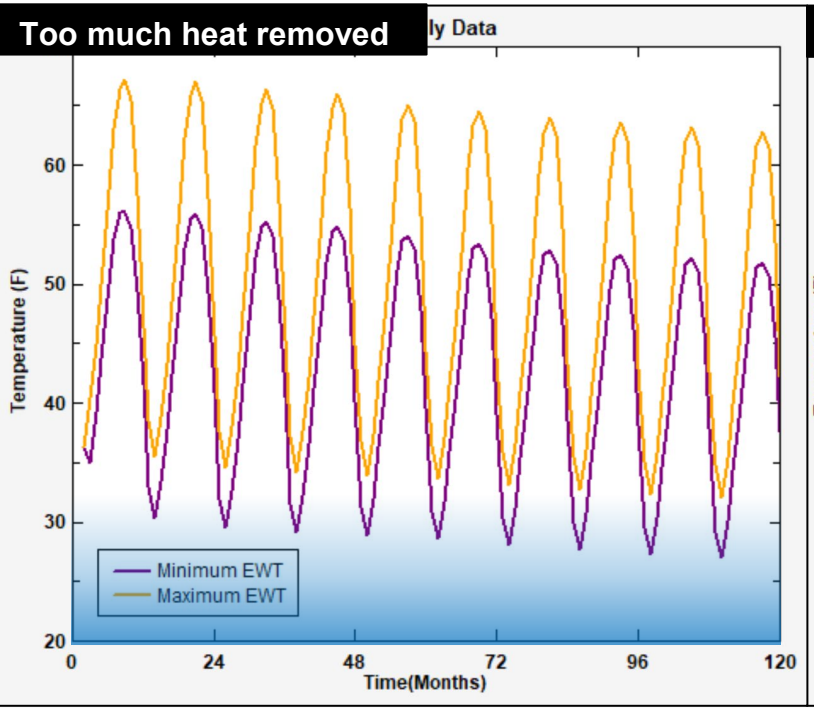
Monitoring & predicting GHX temperature & controlling discretionary heating and cooling loads balances energy loads to and from the ground

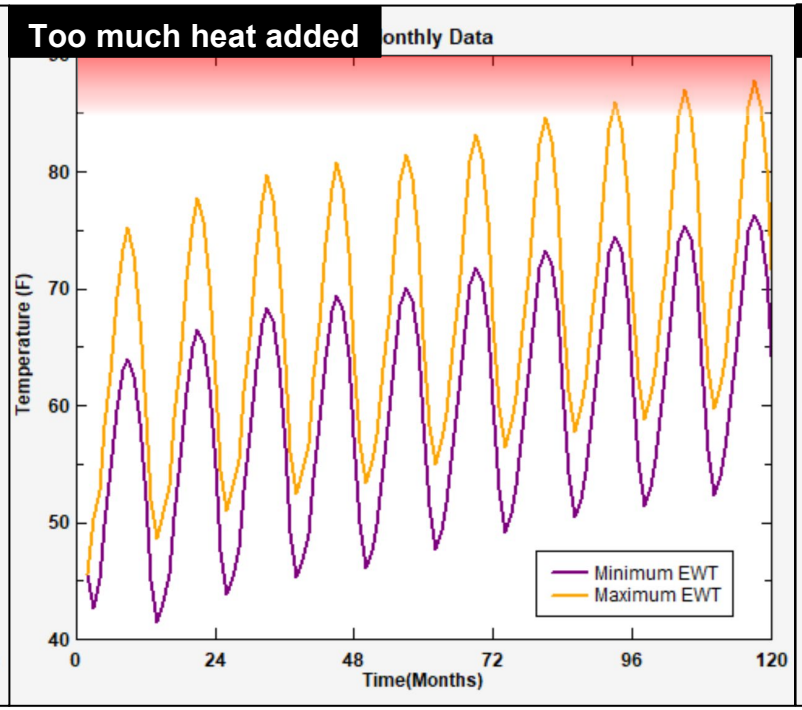
- reduces capital cost
- enhances performance

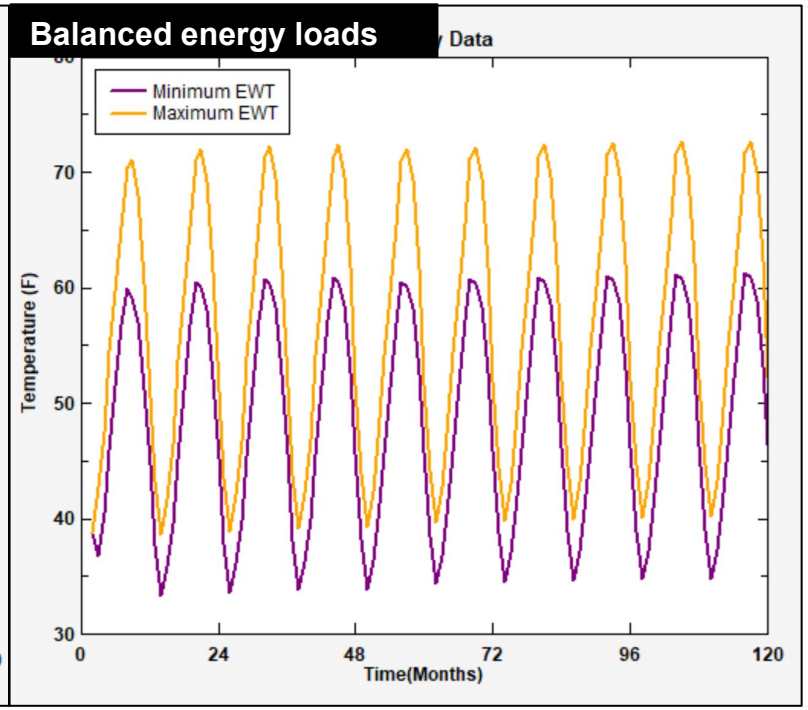
Adding or removing waste heat lowers cost, improves system efficiency

Monitoring and managing energy loads to and from the GHX:

- Lowers first cost
- Improves system efficiency
- Ensures long-term performance

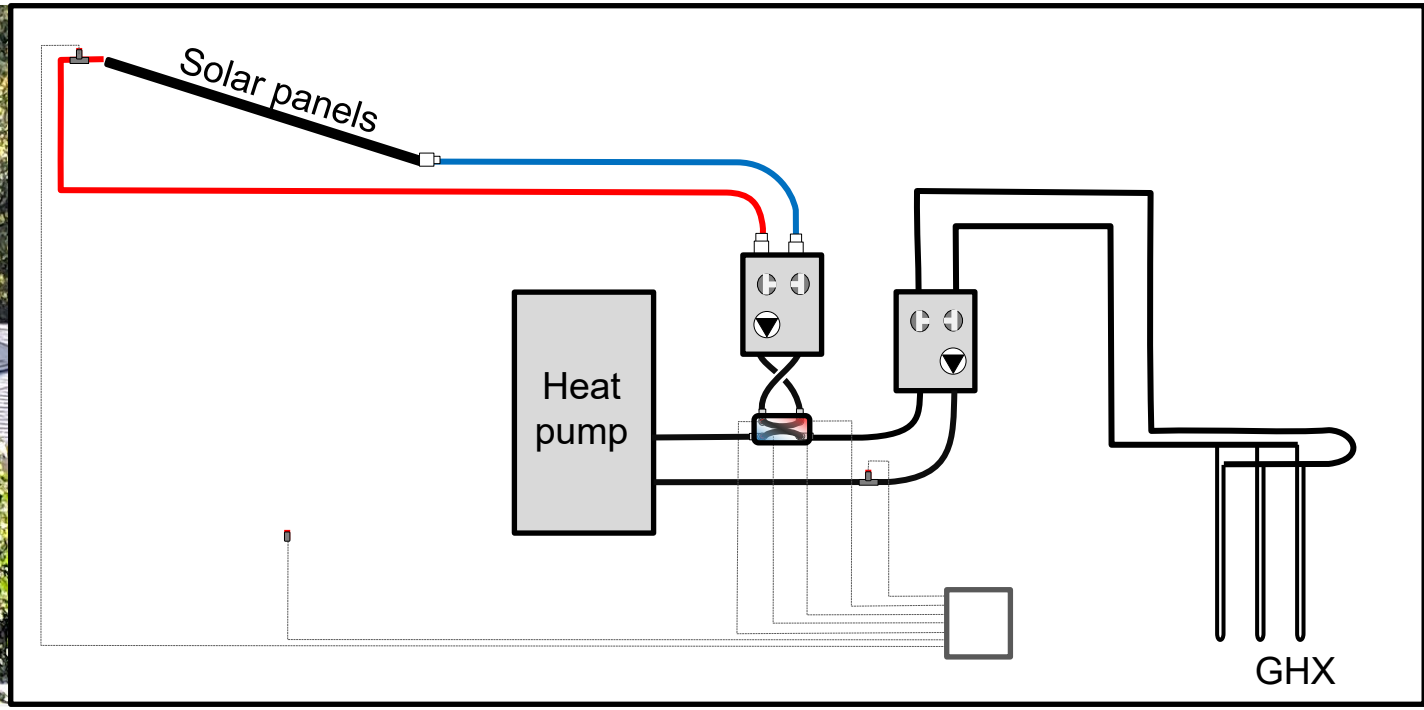






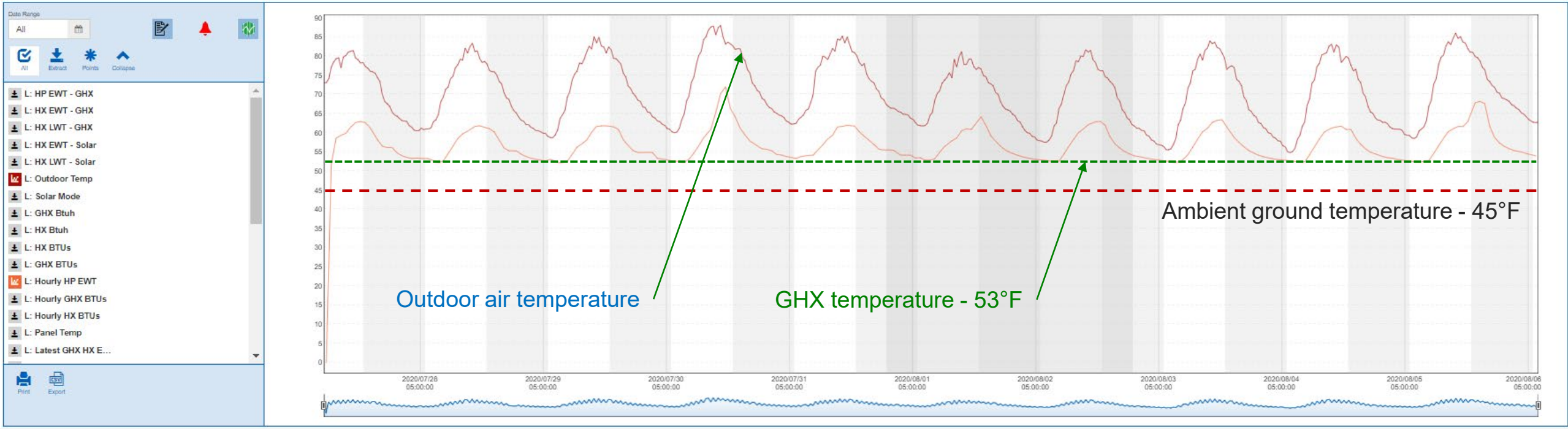
Balancing loads in residential application

- Balancing energy loads to the ground with solar thermal energy increases temperature to heat pump…improves overall system efficiency



Ground temperature increased

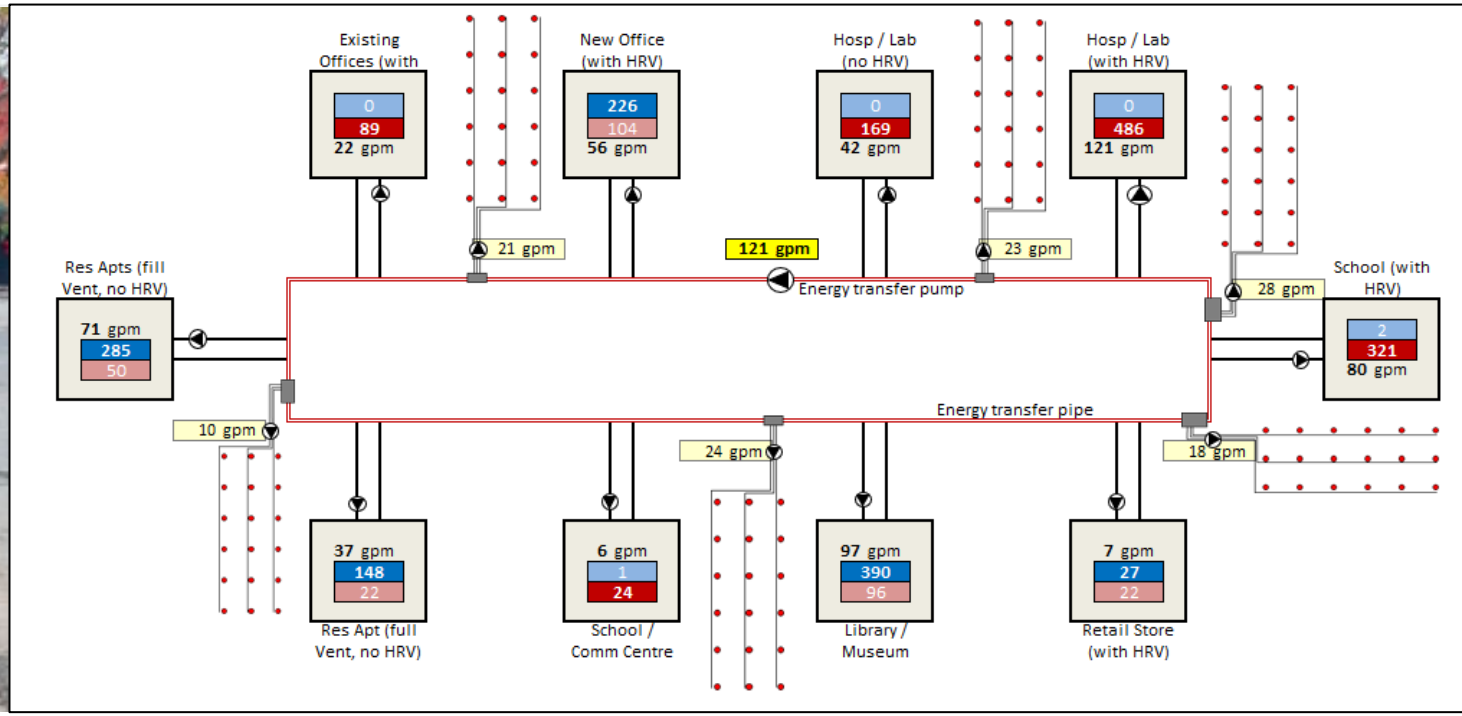
- In our climate air conditioning loads don't add as much energy to the GHX as is removed when heating.
- Solar energy can be used to add energy to the ground to avoid long term temperature deterioration



Energy sharing between buildings

Connecting different buildings to an energy transfer pipe and ground heat exchanger modules facilitates:

- Energy sharing…heat rejected by one building used in others
- Energy storage in the ground when it can't be used immediately

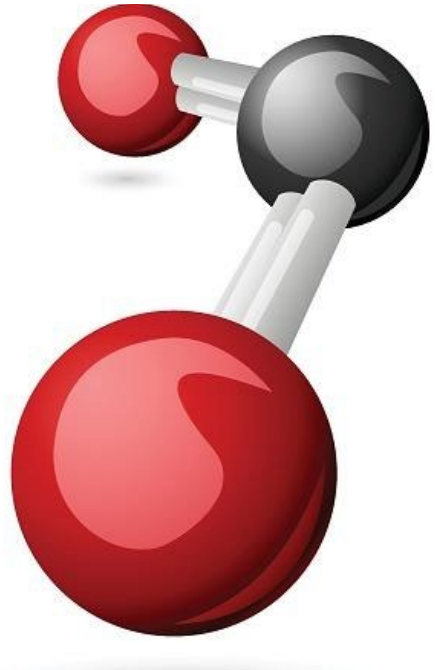


Energy sharing systems

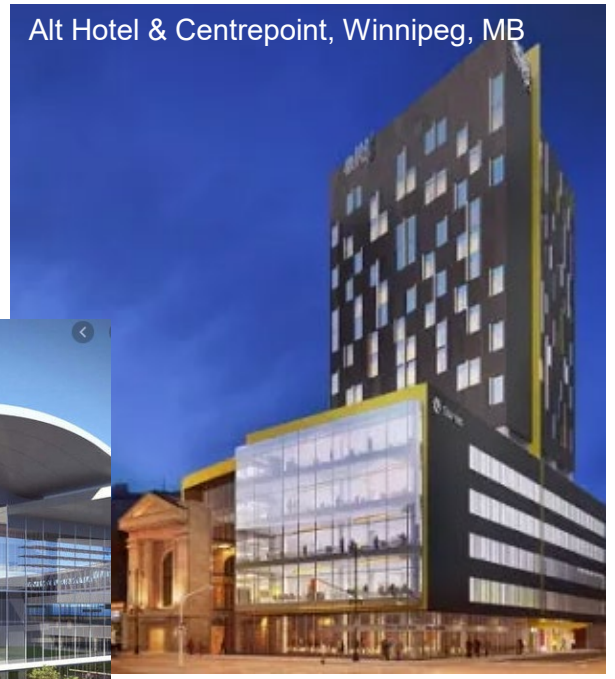
- Universities can eliminate burning fossil fuels and CO2 emissions by sharing energy across the campus…waste heat from ice arenas heat the classrooms and residences.
- Systems can grow with the campus till all buildings are interconnected

A well designed geothermal heat pump system

- Offers a solid return on investment
- Provides a reliable, high-performance system
- Reduces energy consumption and CO_2 emissions
- Can work virtually anywhere in the world

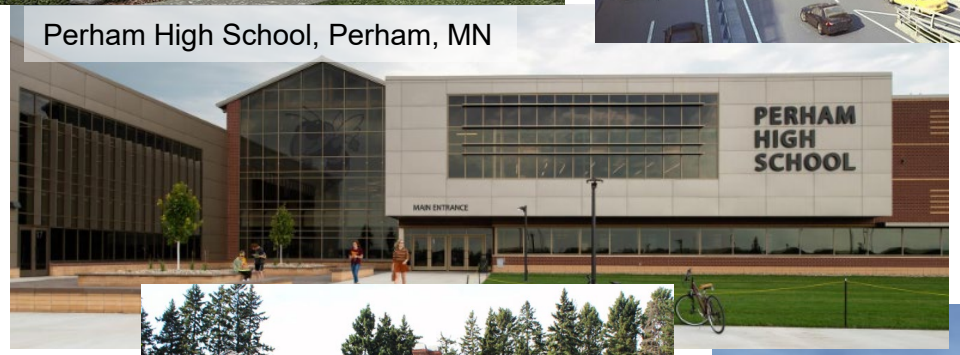


Port Hawkesbury Civic Centre,
Port Hawkesbury, NS


Alt Hotel & Centrepoint, Winnipeg, MB

Mahogany Community Centre, Calgary, AB

Terminal 8, JFK, NYC, NY



Perham High School, Perham, MN


Waterfront Neighbourhood Centre, Toronto, ON


Riding Mountain National Park Visitor Centre, Wasagaming, MB


Fergus Falls Library, Fergus Falls, MN

Feasible Geothermal Heat Pump Systems

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