

In-Person Workshop

Ground source heat pumps

 Canmore, Alberta

 November 18 | 9 AM – 12 PM



BIOSPHERE
INSTITUTE OF THE BOW VALLEY

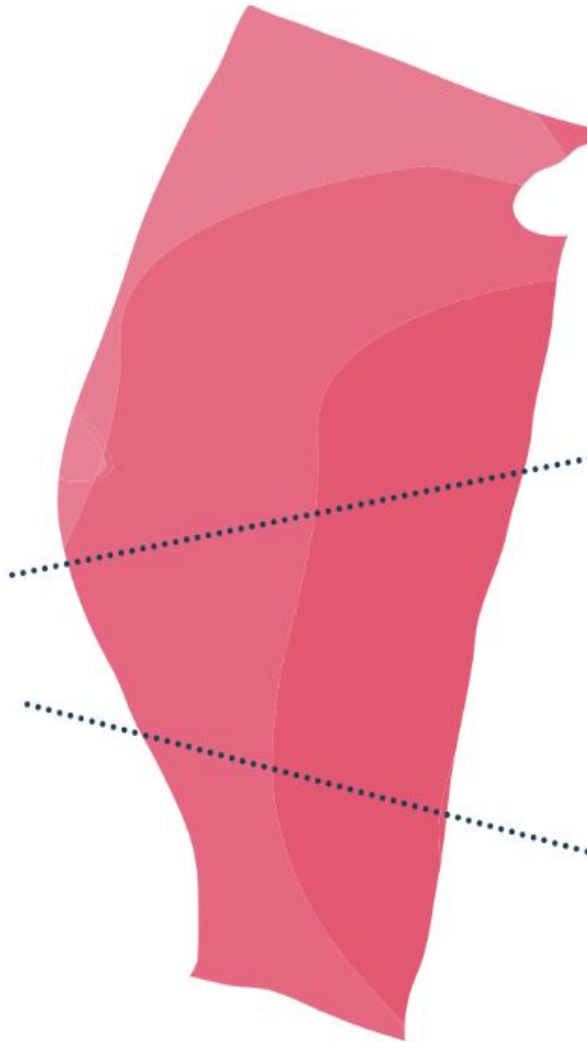


TREATY 8

Signed in 1899

TREATY 7

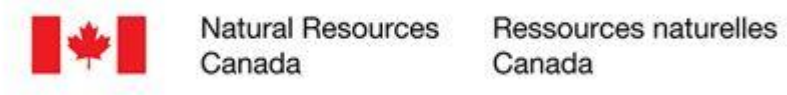
Signed in 1877



TREATY 6

Signed in 1876

Special thanks to the many organizations that have contributed to this presentation:



Alberta Ecotrust Foundation

Vision and Mission

→ *Our Vision*

An Alberta where people and nature thrive.

→ *Our Mission*

We realize our vision by recognizing gaps, mobilizing resources, investing in our communities, creating partnerships, and building capacity across sectors.

What we offer

*Programs
& Initiatives*



Grants



*Impact
Investing*



*Strategic
Engagement*



Alberta Ecotrust's Buildings Initiatives

A dark blue line diagram consisting of a vertical line from the center of the Ecotrust logo, a horizontal line extending to the left and right, and two short vertical lines at the ends of the horizontal line, connecting to the Enbix and Retrofit logos respectively.

enbix

Retrofit
accelerator



enbix   ALBERTA ecotrust

Shaping the Exchange

Establishing a platform for the exchange of knowledge around emissions neutral buildings in Edmonton, Calgary and Alberta

Developed by Alberta Ecotrust Foundation in partnership with:
The Calgary Construction Association, the City of Calgary, the City of Edmonton and their Emission Neutral Buildings Industry Advisory Group, and the Smart Sustainable Resilient Infrastructure Association.

November 2023

Our Funders



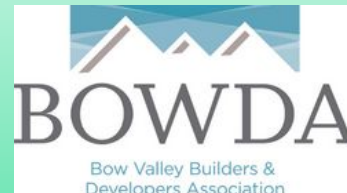
RBC Foundation

ALPINE GEOTHERMAL



Alpine GeoThermal specializes in the design, installation, integration, and management of sustainable Geo Exchange systems, backed by over 40 years of dedicated expertise. Our seasoned team has successfully delivered diverse renewable energy projects, ranging from residential developments to large-scale municipal and district energy systems throughout Alberta, Canada, and internationally.

We excel at navigating intricate permitting processes, regulatory requirements, and engineering standards unique to various jurisdictions. Our comprehensive approach integrates Geo Exchange technologies seamlessly with complementary renewable solutions such as solar power, combined heat and power (CHP), atmospheric water generation, and thermal energy storage.



Today's Speaker



Joseph (Joe) Henke, P. Eng, CEM, REA

Program Specialist – ENBIX, Alberta Ecotrust Foundation,

Joe is Certified Energy Manager, Energy Advisor, and holds a diploma in Sustainable Energy Technology.

Prior to joining Alberta Ecotrust Foundation, he worked as a Residential Energy Advisor, and in the manufacturing industry.

WELCOME – HERE’S WHAT TO EXPECT

Thank-you all for joining ENBIX’s Geo-Exchange Information Workshop

Key Topics:

- What is Geo-Exchange (distilling the language used to describe these systems, description of the ground loop cycle)
- What is a Heat Pump (basis operating principles of a heat pump, how they work, why they’re efficient)
 - **The Science (basic explanation of thermal dynamics & “work” required)**
- System Design (the importance of borehole design and system sizing, cost considerations, who’s involved & when, project scheduling, optimization)
- Types of systems & installation processes
- Applications/Solutions (both residential and commercial)
- Geo-Exchange vs. Traditional HVAC (pros/cons: from initial investment, ROI, energy efficiency, annual operating costs, maintenance requirements, comfort)
- Distilling Myth from Fact (FAQ style page addressing perceived risks and the common “gripes” with geo-exchange)
- Case Studies (residential and commercial case study examples)
- Energy Integration Potential (explore the exciting potential applications of geo-exchange in the context of integrated energy systems)
- Resources & Next Steps (where to find more information, who to talk to etc.)

GSHP for Alberta Buildings

AGENDA

- Attendees input (Slido poll)
- Questions & Feedback

Presentation ~ 2hrs

Questions ~ 45 minutes

Housekeeping

- Emergency - exits
- Washrooms
- Breaks - there is no break scheduled but please feel free to come and go as you need
- Questions - you can use the Slido Q&A feature, or feel free to ask during the session.
 - I may answer some questions at the end of the session
- Phones/laptops - kindly silence any ringers. If you need to take a call please step out of the room

GSHP – Training Page

[Events](#)[Resources](#)[Industry Offerings](#) ▾[News](#)[About](#) ▾[Get Invo](#)

ARTICLES, CASE STUDIES, EVENT TAKEAWAYS

Ground Source Heat Pumps for Builders – Training Page

Author/Contributor: ENBIX

Alberta Context: This page is intended to accompany the “Ground Source Heat Pump for Builders” training offered by ENBIX. This training offers an introduction to the principles of Ground Source Heat Pumps (GSHP). It features information on Alberta climate, regulations, and building practices.

Summary:

Ground Source Heat Pumps are super-efficient heating devices offering excellent comfort, heating and cooling and very low operating costs. GSHP systems also present special challenges for builders. These systems require specialized design knowledge, installation of ground loops, careful sizing, and management of capital costs



<https://www.enbix.ca/document/gshp-for-builders-training-page/>

Geothermal

What do we mean when we talk about geothermal energy?

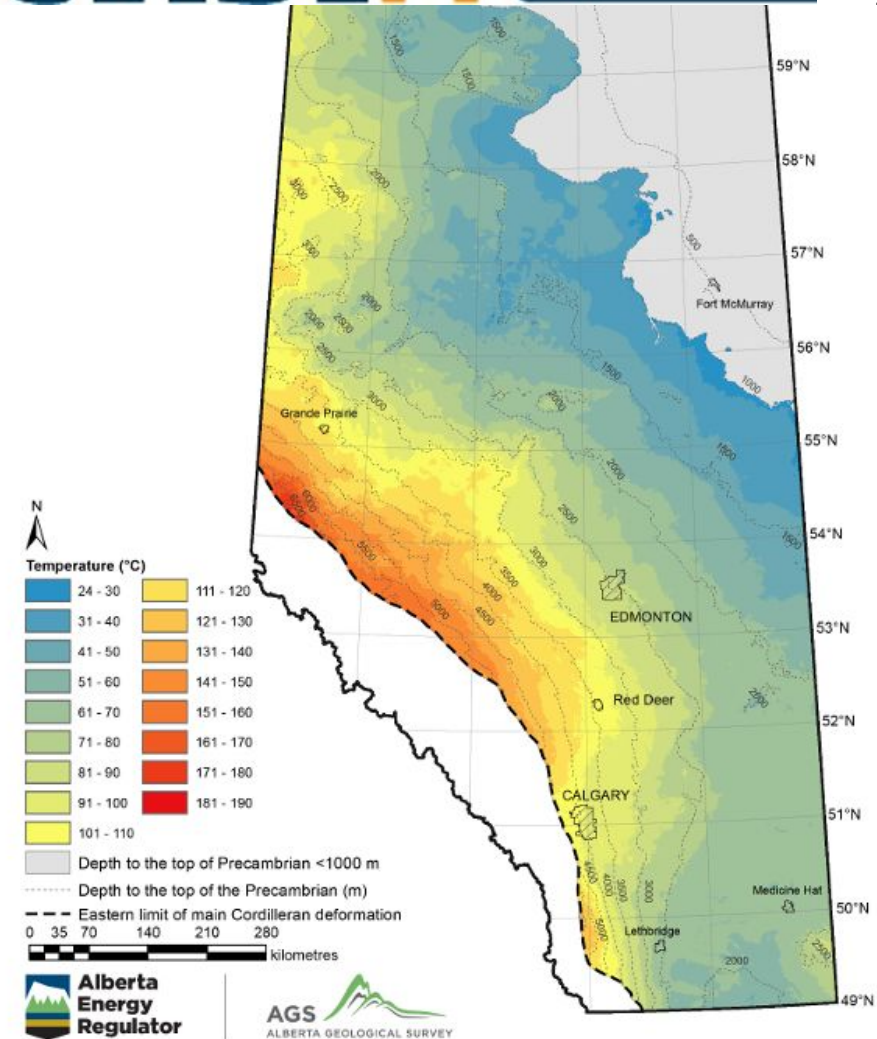
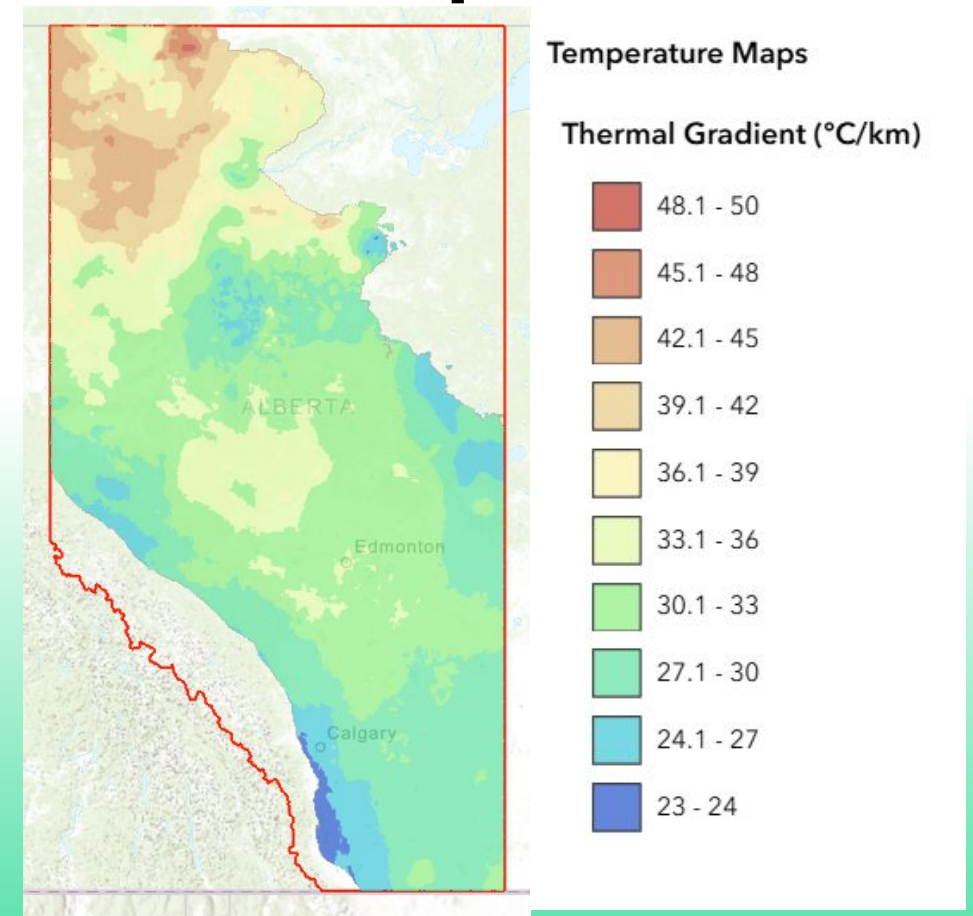


Figure 20. Temperature at the top of the Precambrian.

GEOHERMAL vs. Geoexchange vs. Ground Source Heat Pumps

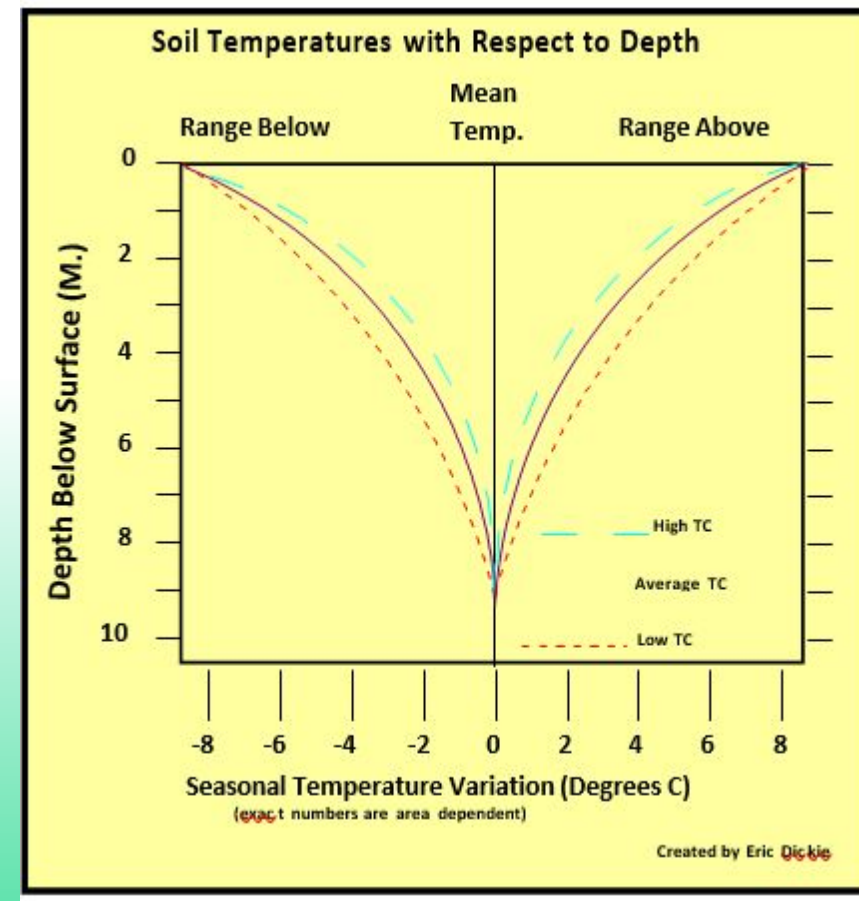
- Geothermal is a general term used to describe the thermal energy (heat) trapped within the earth
- Thermal energy in the ground varies widely based on geographic location, depth, and season
 - From negative temperatures at the surface during winter, to a staggering 900°C in some regions
- High heat geothermal regions are utilized for power generation (through steam)

Figure - Screen shot from the Geothermal Atlas of Alberta showing temperature gradient.



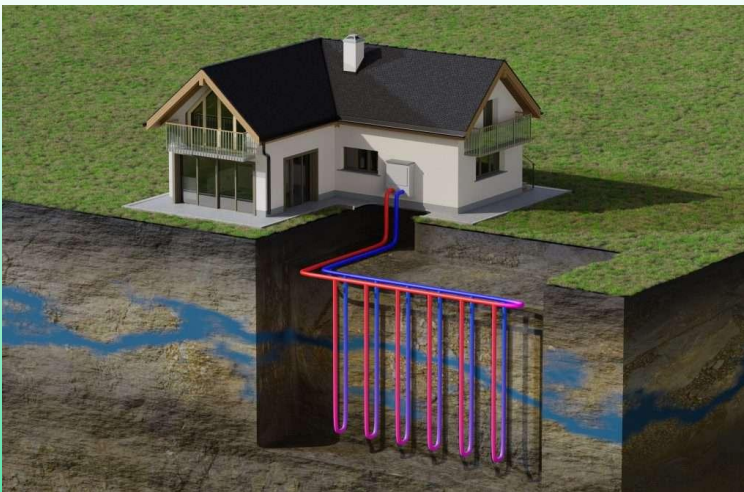
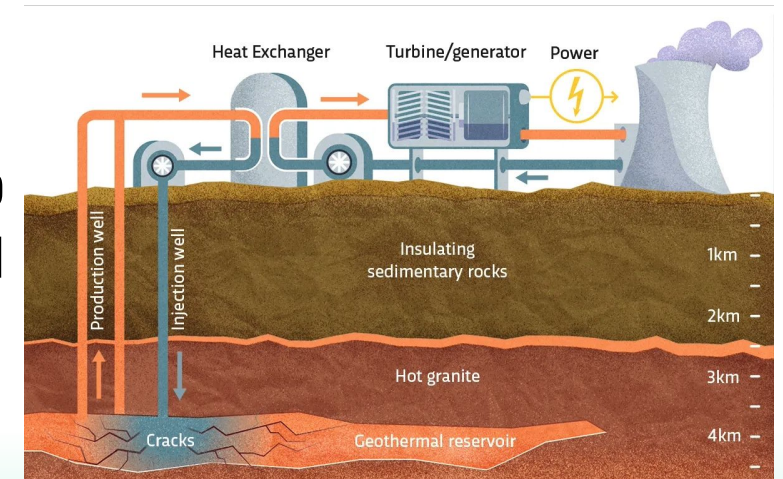
GEOHERMAL vs. Geoexchange vs. Ground Source Heat Pumps

- **Geo-Exchange** refers to the “exchange” or transfer of energy to and from the earth (geo)
- Geo-Exchange takes advantage of the earth’s “constant temperature”
 - Below ~10’ and for 100’s of feet down the ground remains a very steady average temperature, year-round (Average Ground Temperature in Alberta is 7°C)



GEO THERMAL & GEO – EXCHANGE-DISTILLING THE LANGUAGE

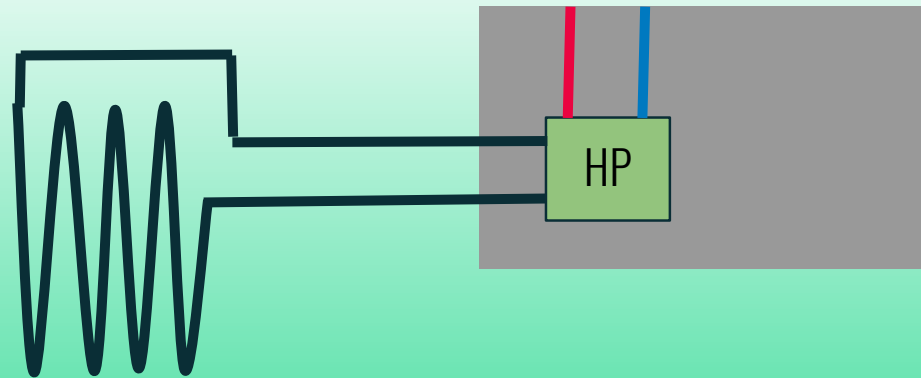
Geothermal systems utilize deep well infrastructure, often kilometers below the surface, to tap into pockets of high thermal energy generated by the earth. They are used for heat and electricity for large loads.



Geo-Exchange systems utilize shallow well infrastructure, not exceeding 152m in Alberta, to tap into the constant low thermal energy stored within the earth's crust. These systems are used for heating, cooling, and hotwater. They can work for both small and large applications. A heat pump is used and it requires electricity.

Parts of a Complete System

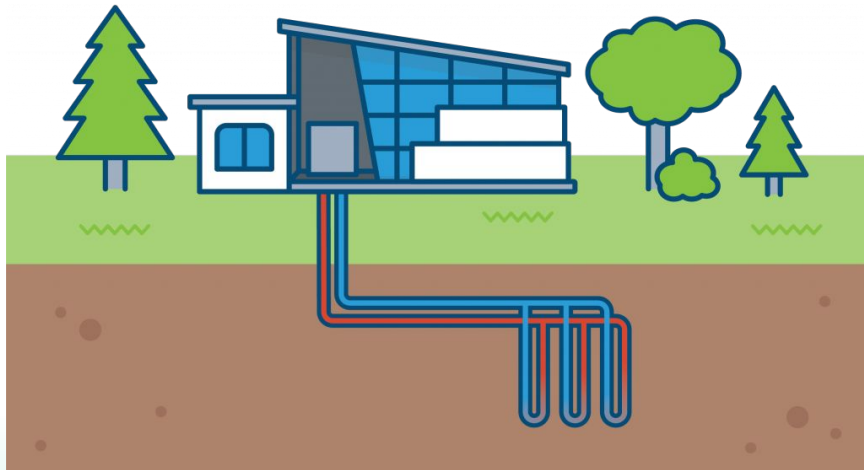
1 - Ground Loop



3 - Distribution

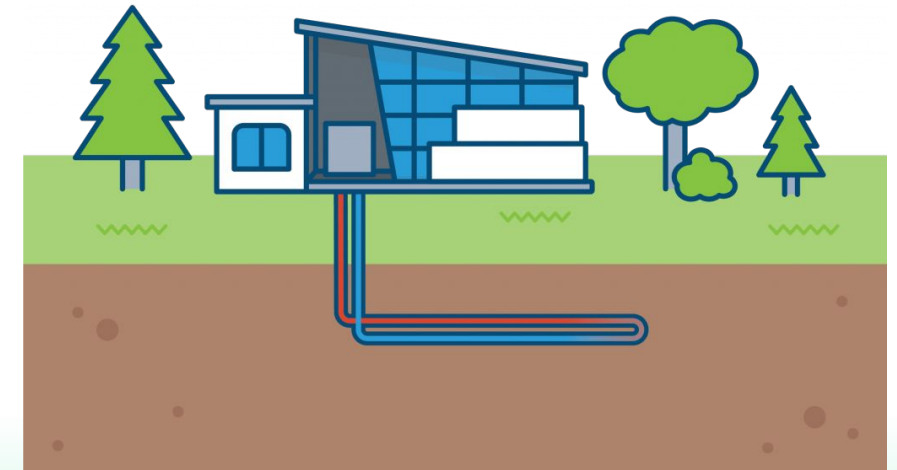
2 - Heat Pump

3 Common Borehole/Field Arrangements

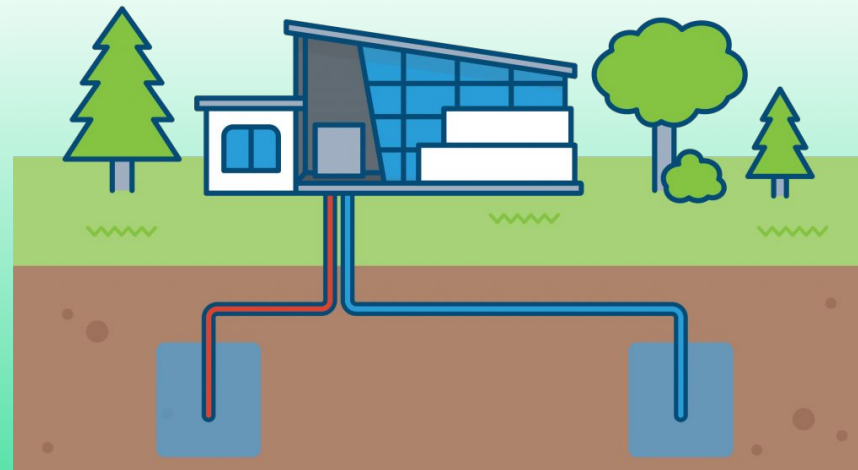


Vertical Closed Loop

Open Loop

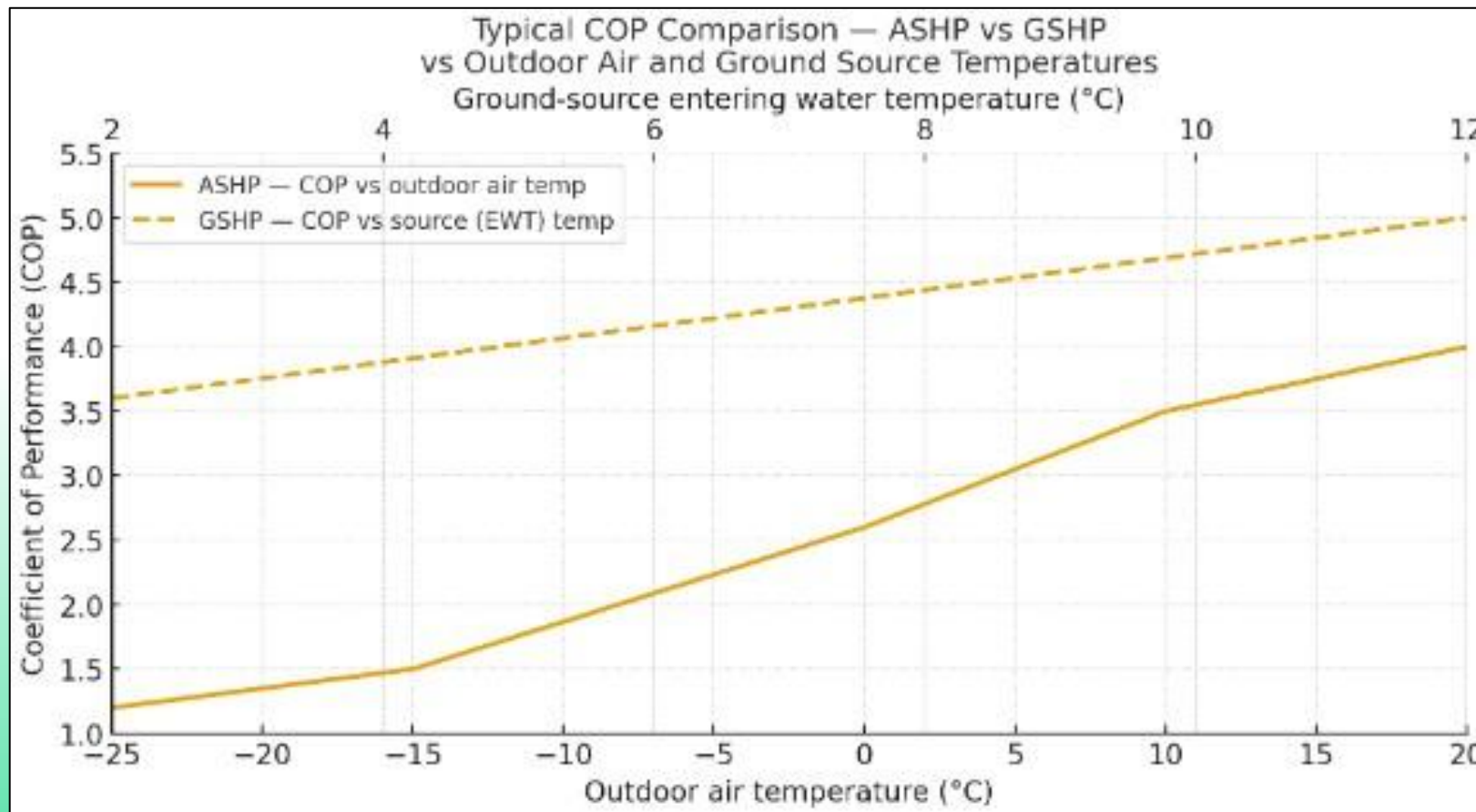


Horizontal Closed Loop



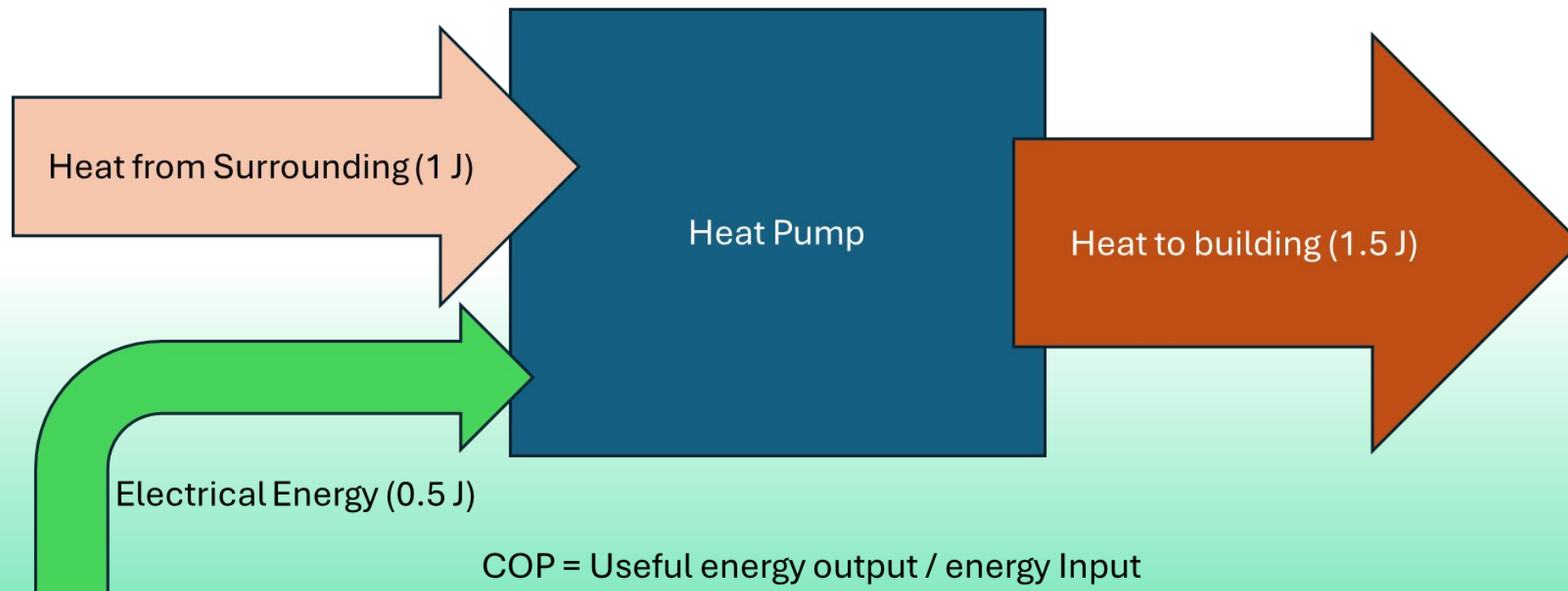
Why use GSHP?

Outside Air Temperature versus COP



Coefficient of Performance (COP)

Heat Pump COP Heating Example

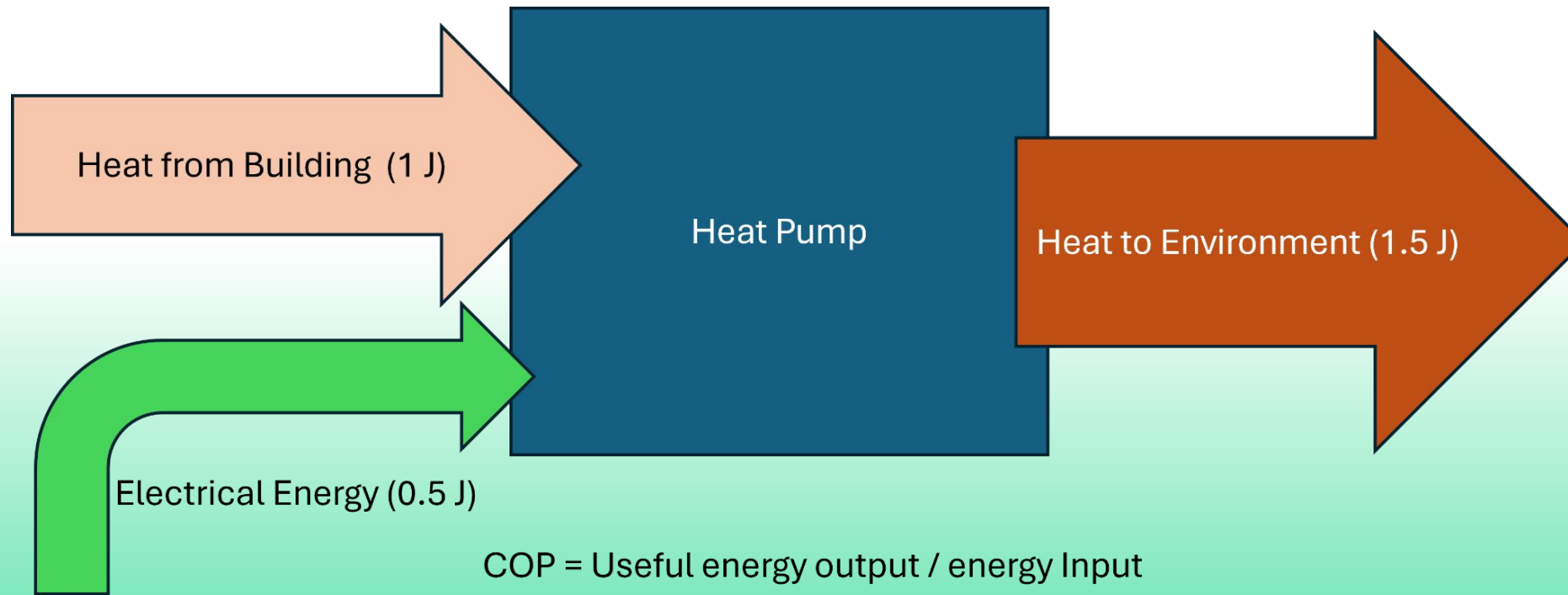


$\text{COP} = \text{Useful energy output} / \text{energy Input}$

e.g. $\text{COP} = 1.5 \text{ J} / 0.5 \text{ J} = 3$ or 300%

Coefficient of Performance (COP)

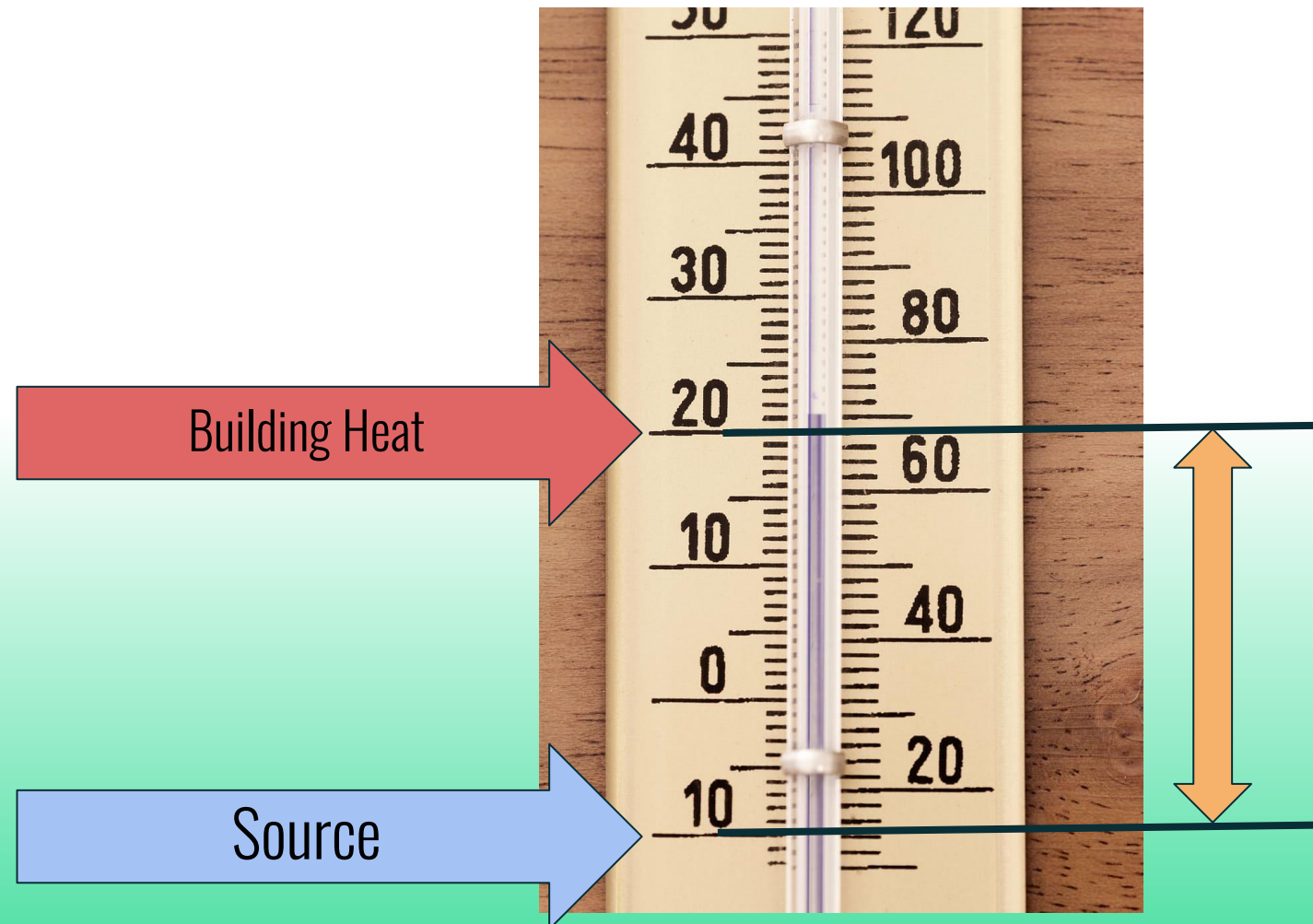
Heat Pump COP Cooling Example



$\text{COP} = \text{Useful energy output} / \text{energy Input}$

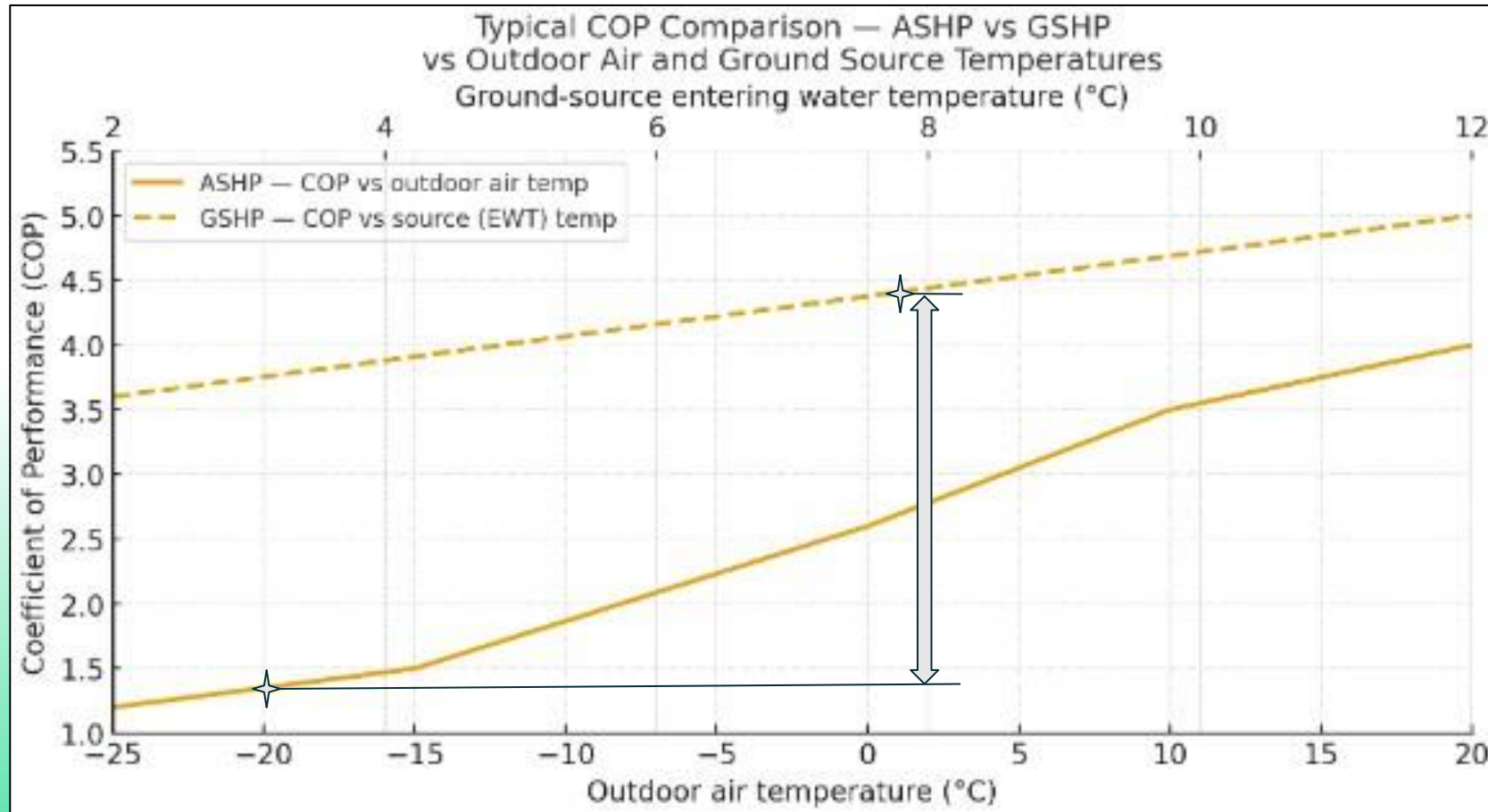
e.g. $\text{COP} = 1.0 \text{ J} / 0.5 \text{ J} = 2$ or 200%

Temperature Difference



The greater the temperature rise, the less efficient the system.

Outside Air Temperature versus COP



APPLICATIONS & SOLUTIONS – RESIDENTIAL

- Space heating & cooling for single-family homes, duplexes and townhomes
- Domestic hot water production either through the installation of a desuperheater or a dedicated system
- Net-zero or passive homes
- Rural/off-grid properties such as farms or acreages with limited or expensive fuel options
- Anyone looking to increase the efficiency and lower the operating costs of their domestic heating, cooling and hot water production

APPLICATIONS & SOLUTIONS – COMMERCIAL

- Schools, universities, hospitals, government facilities
- Office towers, hotels, retail & multi-family buildings
- Centralized plants for condos or districts (shared loop systems)
- Industrial sites with simultaneous heating & cooling demands
- District energy networks (large shared ground loops serving multiple buildings)



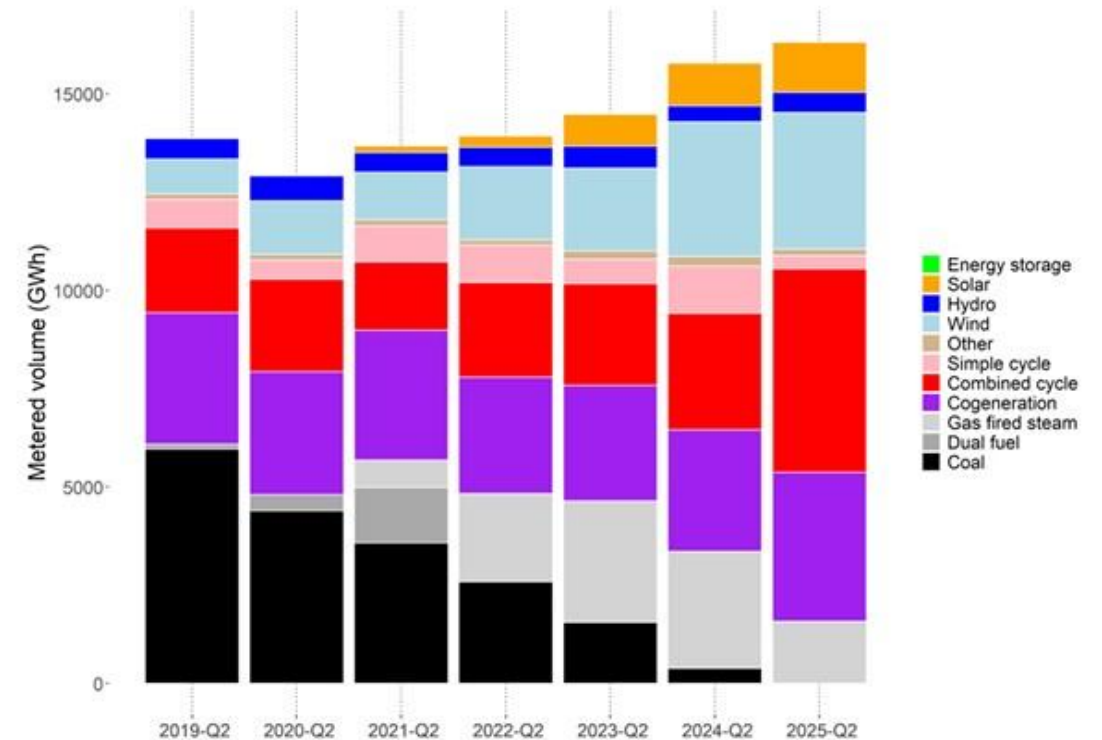
Emissions and Energy

ALBERTA ELECTRICAL GENERATION EMISSIONS

Alberta's Energy Market

- Alberta's energy grid is considered carbon intensive because most of the electricity we produce and consume is derived from natural gas
- A high efficiency natural gas furnace produces approximately 208g of CO₂/kWh (before accounting for electrical usage)
- Electricity supplied by natural gas and utilized by an electric resistance heater (100% efficient) produces approximately 459g of CO₂/kWh
- Electricity supplied by natural gas and utilized by a GSHP (4 C.O.P) produces approximately 114.75g of CO₂/kWh (459g of CO₂ / 4 C.O.P)

Figure 35: Quarterly total net-to-grid generation volumes by fuel type for Q2 (2019 to 2025)



PEAK ELECTRICAL POWER DEMAND

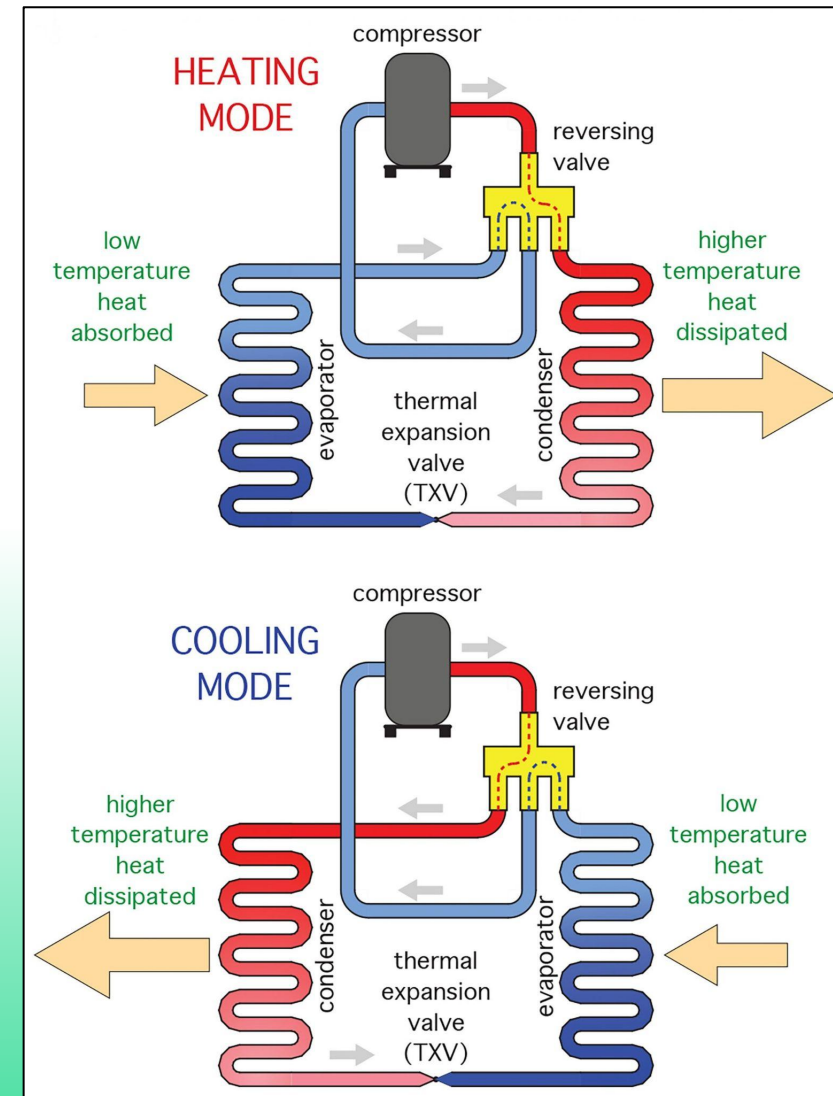
- GSHP have an increased efficiency advantage over other electrical sourced heaters due to their slow and steady (near continuous) operation vs the high peak demand swings seen in standard electric heaters
- The decrease in peak electric demands means that GSHP's operate with a much lower and consistent electrical draw
- This decrease in electrical draw means that GSHP equipment can sometimes be operated with small backup generators or even a battery bank in the event of a power outage
- The 2011-2022 Alberta Electrical forecast shows growth from 74 TWh to 106 TWh, which is a ~43% increase over ~11 years. Extending that trend forward suggests a continuing growth rate



Heat Pump 101

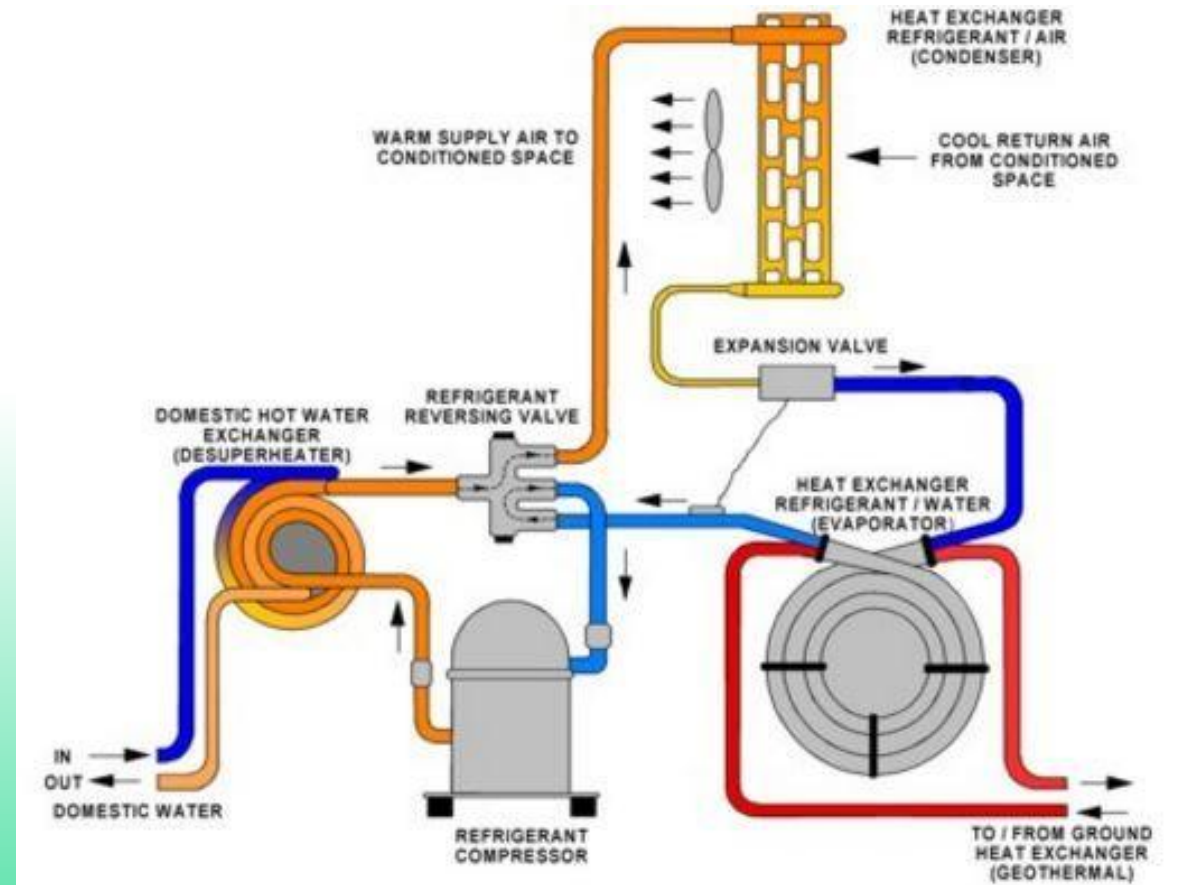
HEAT PUMPS 101 – THEY AREN'T MAGIC!

- A Heat Pump is a refrigeration condenser, with one very important distinction, a Reversing Valve
- This reversing valve (along with the “brains” to control it) allows users to take advantage of both the cooling AND heating end of the “refrigeration cycle”



HEAT PUMPS 101 –Hot Water

- A properly sized system equipped with a de-superheater can produce up to 98% of your DHW requirements, vastly reducing reliance on electric or natural gas hot water heaters
- Almost all residential and commercially available GSHP units can be fit with a de-superheater. Many units have them installed as standard equipment
- A de-Superheater is a heat stripping co-axial loop that is placed between the compressor and the reversing valve of a heat pump. This positioning allows the de-superheater to strip excess heat from the system in heating mode, and strip rejected or waste heat from the system in cooling mode



HEAT PUMPS 101 – examples

- Residential Water-Water Heat Pump (Left)
- Residential Water-Air Heat Pump (Right)



- Commercial Water-Water & Water-Air Heat Pumps





Installation Process

INSTALLATION PROCESS – PROJECT SCHEDULING

Phase	Task	Description	Typical Timing (vs. building schedule)	Duration
1. Design & Coordination	System Design & Load Calculations	GSHP sizing, loop field design, bore layout, coordination with structural & site drawings	During building design phase	2–3 weeks
	Permitting & Utility Locates	Obtain mechanical/geothermal permits, confirm loop field placement	Late design to early site prep	1–2 weeks
2. Ground Loop Installation	Site Prep & Bore Layout	Mark boreholes/trenches before excavation or foundation backfill	Before or during foundation excavation	1–3 days
	Drilling/Boring	Install vertical bores (250–500 ft typical) or horizontal trenches	After rough grading and before foundation backfill	1–4 weeks
	Grouting & Headering	Backfill/grout bores, install loop headers to building entry point	Follows drilling	3–14 days
	Pressure Test & Inspection	Verify integrity before burial	End of loop install	1–2 days

INSTALLATION PROCESS – PROJECT SCHEDULING

Phase	Task	Description	Typical Timing (vs. building schedule)	Duration
3. Interior Mechanical Rough-In	Piping to Mechanical Room	Connect buried header to indoor manifold	During plumbing/mechanical rough-in	2–4 days
	GSHP Equipment Delivery	Deliver and place equipment on pad or in mechanical room	Rough-in stage	1 day
	Ductwork / Hydronic Tie-In	Connect supply/return to ductwork or radiant loops	During HVAC rough-in	3–5 days
4. Commissioning & Finalization	Electrical & Controls	Wire pumps, sensors, thermostat, controls	During electrical trim-out	1–3 days
	System Fill & Purge	Charge loop field with antifreeze, remove air	Before drywall or final finishes	1 day
	Start-Up & Commissioning	Verify performance, flow rates, and COP	After permanent power	1–2 days
	Owner Orientation & Handover	Provide manuals, maintenance schedule	End of construction	1 day

INSTALLATION PROCESS – WHO'S INVOLVED & WHEN

Design Stage

Owner/Client – defines goals, budget, and requirements

Professional Engineer/GSHP Designer – determination of heating and cooling loads, system design (type of GSHP system, HVAC distribution), equipment sizing, code compliance

GSHP Contractor (Designer) – loop field design, load/energy modeling

Geotechnical Consultant (Drillers or Civil Contractors) – soil/rock properties, thermal conductivity tests

Civil Engineer (if required) – site layout, grading, drainage

Regulatory Authorities – review and issue permits (water, environmental, building, electrical)

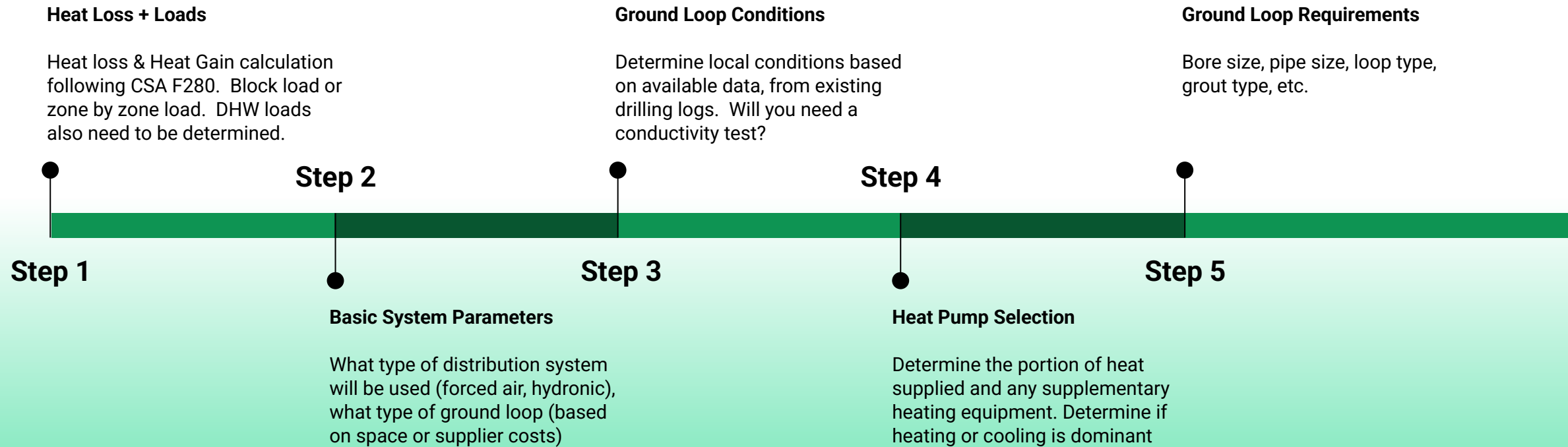
INSTALLATION PROCESS – WHO'S INVOLVED & WHEN

Construction Stage

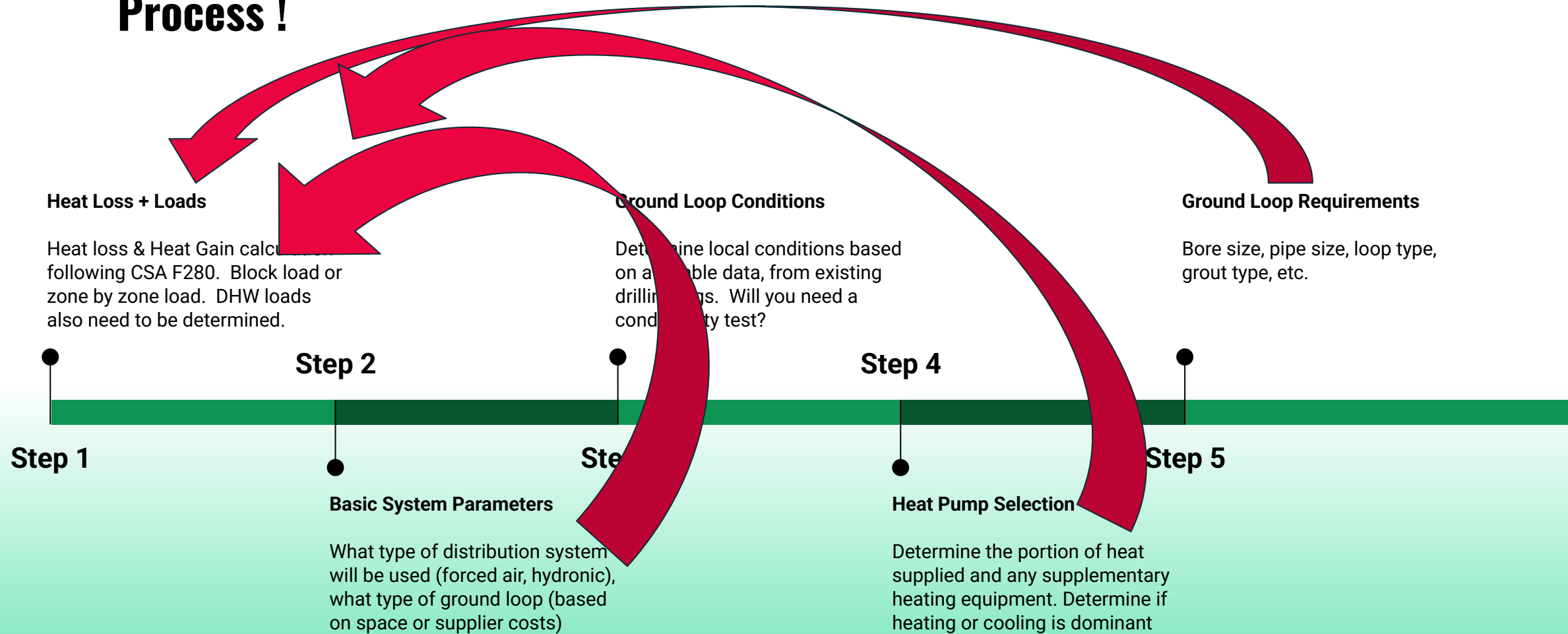
- Drilling/Excavation Contractor – installs vertical boreholes or horizontal trenches
- Fusion Technician (GSHP Contractor) – installs and fuses HDPE piping headers and manifolds
- Mechanical Contractor – piping and building distribution system (duct work or In-floor hydronic)
- GSHP Contractor – installs heat pump and related pumping equipment
- Electrical Contractor – installs power, controls, and interlocks
- Controls/Automation Specialist – integrates controls with BMS or standalone system
- Commissioning Agent – tests and verifies performance before handover.



System Design and Coordination



Integrated Design Process !



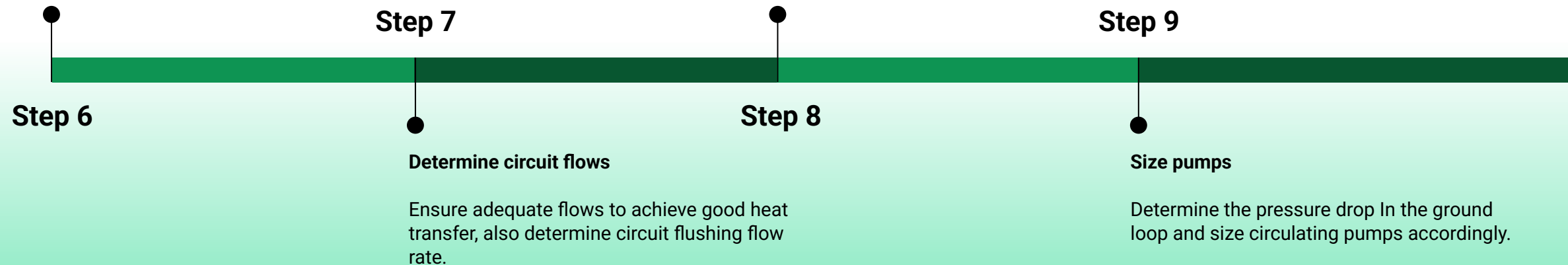
Adapted from Chris Mitchell "Designing a Residential Heat Pump System"

Detailed ground Loop design

Pipe and header sizing, fitting locations, flow rates, antifreeze type and volume, etc.

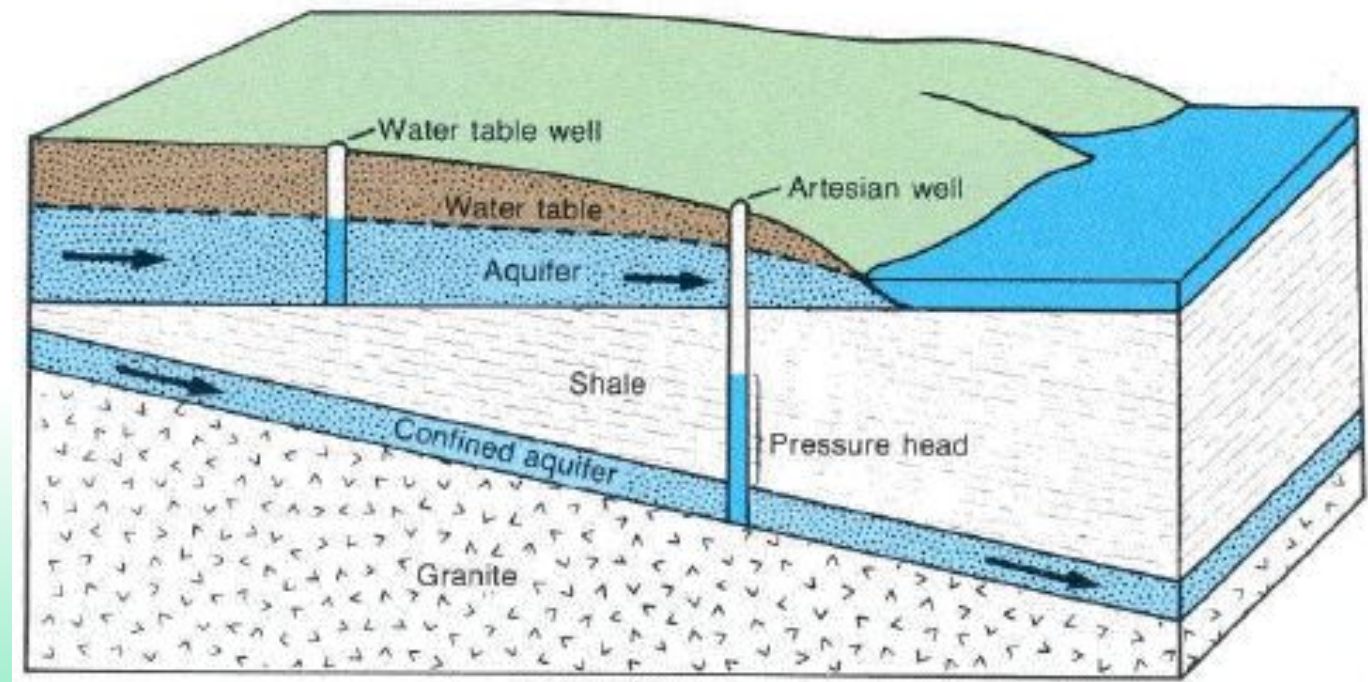
Detailed Header design

Determine Tee-sizes, flushing flow rate



Adapted from Chris Mitchell “Designing a Residential Heat Pump System”

Local Drilling Conditions matter



Make sure the drilling contractors know your area - local knowledge matters.

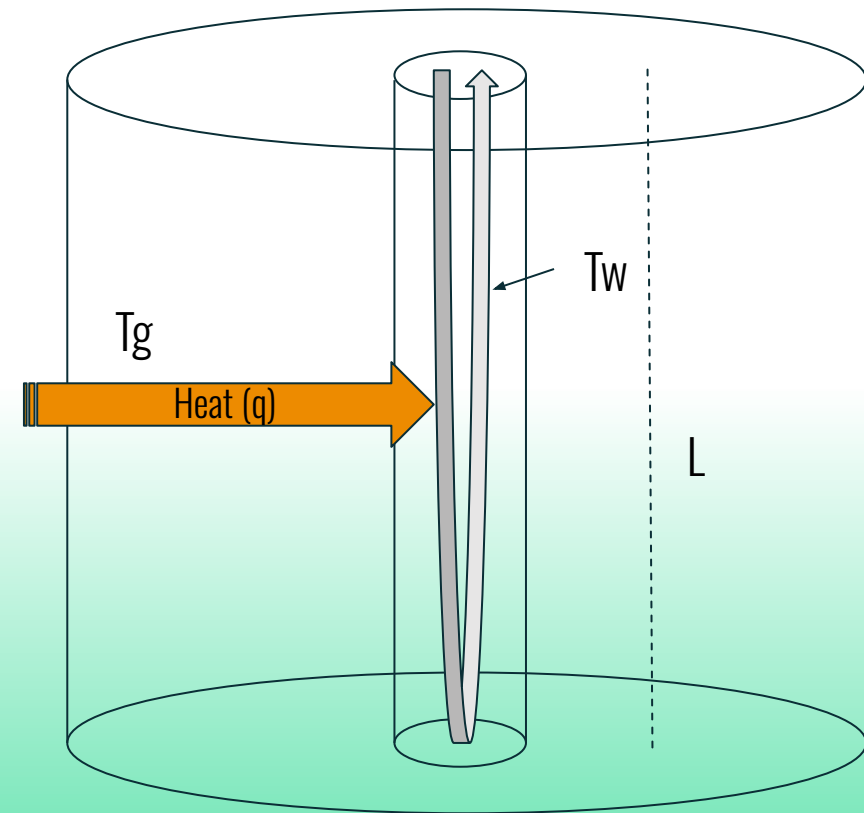
Thermal Conductivity

- Thermal Conductivity: The ground's ability to transfer and absorb heat energy.

$$\text{Length (L)} = \frac{\text{heat (q)} \times \text{Thermal Resistance (R)}}{(T_w - T_g)}$$

T_w = loop fluid temperature

T_g = ground temperature



Thermal Conductivity

- For small applications, a conservative assumption will be made
- For large applications a thermal conductivity is a must



SYSTEM CAPACITY

- GSHP equipment is most efficient when designed to produce 70-105% of the buildings heating or cooling loads. Oversizing equipment beyond 105% of the buildings heat capacity causes the heat pump to short cycle.
- GSHP equipment in Alberta's climate is most often sized based on the heating requirements of the building. Alberta is a heating dominant climate, and when coupled with the highly efficient nature of a GSHP's cooling capacities, it means that these systems are often inherently over-sized for their cooling requirements. Very little work is required to obtain cooling from the earth's 7°C constant ground temperature

System Design - Ground Loops

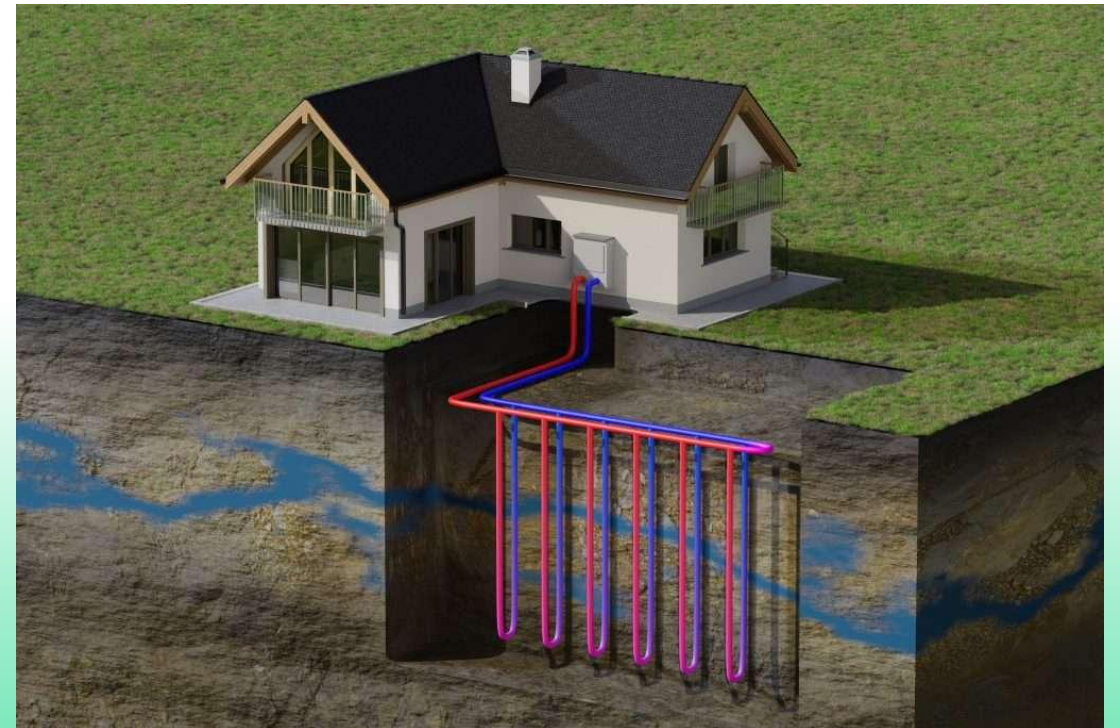
SYSTEM DESIGN – TYPES OF GROUND LOOPS

- Most common system types include:
 - Vertical Borehole Ground Loops (Closed)
 - Horizontal Trench Ground Loops (Closed)
 - Open Loop Systems
- The “best” type of system is dependent on the needs and the geographic location of your GSHP project

TYPES OF GROUND LOOPS

Vertical Borehole Ground Loops (Closed)

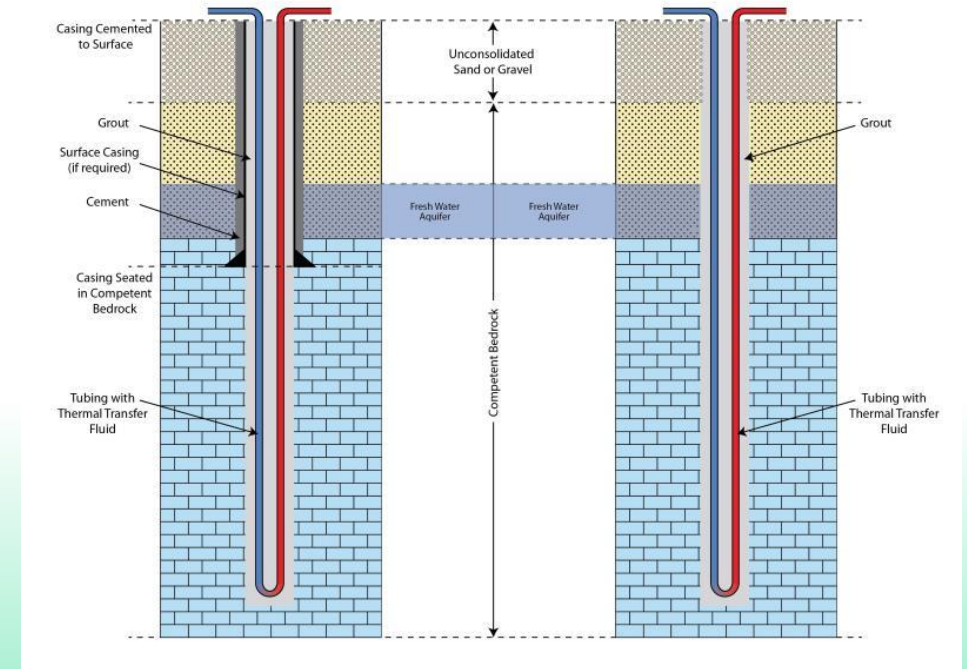
- Identify a qualified and licensed drilling contractor with geo exchange and ground loop installation experience
- The number of boreholes and the depth of each borehole will be pre-determined based on the calculated heating and cooling loads, as well as the thermal conductivity of the soil in the drilling location
- Utilize the drillers expertise to help determine the anticipated drilling conditions



TYPES OF GROUND LOOPS

Vertical Borehole Ground Loops (Closed)

- Boreholes are typically drilled to a depth ranging between 250-500 feet, in Alberta
- Specialized High-Density Polyethylene (HDPE) (PE 4710) ground loops with a pre-installed “u-bend” are then lowered into each borehole by the drilling contractor
- Drillers then backfill the borehole and ground loop with a highly thermal conductive grouting compound. Grouting is a critical step in a GSHP and works to:
 - stabilize the borehole
 - protect the ground loop piping
 - minimize downhole loop head pressure
 - maximize the thermal conductivity of the borehole to the surrounding ground



TYPES OF GROUND LOOPS

Vertical Borehole Ground Loops (Closed): PROS, CONS, Risk Avoidance

PROS

- Requires less land area — ideal for small lots
- Stable ground temperature year-round (deeper soil) meaning increased efficiency
- Ground loop is protected with grout and/or casing near surface
- Long lifespan (50+ years for boreholes)

CONS

- Higher drilling cost due to depth (often the most expensive loop type)
- Requires skilled drilling contractors and suitable geology
- Harder to inspect or repair after installation

Risk Avoidance

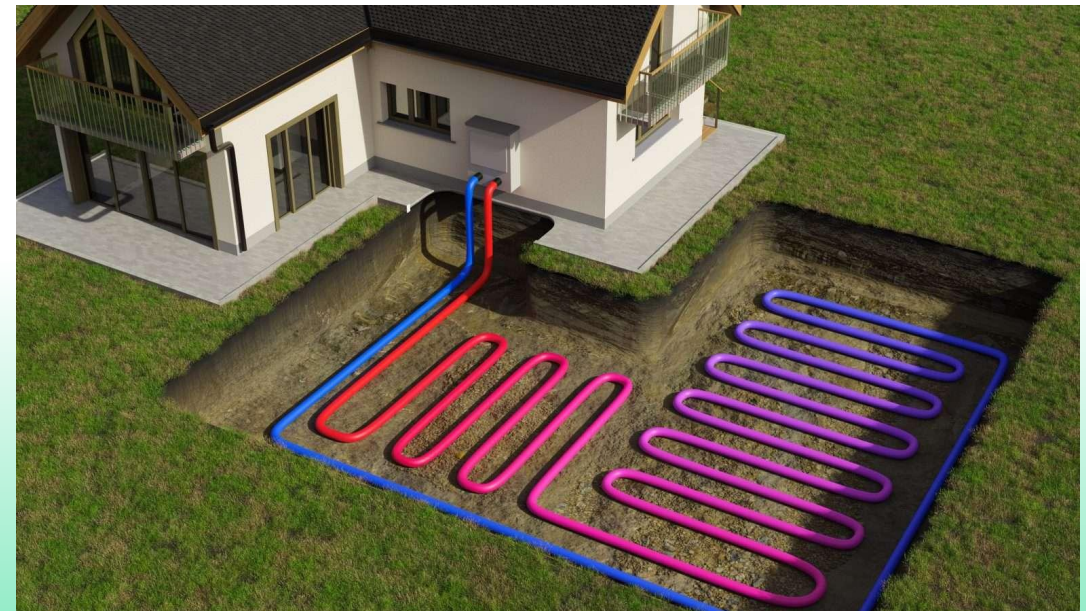
- Conduct geotechnical and thermal conductivity testing before drilling
- Use experienced, certified drillers familiar with local conditions
- Maintain accurate as-built borehole mapping for future reference
- Use grout with proper thermal conductivity to prevent voids and water migration



TYPES OF GROUND LOOPS

Horizontal Trench Ground Loops (Closed)

- Identify a qualified and licensed civil contractor with experience in deep trench excavation
- The length of trenches and pipes required will be pre-determined based on the calculated heating and cooling loads, as well as the thermal conductivity of the soil in the digging location. A test pit can be dug to determine to properties of the soil
- Trench lengths and widths will vary based on project needs. However, trench depth will remain relatively consistent between projects at 6-8 feet in Alberta



TYPES OF GROUND LOOPS

Horizontal Trench Ground Loops (Closed)

- Once civil contractors have completed excavation, the process of installing the ground loop lines can begin
- Specialized HDPE (PE 4710) ground loop is laid into the trench by GSHP contractors.
- The pipe can be laid straight or coiled depending on space and energy requirements. Coiling the pipe maximizes its contact area for energy transfer, giving the nickname “slinky loops”
- Tracer wire can be run down the center of the trenches to assist with future locates of the ground loops
- Civil contractors then carefully backfill the trench with native soil to insulate the ground loops from the elements. Non-native soil can be utilized if the existing soil possess weak conductivity properties



TYPES OF GROUND LOOPS

Horizontal Trench Ground Loops (Closed): PROS, CONS, Risk Avoidance

PROS

- Lower installation cost than vertical systems
- Relatively easy access for maintenance or repair
- Little to no communication with groundwater or aquifers
- Simpler to install with standard excavation equipment
- No risk of ground temperature degradation “recharges from the the sun”

CONS

- Requires large, unobstructed land area
- Lower efficiency in extreme temperatures due to shallow depth
- Disturbs landscaping and soil during install

Risk Avoidance

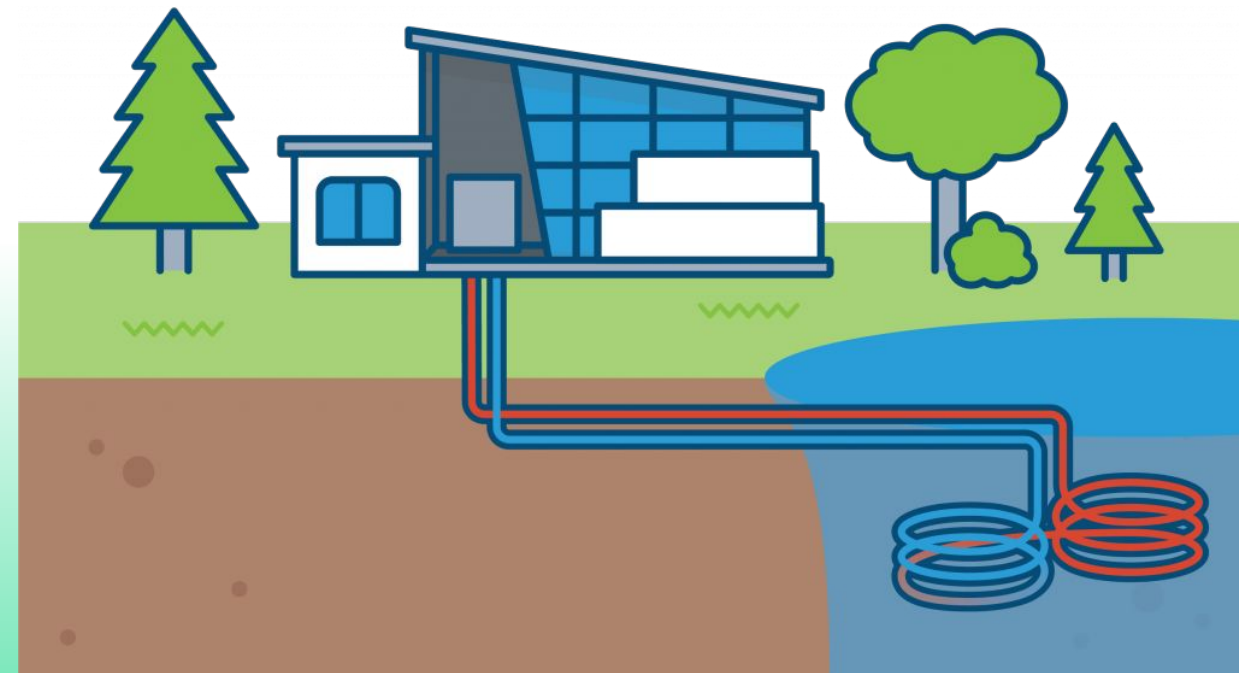
- Thermal modeling of soil and loop spacing to prevent heat saturation
- Install below frost line (typically 6–8 ft in cold climates)
- Avoid areas with future construction or heavy loads (ie. driveways)
- Backfill with thermally stable material and proper compaction



TYPES OF GROUND LOOPS

Pond/Lake Loop (Closed)

- Identify a qualified and licensed GSHP Contractor or Earth Loop Technician. Consultation with local/provincial regulatory agencies may be required
- Closed loop pond/lake systems utilize large open bodies of water where specialized HDPE (PE 4710) ground loop coils are submerged to exchange energy with stable deep water temperatures
- These systems can achieve high efficiencies due to the stable temperatures and high heat transfer properties of deep water
- These systems are less common in Alberta mostly due to location and lack of suitable bodies of water



TYPES OF GROUND LOOPS

Pond/Lake Loop (Closed): PROS, CONS, Risk Avoidance

PROS:

- Lower installation cost compared to vertical drilling (if a suitable water body exists)
- High and stable heat transfer efficiency, as water temperatures fluctuate less than air or shallow soil
- Minimal land disturbance on shore or property
- Simpler loop installation (weighted coils sunk into water)

CONS:

- Requires a sufficiently large, deep, clean water body (typically 8–10 ft deep)
- Potential environmental or aesthetic concerns
- Loop damage risk from boats, anchors, ice movement, or debris
- Permitting requirements for water use and environmental impact
- Limited to sites with appropriate pond/lake access

Risk Avoidance:

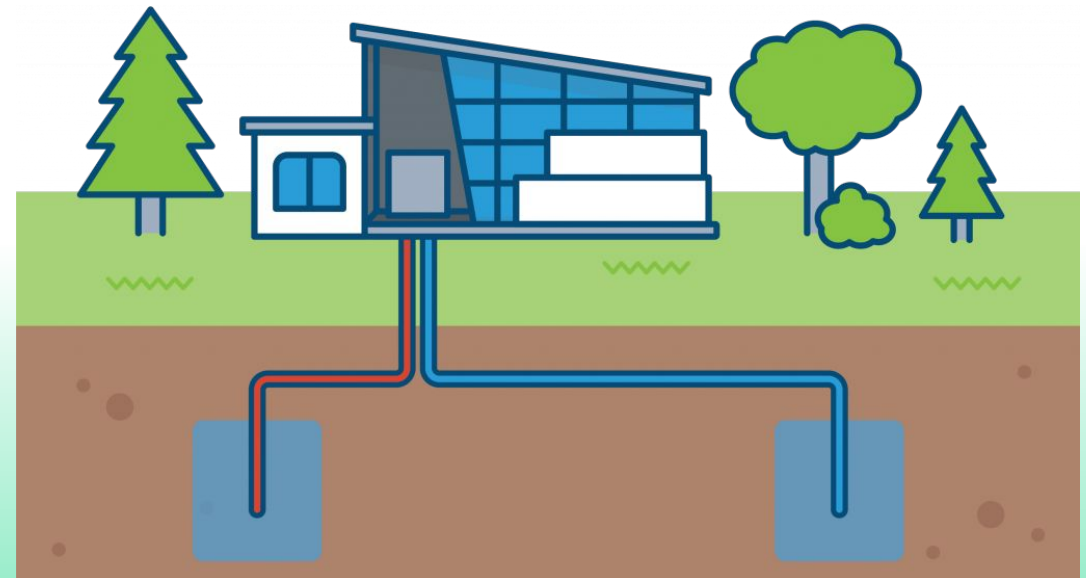
- Assess pond suitability. Verify minimum depth, volume, and water quality
- Confirm water levels remain stable year-round (not seasonal or stagnant)
- Obtain any local water use or environmental permits early
- Follow setback distances and avoid ecologically sensitive zones
- Weight and anchor coils securely below ice level (at least 8 ft deep)
- Install protective barriers or signage to prevent boat or anchor damage



TYPES OF GROUND LOOPS

Open Loop Systems

- Consultation with local and/or provincial regulatory bodies is required
- Open loop systems utilize a large body of groundwater, such as an aquifer, well, lake, or pond as its heat source (or sink)
- They directly pump the water through a heat exchanger in the heat pump unit



TYPES OF GROUND LOOPS

Open Loop Systems

- After heat is added or removed, the water is returned to a different well or is discharged back into the source body of water
- These systems are highly efficient and can be a cost-effective option if a plentiful and suitable water supply is available
- Costs for these open loop systems can increase substantially if drilling is required to reach an aquifer or well water source



TYPES OF GROUND LOOPS

Open Loop Systems: PROS, CONS, Risk Avoidance

PROS

- High efficiency from constant groundwater temperature
- Lower installation cost if water source exists close to surface
- Simple heat exchange process

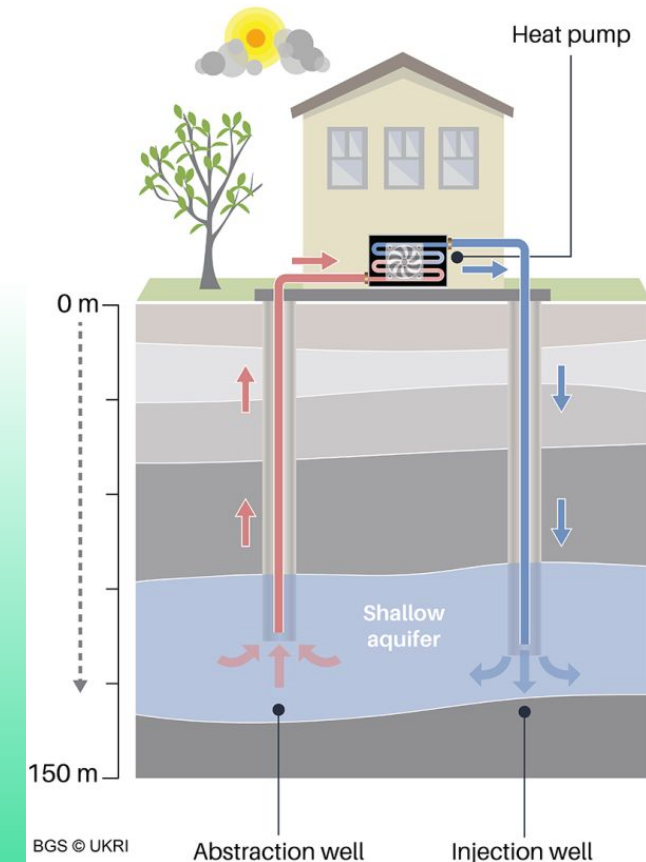
CONS

- Dependent on consistent water supply and quality
- Potential fouling, scaling, or biological growth
- Regulatory permitting and environmental compliance required
- Risk of contamination of the aquifer

Risk Avoidance

- Perform water quality and flow testing before design
- Use heat exchangers made from corrosion-resistant materials (e.g., stainless steel, titanium)
- Include filtration and water treatment systems where needed
- Implement redundant well design or re-injection wells to maintain aquifer balance
- Verify permits and environmental approvals early in design

Open-loop ground source heat-pump system



TYPES OF GROUND LOOPS – COST CONSIDERATIONS

Vertical Borehole

- \$15-18 per foot (Drilling)
- \$3-5 per foot (HDPE Ground Loop)
- \$3-5 per foot (Thermal Conductive Grout)

Typical cost to drill, install ground loop and grout for a 500' borehole in Alberta: **\$12,250.00**



Image from Urban Geoxchange

TYPES OF GROUND LOOPS – COST CONSIDERATIONS

Horizontal Trench

- \$25-40 per foot (Trenching + Backfill)
- \$3-5 per foot (HDPE Ground Loop)

Typical cost to trench, install ground loop and backfill for a 300' trench in Alberta:
\$10,950.00



TYPES OF GROUND LOOPS – COST CONSIDERATIONS

Open Loop

- **\$15-18 per foot (Drilling, If Required)**
- **\$3-7 per foot (HDPE Ground Loop)**

Typical cost to install an open loop is dependent on several factors, examples from Alberta show: **\$8000.00-10,000.00**

Overview of Distribution

Overview of Distribution



Forced Air

- 'Condenser' air-to-refrigerant heat exchanger installed in the air handler.
- De-superheater option for hot water
- Lower temperatures than a NG furnace = larger duct flows
- Provides cooling in the same distribution
- Ventilation



Hydronic

- Water-to-water heat pump
- Likely uses a buffer tank
- De-superheater option for hot water supply
- Lower temperature than NG boiler = more loops and smaller spacing
- Unlimited zoning options
- In floor / radiators / baseboards
- Separate cooling / ventilation

Mixed (triple function)

- Water-to-water HP
- Water coil to air handler
- Separate loops for radiant heat
- Desuperheater option for DHW
- Packaged unit or engineered systems
-

Decentralized (commercial)

- Large systems
- Heat carried in medium temperature loop
- Local Heat pumps provide zone specific heating and cooling
- Simplified distribution

GSHP VS. TRADITIONAL HVAC

- GSHP systems provide even heating, gentle cooling, and efficient humidity control
- GSHP systems are designed to produce warm and/or cool air that is close to the desired temperature of the space at a near constant rate
- Traditional systems are typically designed to produce a “blast” of hot and/or cold air, usually at a much higher or lower temperature than the desired set point. Traditional systems have more of a tendency to “short cycle” their energy output, meaning increased temperatures for shorter periods of time
- GSHP systems are nearly silent indoors and completely unseen and unheard outdoors. The sound of a fan motor is present in water-air GSHP’s
- Traditional systems can be noisy indoors, with the operation of both fan motors and burners. Outdoor A/C condensers take up space and create noise levels sometimes exceeding 75 dBA

Design Considerations

Design Considerations

Equipment Size & Space Considerations

- GSHP systems have a very similar layout and space requirement when compared to a traditional furnace or boiler system.
- Gas lines are replaced with ground loop lines. Ground loop lines are brought into the building either through the foundation wall or up through the slab.



Design Considerations



Equipment Size & Space Considerations

- Most water-air GSHP's available have a similar or smaller footprint when compared to a natural gas furnace. The evaporator/heat exchange coil come pre-installed in the GSHP units, reducing the footprint of an A/C coil that would need to be added on-top of a traditional furnace to facilitate air conditioning

Design Considerations

Equipment Size & Space Considerations

- Water-Water GSHP systems utilize a hot water storage tank (separate from your DHW heater). This tank is placed in between your heat pump and the manifolds which feed the in-floor radiant system. The tank allows for hot water storage, as well, an auxiliary heater is installed in the tank to act as either a booster for extremely cold conditions, or as an emergency backup should the GSHP experience a mechanical issue



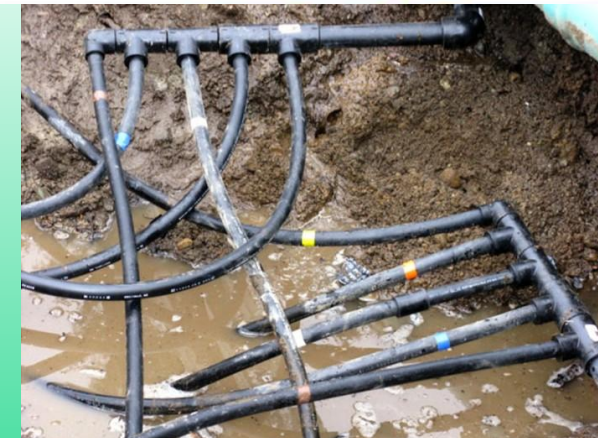
Design Considerations

Ground Loop Header/Manifold Space Considerations

- Unless your GSHP project employs only 1 ground loop, then a header system is required
- Headers are a critical component of GSHP ground loops for ensuring even flow rates, pressures and energy capture for each loop in the system while also eliminating the need for a circulating pump on every loop
- Header and manifold systems can be installed on the building exterior (buried in a trench) or on the interior of the building

Geothermal Manifold

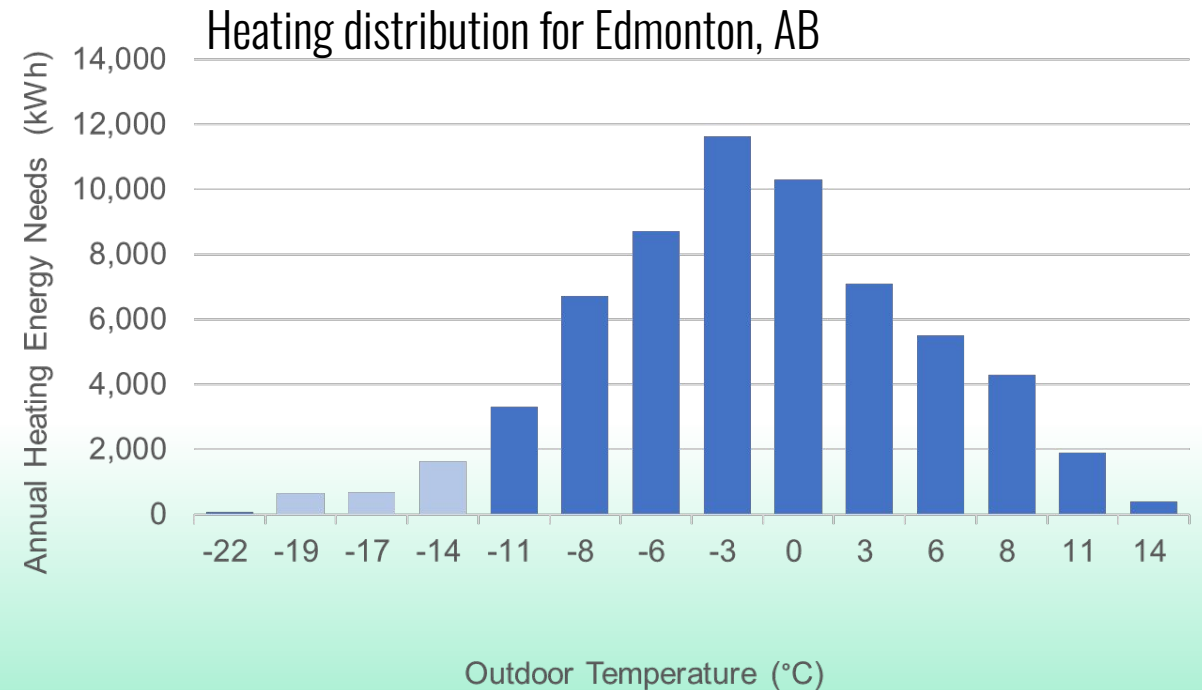
- 1 Supply/Return Header
- 2 Supply/Return Circuit
- 3 Isolation Valve (Typ)
- 4 Pressure Gauge
- 5 Thermometer
- 6 Pressure and Temp (PT) Test Port
- 7 Charging Station



Design Considerations - Electrical Service Sizing

Electrical Requirements Example

- Standard 4-ton GSHP Electrical requirements:
 - Heat Pump, Condenser, Fan-Motor (if w-a):
208-230/60/1 – 50-amp Breaker (40-amp Breaker w-w)
- GSHP systems do not by themselves necessitate the need to increase your electrical capacity above 100 amps. Other loads within the building must be factored before making that decision



In this example 70% of the heating load is met exclusively with the Heat Pump.



Ground Loop Installation

INSTALLATION PROCESS – PERMITTING & REGULATORY

Jurisdictions:

- Provincial (Alberta Environment and Protected Areas AEPA) – governs drilling, groundwater protection, and geothermal licensing.
- Provincial - Building code - NBC 2023 (AE) references CSA C448 series 13 for the design and installation of earth energy systems
- Municipal – governs building, mechanical, and electrical permits

System Type Matters:

- Closed-loop Vertical: generally shallow wells (<150 m); provincial drilling & reclamation approval often required
- Closed-loop Horizontal: trench to 6-8 feet; Alberta One-Call, Ground Disturbance Certification
- Open-loop or deep systems: trigger Water Act licenses or AER Geothermal Resource Development Act review

INSTALLATION PROCESS – PERMITTING & REGULATORY

1. Approval to Drill & Reclaim

- Required for vertical closed-loop boreholes
- Must follow provincial Ground Source Heat Exchange Systems directive laid out by AEPA (well construction, grouting, spacing, abandonment)

2. Qualified Personnel

- Bore field design sealed by Alberta P.Eng
- Accredited installer (Canadian Geotexchange Coalition - CGC or International Ground Source Heat Pump Association IGSHPA) and
- Drilling contractor licensed by AEPA drilling contractor following provincial well standards per the 'Water Wells and Ground Source Heat Exchange System Directive'

3. Reporting & Protection

- Maintain separation distance from water wells and aquifers
- Report drilling and reclamation as required

INSTALLATION PROCESS – PERMITTING & REGULATORY



Geoexchange Application Requirement List

Geoexchange Project

All of the following information is necessary to facilitate a thorough evaluation and timely decision on your application. To expedite the evaluation, all materials submitted must be clear, legible and precise. To achieve this level of customer service, staff have been instructed to accept only complete applications which include plans prepared to professional drafting standards.

Project address: _____

completed by applicant	office use only	Required items
☐	☐	1. An approved development permit, if the Land Use Bylaw requirements are not met
☐	☐	2. Completed <u>Mechanical Permit Application Form</u>
☐	☐	3. Two (2) copies of a dimensioned site plan, including: (preferred scale is Metric - 1:200 or Engineer - 1" = 20' 0")
☐	☐	north arrow
☐	☐	municipal address
☐	☐	property lines
☐	☐	adjacent City streets, lanes, and adjacent lots
☐	☐	site area & coverage
☐	☐	front, side and rear yard dimensions
☐	☐	right-of-way setbacks, easements and utility rights-of-way, if any
☐	☐	overhead utilities
☐	☐	outline of all structures on property covered by permit
☐	☐	outline of all structures on adjoining properties (private or public)
☐	☐	planned ground exchanger field with bore hole placements, piping sizes, depths and spacing
☐	☐	layout of all ground circuits and headers including into structure
☐	☐	4. System information – contractor verification. Failing to meet standard requirements may result in replacement of any or all non-compliant equipment and materials.
☐	☐	Part 3 (commercial) system per Alberta Building Code 2014 definition – Mechanical Engineer stamped and signed drawings.
☐	☐	Part 9 (residential/small building) system per Alberta Building Code 2014 definition – Mechanical Engineer OR geoexchange designer drawings
☐	☐	Cathodic protection system designed by Corrosion Engineer or system specialist, if DX system
☐	☐	All pipe shall be line printed in compliance with CAN/CSA C448 and be marked with "C448" and "Geo" or "Geothermal"

Updated 2017 October 25

LUD _____
PST _____

☐	☐	5. Ground loop information
☐	☐	Refrigerant (DX) information:
☐	☐	refrigerant specification sheet
☐	☐	refrigerant type (per CAN/CSA B52 and/or ASHRAE 34):
	☐	R-22
	☐	R-410A
	☐	other
☐	☐	operating pressures:
		Maximum Minimum
☐	☐	Thermal transfer fluid information:
☐	☐	transfer fluid specification sheet
	☐	propylene glycol
	☐	methanol
	☐	ethanol
	☐	other
☐	☐	dilution level of antifreeze:
		_____ % water _____ litres of antifreeze
		_____ % antifreeze _____ litres total volume
☐	☐	6. Additional documentation, where required
☐	☐	thorough heat loss calculation for main structure (to meet CAN/CSA F280 for Part 9 applications and ASHRAE standards for Part 3 applications)
☐	☐	thorough and separate heat loss calculations for each peripheral heating/cooling load:
	☐	on-demand domestic hot water (not applicable for desuperheater function)
	☐	snow/ice melt
	☐	spa
	☐	pool
	☐	other:
☐	☐	back-up heat source specification sheet including type, size, output, etc
☐	☐	for DX systems only – Certified brazing (refrigeration) certificate (photocopy is acceptable)
☐	☐	for DX systems only – cathodic protection documentation (per NACE)
☐	☐	approval letter from Alberta Environment for regulated open loop system
☐	☐	Alberta Energy Resources (AER) licence for bores deeper than 150 metres below grade
☐	☐	geotechnical report
☐	☐	hydrogeological report (required if Alberta Environment letter is required)
☐	☐	copy of independent utility locate report
☐	☐	copies of specification sheets for each equipment item
☐	☐	7. Drilling company: _____
		Contact name & phone number: _____
☐	☐	8. Fee (<u>Fee Schedule</u>), based on marked-up construction costs, including all labour, equipment and material (including drilling, trenching, excavating and backfilling)

FOIP DISCLAIMER: The personal information on this form is being collected under the authority of The Calgary Building Permit Bylaw 548M4 (Section 5) and amendments thereto. It will be used for the permit review and inspection processes and may be transmitted to relevant City Business Units, utility providers, and Alberta Health Services. It may also be used to conduct ongoing evaluations of services received from Planning & Development. The name of the applicant and the nature of the permit will be available to the public. Please send inquiries by mail to the FOIP Program Administrator, Planning & Development, P.O. Box 2100, Station M, Calgary, AB T2P 2M6 or contact us by phone at 311.

Recommended Steps:

1. Confirm municipal permit needs early
2. Engage P.Eng. & accredited installer
3. Apply for provincial drilling approval
4. Obtain municipal permits, install, inspect, and report

Best Practices

BEST PRACTICES

1. Load & Building Optimization (Before System Design)

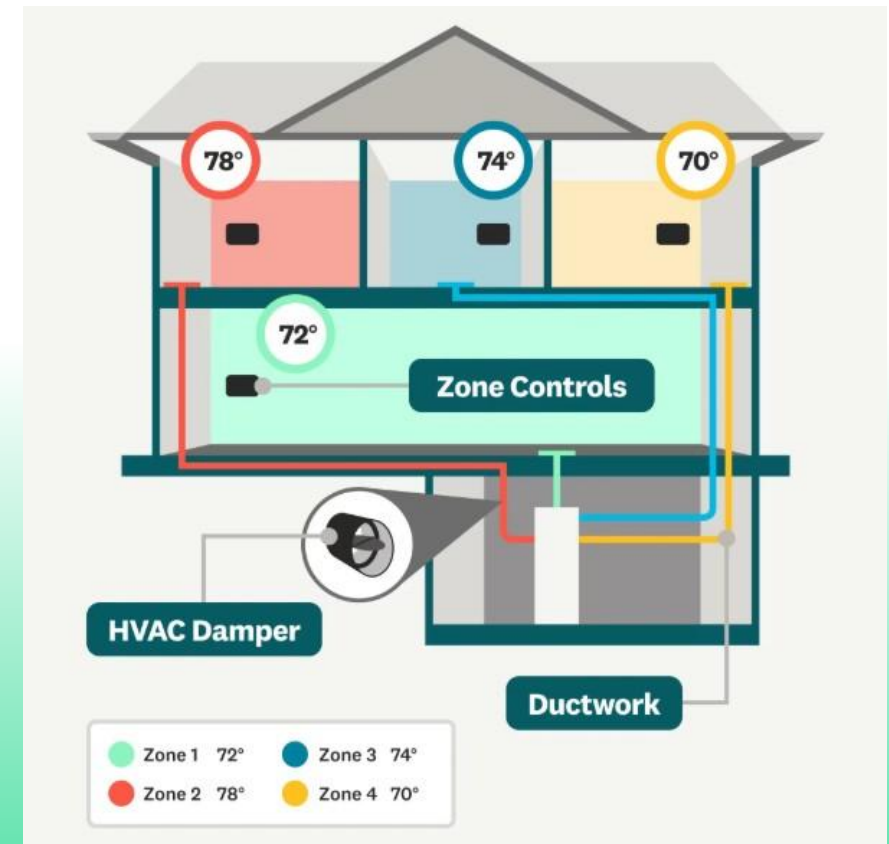
Most cost savings come from reducing the load before sizing the GSHP

- **Improve building envelope:** airtightness, insulation, and window U-values directly reduce required bore field size and pump capacity
- **Right-size HVAC system:** avoid oversizing — accurate heat-loss/heat-gain calculations (CSA F280 or equivalent) reduce loop length and equipment cost
- ***Thermal zoning*:** separate large open spaces or solar-gain areas to prevent unnecessary full-system load increases
- **Integrate passive design:** orientation, shading, and ventilation strategies can flatten seasonal peaks

BEST PRACTICES

Zoning

Creating individually controlled spaces (zones) ie. 1st/2nd/3rd floors, bedrooms, living rooms etc. allows for systems to meet heating or cooling demands on an individual basis instead of applying heating or cooling to spaces that may not require it. This helps to avoid hot and cold spots felt within buildings and reduces the load on the system. Costs must be balanced between the increased requirement for HVAC/Plumbing and controls, the increased system efficiency (reduced operating costs) and the desired comfort of the space



BEST PRACTICES

2. Ground Loop Optimization

Loop design is the largest cost driver. Optimize borehole count, depth, and layout

- **Thermal conductivity testing:** use local or regional data to size accurately; high-conductivity soils mean shallower or fewer boreholes
- **Hybrid systems:** combining GSHP's with **solar power** generation or with other auxiliary sources (e.g., natural gas backup, air-source heat pump, or cooling tower) to cut loop cost while bolstering system efficiency. This can also help balance heating and cooling loads.
- **Borehole optimization:**
 - Optimize spacing (typically 15–20 ft) to minimize thermal interference
 - Use high-conductivity grout to improve heat transfer and reduce total bore length
- **Horizontal or slinky loops:** where land is available, horizontal configurations can be cheaper to install than vertical bore fields

BEST PRACTICES

3. Equipment & Control Optimization

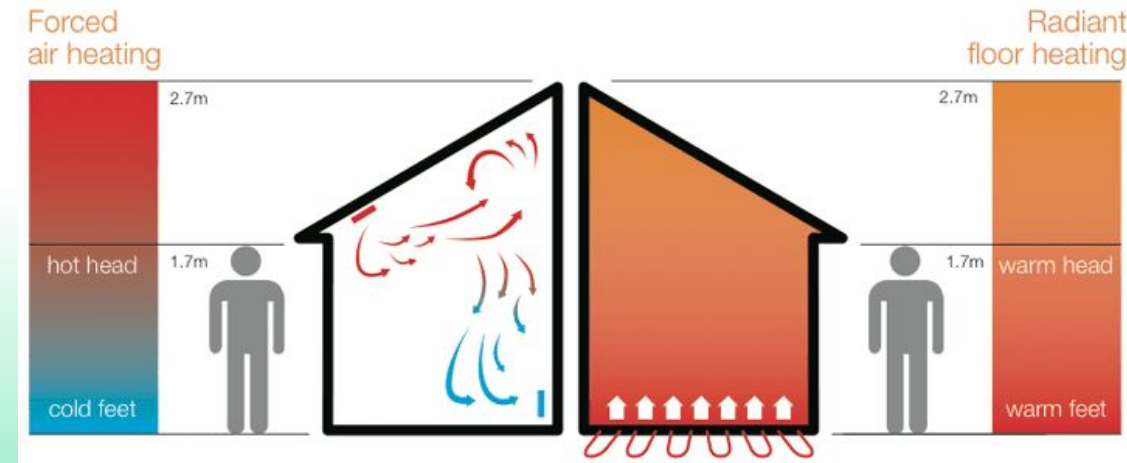
Smart design and controls enhance efficiency and lower lifecycle cost

- **Variable-speed compressors and pumps:** modulate output to match part-load operation — saves 20–40% electricity annually
- **Integrated controls:** coordinate compressors, pumps, and valves for temperature and flow optimization
- **Proper loop flow design:** avoid oversizing circulation pumps — the use of variable frequency drives (VFDs) can reduce pumping energy consumption/costs from 10-80%*
- ***Use low-temperature distribution*:** radiant floors or fan coils improve COP (Coefficient of Performance) by allowing lower supply temps

BEST PRACTICES

Low-temperature Distribution

Radiant (in-floor) heating distribution systems allow for lower exiting temperatures to achieve desired ambient (room) temperatures when compared to forced air systems. This is due to the principles of Radiation & Conduction versus Convection; Where radiation & conduction are the direct transfer of heat energy to your body, convection relies on the transfer of heat energy via a transfer medium (air in this case). This means that a radiant heating system (set to 19°C) will feel the same as a forced air system (set to ~22°C). This decrease in temperature demand provides increased system efficiency, as well, may even impact system sizing in larger applications



BEST PRACTICES

4. Construction & Commissioning Practices

Good workmanship is critical to long-term efficiency and reliability

- **Loop pressure testing & flushing:** ensures clean, air-free circuits with proper antifreeze concentration
- **Thermal grouting quality control:** consistent mixing and placement
- **System commissioning:** verify flow rates, entering/exiting water temps, and controls operation — many systems underperform from lack of commissioning

RISK MITIGATION

A. Design & Engineering

- Perform a Thermal Conductivity Test before final bore field design
- Engineer-sealed design (CSA C448 or IGSHPA standard)
- Model thermal balance (heating vs. cooling over 10+ years)
- Select proven equipment with accessible service network

B. Construction & Quality Assurance

- Use qualified, CGC/IGSHPA-accredited contractors
- Pressure-test & document each loop pre- and post-grout
- Thermal grout verification: monitor mix consistency and volume
- As-built documentation: loop maps, bore depths, and serials for serviceability

RISK MITIGATION

C. Operation & Monitoring

- Include flow, temp, and pressure sensors for monitoring
- Commission and log baseline system data at handover
- Plan annual performance review (energy use vs. expected COP)
- Maintain antifreeze quality and pump calibration

D. Financial & Regulatory

- Conduct sensitivity analysis on electricity vs. gas pricing
- Confirm AER & municipal permitting early to avoid project delays
- Use a performance guarantee or commissioning validation clause in contracts

COMMON MISCONCEPTIONS

DISTILLING MYTHS FROM FACTS

- **“Only for big projects.”** - Geo-exchange is highly scalable. It can serve a single-family home, a farm, a school, a condo complex, or a community-wide district energy system
- **“Geo Exchange won’t work in cold climates.”** - This is a major misconception. The ground temperature at drilling depths is stable year-round (around 5–10°C in Canada). Systems are proven effective in cold climates like Alaska, northern Canada, and Scandinavia

DISTILLING MYTHS FROM FACTS

- **“Drilling/digging will ruin my yard.”** - After installation, the ground is fully restored. Vertical boreholes require only small access points, and horizontal loops are buried and invisible. Landscaping is reinstated
- **“Maintenance is complicated.”** - GSHP are no harder to maintain than ASHP or air conditioners. The ground loop requires zero maintenance. Pumps used in the system are common HVAC components. There are several companies in Alberta with professionally trained heat pump technicians that can maintain these systems.



CASE STUDIES

CASE STUDIES

Project Overview

Calgary Airport International Terminal Expansion

Solutions

This project represents the largest geo-exchange (GSHP) project in Canada to date. It utilizes 650 vertical boreholes drilled to a depth of 450 feet consisting of over 185 kilometers of pipe. The system provides heating and cooling to over 1,000,000 sqft of the new terminal, including a hotel

Results

Through incorporating geo-exchange into their sustainable design, the project was able to successfully balance the need to create additional space, reduce energy consumption and minimize environmental impacts



CASE STUDIES

Project Overview

WestJet Calgary Campus

Solutions

A vertical borehole GSHP system was designed to meet the buildings heating and cooling requirements. The implementation of GSHP technology was instrumental in helping it achieve a LEED Gold Certification

Results

WestJet was able to benefit from the implementation of geo-exchange – both on its bottom line & its carbon footprint

- 35% energy consumption reduction
- Reduced carbon emissions by 1,250 tonnes of CO₂ per year



CASE STUDIES

Project Overview

Copper Ridge Bigway Foods, a community grocery store in Whitehorse, Yukon

Solutions

The team designed an innovative system that is made up of seven heat pumps, a secondary loop that collects the heat rejected from the compressors on the refrigeration units and freezers, a boiler and an air handler

- The rejected heat from the refrigeration and coolers is then used to warm the building and provide hot water
- The small boiler is used to provide back up heat for those very cold days in the height of winter

“This system has really impressed us. This store operates around 70% less than our other stores”

-Sam Jurowich, Owner of Copper Ridge Food Store

Results

The building achieved a rating from Natural Resources Canada's Commercial Building Incentive Program of 31.5% higher than the Model National Energy Code for Buildings, which itself is 25% higher than the standard building code



CASE STUDIES

Project Overview

Machine Shop, Rural Alberta. Project commissioned winter 2023

Solutions

Installed a single 475-foot vertical borehole and a 2-ton water-air GSHP



Results

This customer was faced with a scenario in which the cost of running a new natural gas line to the building outweighed the costs of drilling a borehole. The customer now benefits from the low operational costs and extended life cycle of a GSHP

CASE STUDIES

Project Overview

Keith GMC Dealership in Okotoks, Alberta

Solutions

The team installed a vertical borehole GSHP with the aim of reducing the buildings operating costs as well as their carbon footprint

Results

Ownership have indicated the GSHP system has lowered their energy consumption by 30-50% in heating and by 25-30% in cooling



CASE STUDIES



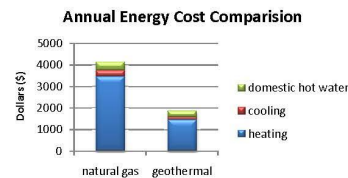
999, 8th Street S.W., Suite 400
Calgary, AB Canada T2R 1J5
Tel: (403) 244-0111 Fax: (403) 244-6866
www.cleanenergydevelopments.com

2150 Dunwin Drive, Unit 4,
Toronto, ON Canada L5L 5V8
Tel: (905) 603-4340 Fax: (666) 361-1714
www.cleanenergydevelopments.com

Case Study: Greenboro Homes Lottery Show Home Location: Calgary, Alberta

Approximate Design Data*:
Heating Load: 107,932 btu
Cooling Load: 113,020 btu

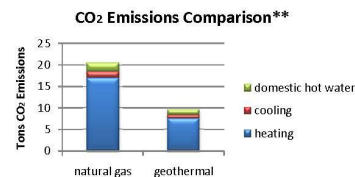
Assumptions:
Electrical Rate: \$0.085/kWh
Natural Gas Rate: \$1.20/CFF



Conventional System:
Fossil Furnace and External Condensing Unit
Annual Operating Cost:
Heating: \$ 3,448
Cooling: \$ 280
Water Heating: \$ 398
TOTAL ANNUAL ENERGY COST: \$4,126

Geothermal System:
Water Furnace Envision Reversible Ground Source Heat Pump (two units ND060 & ND042)
Ground Loop – 2348 ft (9 holes at 261ft each)
Annual Operating Cost:
Heating: \$ 1,463
Cooling: \$ 120
Water Heating: \$ 291
TOTAL ANNUAL ENERGY COST: \$1,874

*The calculations above are based on known assumptions and are said to be used to provide design direction. Proper confirmation and load calculations should be done by a mechanical engineer.



**The amount of CO₂ produced by an electric heating system or electrically powered earth energy system is dependent on how the electricity is produced. Utilities that generate electricity by burning fossil fuels produce greater amounts of CO₂ than utilities that use hydro-electric or nuclear power. This chart uses data produced by Environment Canada and the U.S. Environmental Protection Agency and reflects the average amount of CO₂ produced per kWh in the specific province selected.



Clean
Energy
Developments

999, 8th Street S.W., Suite 406
Calgary, AB Canada T2R 1J5
Tel: (403) 244-0111 Fax: (403) 244-2623

243 Queen Street West, 3rd Floor,
Toronto, ON Canada M5V 1Z4
Tel: (416) 777-2817 Fax: (416) 760-7172
www.cleanenergydevelopments.com

Case Study : Provost Seniors Townhouse 8 unit Complex Location : Provost, AB

Design Data-
Estimated Heating Load 204,000 btu/hr
Estimated Cooling Load 114,400 btu/hr

Assumptions-
Electrical Rate \$0.10 / kwh
Natural Gas Rate \$0.95 / ccf (\$9/GJ)
Electrical Energy Emissions 0.93 kg CO₂e / kWh
Natural Gas Emissions 1.891 kg / m³
Data provided by Climate Change Central
Data provided by Climate Change Central

Conventional Fossil Furnace with external condensing unit
Estimated Annual Operating Cost \$9,190 Space heating, cooling & DHW
Estimated Equipment & Install Cost \$85,000 Heat/Cool Equipment & Install

Geothermal Geothermal, 2 - 3 ton heat pumps for exterior dwellings (1 ea unit)
6 – 2ton heat pumps for interior dwellings (1 ea unit)
Estimated Bore hole 3960 ft
Estimated Aux Heat 16.0 kw
Estimated Annual Operating Cost \$5,750 Space heating, cooling & DHW
Estimated Equipment & Install Cost \$130,000 Equipment, Install & Drilling

Net Results
Estimated Annual Saved \$3,440
Estimated Simple Payback 13.1 yrs
Estimated Saved GHG 26.4 tonnes CO₂e / yr

Note: The calculations above are based on known assumptions and are to be used to provide design direction. Proper confirmation and load calculations should be done by a mechanical engineer.

CASE STUDIES



999, 8th Street S.W., Suite 406
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Case Study : Ronmor Business Centre IV (34,000 sq. ft.) Location : Calgary, Alberta			
Design Data			
Heating Load	668,000	btu/hr	
Cooling Load	140,000	btu/hr	
Summer (db/wb)	86	F	
Winter	-28	F	
Assumptions-			
Electrical Rate	\$0.10	/kwh	
Natural Gas Rate	\$0.93	/ccf	
Electrical Energy Emissions	0.93	kg CO ₂ e / kWh	(Data provided by Climate Change Central)
Natural Gas Emissions	1.891	kg / m ³	(Data provided by Climate Change Central)
Design #1			
Fossil Furnace (Gas Fired RTU's)			
Annual Operating Cost	\$19,370	Space heating, cooling & domestic hot water (DHW)	
CO ₂ e / yr	123.1	tonnes	
Design #2			
Geothermal heat pump integrated with Twelve (12) Enerworks Solar Panels			
Bore hole	9,600	Ft	
Annual Operating Cost	\$6,626	Space heating, cooling & domestic hot water (DHW)	
CO ₂ e / yr	60.9	tonnes	
Average Heat Pump COP	5.45		
Annual Savings			
Operational Cost Savings	\$12,744	per year	
Carbon Dioxide Emissions Saved	62.2	tonnes	

Note: The calculations above are based on known assumptions and are to be used to provide design direction. Proper confirmation and load calculations should be done by a mechanical engineer.



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Tel: (403) 244-0111 Fax: (403) 244-2623

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Case Study : Domaine Fontainebleau Apartment Condominium Location : Beaumont, Alberta			
Design Data-			
Heating Load	1,800,000	btu/hr	
Cooling Load	1,260,000	btu/hr	
Summer (db/wb)	82	F	
Winter	-26	F	
Assumptions-			
Electrical Rate	\$0.10	/kwh	
Natural Gas Rate	\$0.95	/ccf	
Electrical Energy Emissions	0.93	kg CO ₂ e / kWh	Data provided by Climate Change Central
Natural Gas Emissions	1.891	kg / m ³	Data provided by Climate Change Central
Design #1			
Fossil Furnace			
Annual Operating Cost	\$91,888	Space heating, cooling & DHW	
CO ₂ e / yr	587.1	tonnes	
Design #2			
Geothermal heat pump with NO Solar Panels			
Bore hole	23,725	Ft	
Annual Operating Cost	\$46,984	Space heating, cooling & DHW	
CO ₂ e / yr	436.7	tonnes	
Average Heat Pump COP	3.28		
Design #3			
Geothermal heat pump integrated with Ten (10) Enerworks Solar Panels			
Bore hole	23,725	Ft	
Annual Operating Cost	\$32,370	Space heating, cooling & DHW	
CO ₂ e / yr	300.8	tonnes	
Average Heat Pump COP	4.84		
Design #4			
Geothermal heat pump integrated with Ten (10) Enerworks Solar Panels (less 3725 ft bore hole)			
Bore hole	20,000	Ft	
Annual Operating Cost	\$33,422	Space heating, cooling & DHW	
CO ₂ e / yr	310.6	tonnes	
Average Heat Pump COP	4.68		

Note: The calculations above are based on known assumptions and are to be used to provide design direction. Proper confirmation and load calculations should be done by a mechanical engineer.

CASE STUDIES



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Tel: (403) 244-0111
Fax: (403) 244-2623

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www.cleanenergydevelopments.com

Case Study : Towne Centre Place Location : Lacombe, Alberta			
Design Data-			
Heating Load	735,900	btu/hr	
Cooling Load	551,925	btu/hr	
Summer (db/wb)	84	F	
Winter	-26	F	
Assumptions-			
Electrical Rate	\$0.085	/ kwh	
Natural Gas Rate	\$0.93	/ ccf	
Electrical Energy Emissions	0.93	kWh	Data provided by Climate Change Central
Natural Gas Emissions	1.891	kg / m3	Data provided by Climate Change Central
Design #1	Fossil Furnace		
Annual Operating Cost	\$26,869	Space heating, cooling	
CO2 e / yr	184.3	tonnes	
Design #2	Geothermal heat pump with NO Solar Panels		
Bore hole	15870	Ft	
Annual Operating Cost	\$10,950	Space heating, cooling	
CO2 e / yr	118.4	Tones	
Average Heat Pump COP	3.55		
Design #3	Geothermal heat pump integrated with Ten (20) Enerworks Solar Panels		
Bore hole	12,695	Ft	
Annual Operating Cost	\$7,086	Space heating, cooling	
CO2 e / yr	76.8	tonnes	
Average Heat Pump COP	5.62		

Note: The calculations above are based on known assumptions and are to be used to provide design direction. Proper confirmation and load calculations should be done by a mechanical engineer.



999, 8th Street S.W., Suite 406
Calgary, AB Canada T2R 1J5
Tel: (403) 244-0111 Fax: (403) 244-2623

243 Queen Street West, 3rd Floor,
Toronto, ON Canada M5V 1Z4
Tel: (416) 777-2817 Fax: (416) 760-7172
www.cleanenergydevelopments.com

Case Study : Hotel & Spa (110,000 sq.ft.) 70 units Location : British Columbia			
Design Data-			
Heating Load	3,075,186	btu/hr	Includes: Space & Pool Heating, Domestic Hot Water
Cooling Load	1,845,014	btu/hr	
Summer	90	F	
Winter	-16	F	
Assumptions-			
Electrical Rate	\$0.079	/ kwh	
Natural Gas Rate	\$0.95	/ ccf	
Electrical Energy Emissions	0.032	kg CO2e / kWh	Data provided by Climate Change Central
Natural Gas Emissions	1.891	kg / m3	Data provided by Climate Change Central
Design #1	Fossil Furnace		
Annual Operating Cost	\$144,722		
CO2 e / yr	526.8	tonnes	
Design #2	Geothermal heat pump with NO Solar Panels		
Bore hole	47,160	Ft	
Annual Operating Cost	\$41,464		
CO2 e / yr	16.8	tonnes	
Average Heat Pump COP	3.77		
Min'm Ground Loop Temp.	31	F	
Design #3	Geothermal heat pump integrated with Twelve (12) Enerworks Solar Panels		
Bore hole	44,000	Ft	
Annual Operating Cost	\$29,755		
CO2 e / yr	12.05	tonnes	
Average Heat Pump COP	5.67		
Min'm Ground Loop Temp.	30	F	

Note: The calculations above are based on known assumptions and are to be used to provide design direction. Proper confirmation and load calculations should be done by a mechanical engineer.

CASE STUDIES



999, 8th Street S.W., Suite 406
Calgary, AB Canada T2R 1J5
Tel: (403) 244-0111 Fax: (403) 244-2623

2150 Dunwin Drive, Unit 4
Mississauga, ON Canada L5L 5M8
Tel: (905) 603-4340 Fax: (866) 381-1714
www.cleanenergydevelopments.com

Project : George residence
Location : Calgary, AB

Design Data-			
Estimated Heating Load	90,000	btu/hr	
Estimated Cooling Load	48,400	btu/hr	
Assumptions-			
Electrical Rate	\$0.10	/ kWh	
Natural Gas Rate	\$0.95	/ ccf (\$9/GJ)	
Electrical Energy Emissions	0.93	kg CO ₂ e / kWh	Data provided by Climate Change Central
Natural Gas Emissions	1.891	kg / m ³	Data provided by Climate Change Central
Conventional			
Fossil Furnace with external condensing unit			
Estimated Annual Operating Cost	\$3,225	Space heating, cooling & DHW	
Estimated Equipment & Install Cost	\$30,000	Heat/Cool Equipment & Install	(not including plumbing, infloor piping, ductwork)
Geothermal			
Geothermal, 1 – 3.5 ton hydronic heat pump for basement & domestic hw, 1 – 5ton forced air heat pump for main & upper floors			
Estimated Bore hole	1800	ft	
Estimated Aux Heat	5.0	kw	
Estimated Annual Operating Cost	\$1,775	Space heating, cooling & DHW	
Estimated Equipment & Install Cost	\$49,800	Equipment, Install & Drilling	(not including plumbing, infloor piping, ductwork)
Net Results			
Estimated Annual Saved	\$1,450		
Estimated Simple Payback	13.6 yrs		
Estimated Saved GHG	6.4	tonnes CO ₂ e / yr	

Note: The calculations above are based on known assumptions and are to be used to provide design direction. Proper confirmation and load calculations should be done by a mechanical engineer.



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Project : Hanus residence
Location : Hinton, AB

Design Data-			
Estimated Heating Load	32,900	btu/hr	
Estimated Cooling Load	25,400	btu/hr	
Assumptions-			
Electrical Rate	\$0.11	/ kWh	
Natural Gas Rate	\$1.15	/ ccf (\$9/GJ)	
Electrical Energy Emissions	0.93	kg CO ₂ e / kWh	Data provided by Climate Change Central
Natural Gas Emissions	1.891	kg / m ³	Data provided by Climate Change Central
Conventional			
Fossil Furnace with external condensing unit			
Estimated Annual Operating Cost	\$1,825	Space heating, cooling & DHW	
Estimated Equipment & Install Cost	\$16,500	Heat/Cool Equipment & Install	(not including plumbing, infloor piping, ductwork)
Geothermal			
Geothermal, 1 – 3.5 ton forced air heat pump for entire cabin & domestic hw assist			
Estimated Bore hole	690	ft	
Estimated Aux Heat	3.0	kw	
Estimated Annual Operating Cost	\$1,085	Space heating, cooling & DHW	
Estimated Equipment & Install Cost	\$23,800	Equipment, Install & Drilling	(not including plumbing, infloor piping, ductwork)
Net Results			
Estimated Annual Saved	\$740		
Estimated Simple Payback	9.86 yrs		
Estimated Saved GHG	4.7	tonnes CO ₂ e / yr	

Note: The calculations above are based on known assumptions and are to be used to provide design direction. Proper confirmation and load calculations should be done by a mechanical engineer.

Case Study - Hitech Seals



Built in 1996, this facility has been renovated with solar PV, insulated warehouse, and geothermal providing heat and hot water.

A complete case study and analysis of the financial case is being prepared by ALberta Ecotrust Retrofit Accelerator.

Case study - City of Edmonton - Geothermal Approach to Net-Zero

GEOTHERMAL APPROACH TO NET ZERO

Revolve Engineering Inc. was engaged to perform an analysis of the potential of utilizing geothermal (GeoExchange) technology in reducing GHG emissions in Edmonton. In particular, this analysis compared using GeoExchange technology to a more passive approach (with Air Source Heat Pump (ASHP)) to achieve Net Zero energy in a home. The two approaches were compared in terms of energy use, capital and operating costs, complexity, and installation time.

Technical Assumptions

For the analysis a typical detached home built in the last 10 years was modelled using the IES Virtual Environment energy modelling software. A visual representation of the modelled home can be seen in Figure 1. Since home construction has not changed significantly in the last 20 years, this home was chosen as a representation of homes built in the last 10-15 years. To capture newer homes, the analysis assumed that the main furnace has been replaced or upgraded to a modern 95% efficient furnace.

This analysis compared using GeoExchange technology to a more passive approach with an Air Source Heat Pump to achieve Net Zero energy in a home

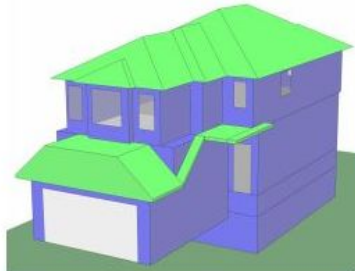


Figure 1: Image of the home modelled in the IES Virtual Environment

City of Edmonton completed a case study

What Can you do next?

- Access the LEEP Guide
- Check out Solar Alberta Resources
- Talk to your teams about adding solar on your next project
- Talk to your customers
- Could solar make your buildings standout?



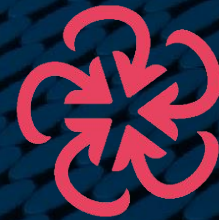
Thank you

j.henke@albertaecotrust.com
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