Feasibility Studies: Approaches & Tools

Scott Thompson/ *Climate Control Group*
&
Tim Ashmore / *CDM Smith*

Feasibility Studies: Approaches & Tools

Scott Thompson/ *Climate Control Group*

Geothermal Feasibility Tools

Presenter:
Scott Thompson
Climate Control Group

NY Geo 2024 Conference

About Your Presenter

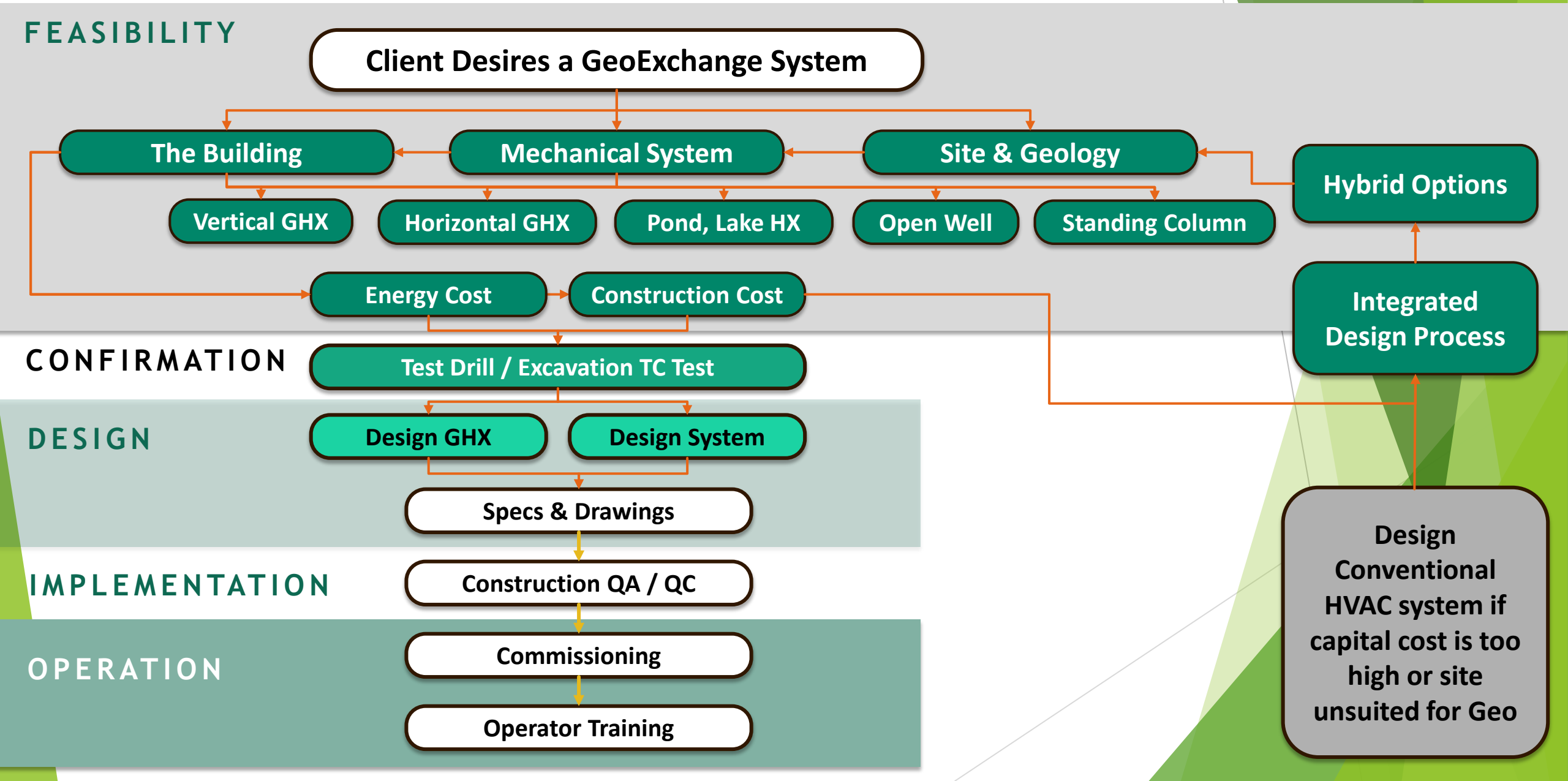
Scott Thompson

Regional Sales Engineer, CCG

- Throughout his career, Scott has remained active in the HVAC and geothermal industries through equipment sales, application and engineering.

- 10+ years of commercial HVAC experience with a focus on renewables and geothermal heat pumps
- Graduate from the University of Oklahoma School of Engineering. Boomer Sooner!
- Current focus is education and utilization of geothermal technologies and tax incentives.

LET'S DISCUSS FEASIBILITY



Feasibility Tools

- **System operating and lifecycle costs**
  - Geo vs alternative systems – **BEST software**
  - Energy efficiency and lifecycle cost
- **Initial Cost**
  - Incentives and tax credits – **Geo Economics Calculator**
  - IRA geo tax incentives
- **Alternative Geo Application**
  - Hybrid geo system – **HyGCHP Tool**
  - Balancing initial and long-term costs

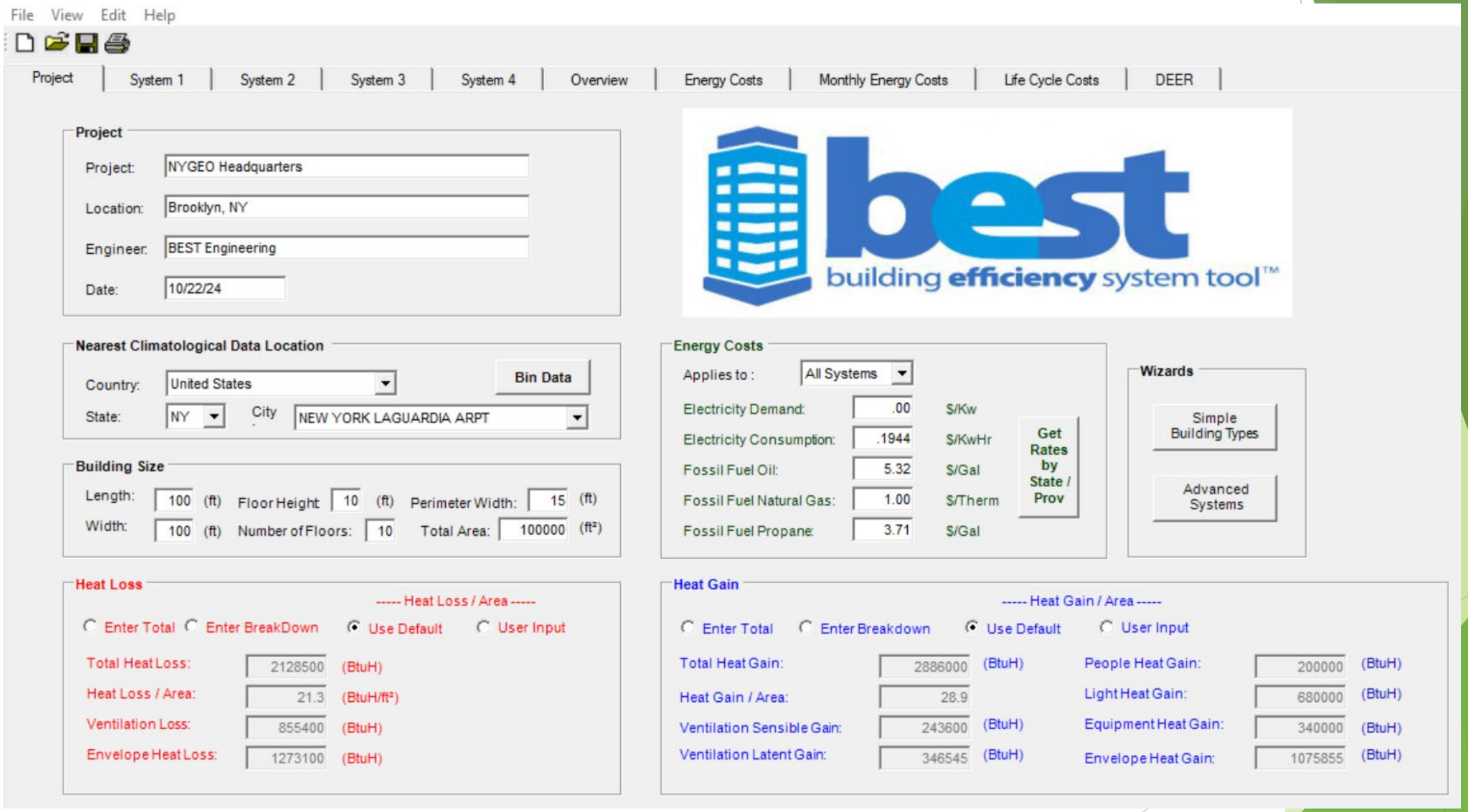
System Comparison

- **BEST – Building Efficiency System Tool**
- Developed by the Hydronic Industry Alliance
- Interactive commercial building HVAC system efficiency comparison application

Download Here!

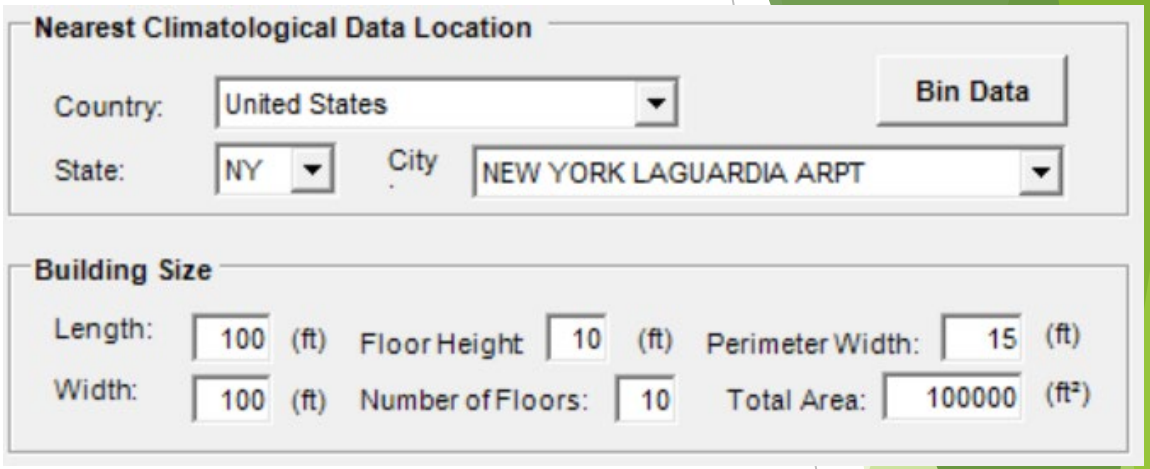
*https://www.tacocomfort.com/software/best-building-efficiency-systems-tool/

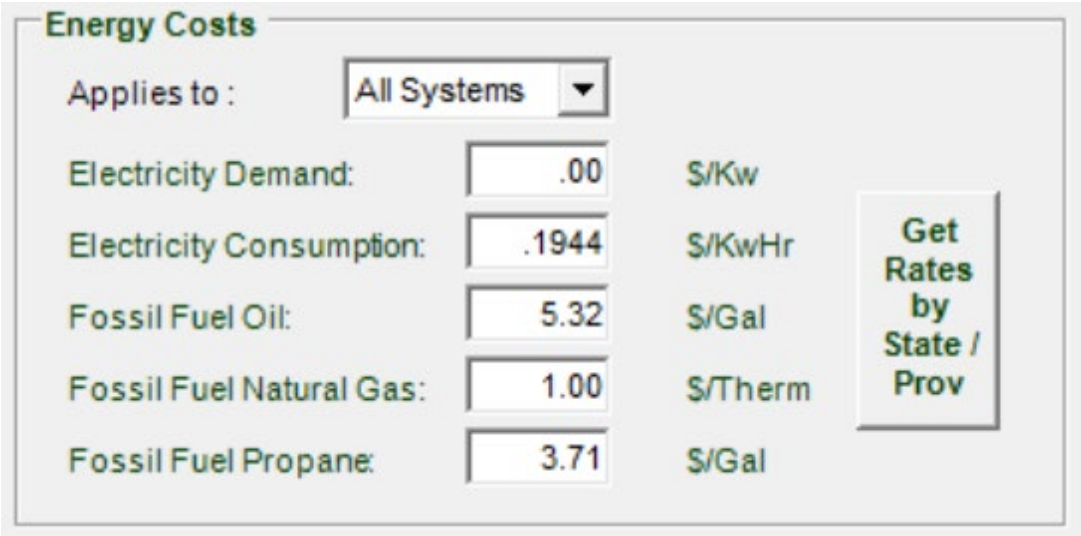
System Comparison - BEST



System Comparison - BEST

- Preloaded with ARI data for all 50 states
- Customizable Building Design

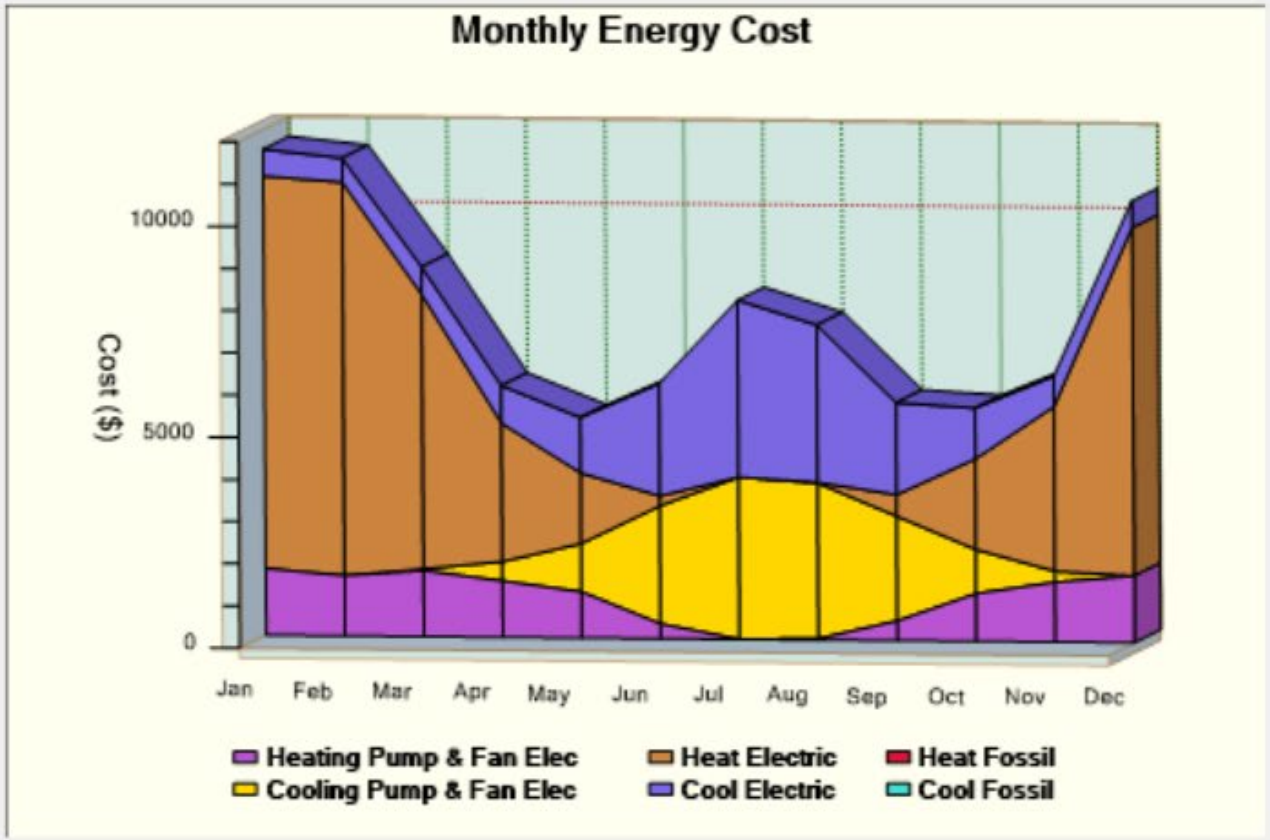




- Regularly updated energy costs for each state
- Reliable financial estimates

System Comparison - BEST

System Description: WSHP Closed Loop Geothermal



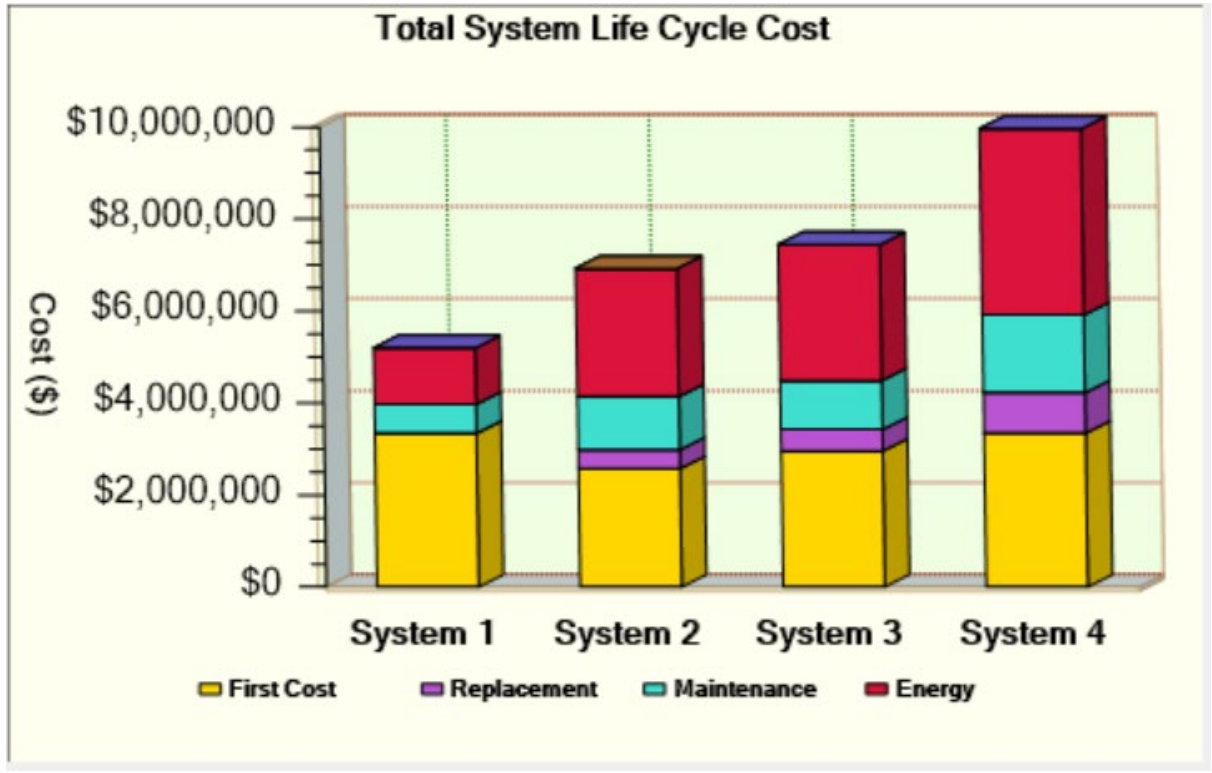
Total Annual Energy Cost

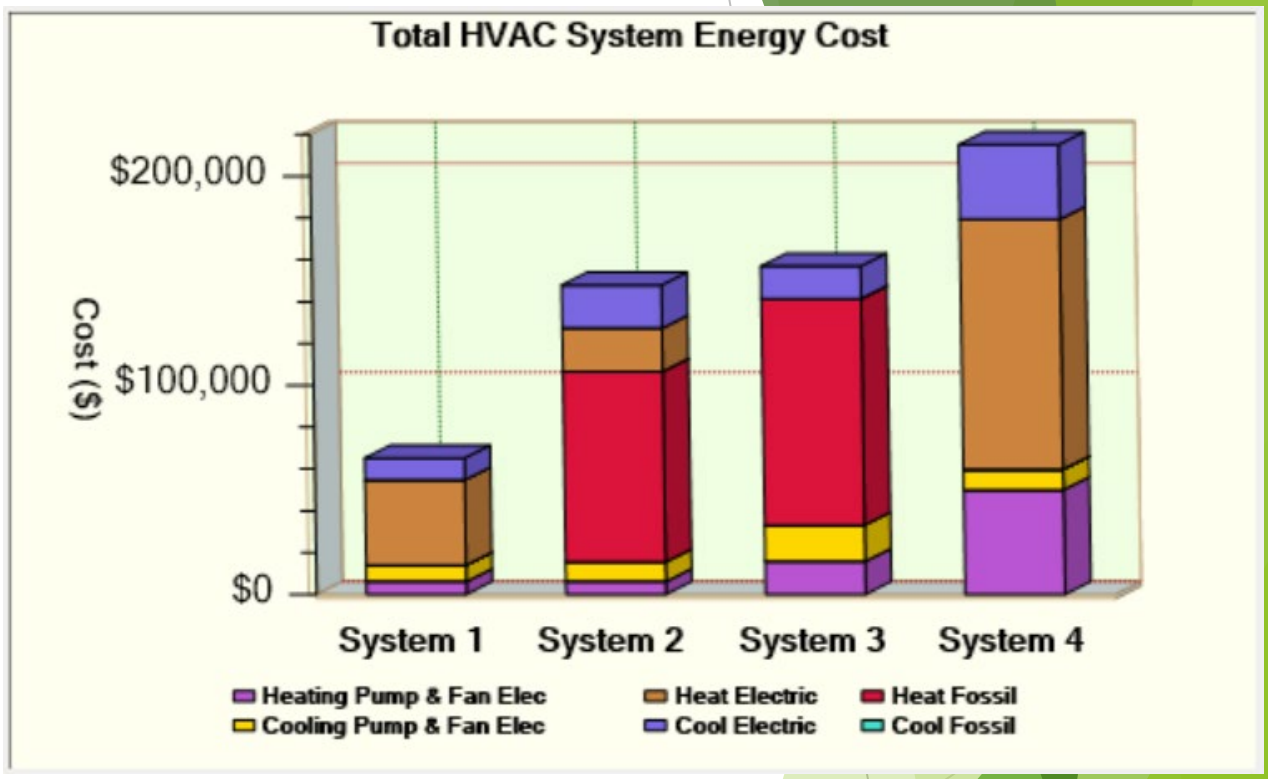
	HVAC	Domestic Hot Water	
Electrical Consumption:	474924	0	KwHr
Electrical Consumption Cost	92325	0	$
Electrical Demand Cost	0	0	$
Total Electrical Cost	92325	0	$
Fossil Fuel Consumption:	0	0	MMBtu
Fossil Fuel Cost	0	0	$
Total Energy Cost	92325	0	$

System Performance

	Heating	Cooling
Pump & Fan Distribution HP	11.27	53.18
System BEER	49.79	

System Comparison - BEST





System Description

System 1: WSHP Closed Loop Geothermal

System 2: WSHP Boiler/Tower

System 3: VAV, Hot Water Heating, Chilled Water Cooling, Air Cooled Chiller, 4 Pipe

System 4: VRF, Air To Air

System Comparison – BEST

Cooling

	Pump & Fan ($)	Other Elec ($)	Fossil Oil ($)	Fossil Nat Gas ($)	Fossil Propane ($)	Total ($)
Jan	0	404	0	0	0	404
Feb	0	365	0	0	0	365
Mar	13	409	0	0	0	422
Apr	415	696	0	0	0	1110
May	715	884	0	0	0	1599
Jun	1496	1541	0	0	0	3037
Jul	2122	2153	0	0	0	4276
Aug	1809	1678	0	0	0	3487
Sep	1089	1054	0	0	0	2143
Oct	154	484	0	0	0	638
Nov	47	411	0	0	0	459
Dec	0	404	0	0	0	404
Total	7860	10485	0	0	0	18345

Total Annual HVAC Energy Cost

	System 1	System 2	System 3	System 4	
Electrical Consumption:	527,044	459,002	392,956	1,739,309	KwHr
Electrical Consumption Cost	65,195	56,779	48,609	215,152	$
Electrical Demand Cost	0	0	0	0	$
Total Electrical Cost	65,195	56,779	48,609	215,152	$
Fuel Consumption Oil:	0	0	0	0	Therm
Fuel Consumption Natural Gas:	0	54,196	64,427	0	Gal
Fuel Consumption Propane:	0	0	0	0	Gal
Fossil Fuel Cost	0	91,212	108,430	0	$
Total Cost:	65,195	147,991	157,039	215,152	$
Savings for System 1:		82,796	91,844	149,957	$

Key Takeaways

- **Powerful tool, but easy to use**
  - "Wizard" style easy selection or fully customizable
  - Preloaded data for over 30 different systems
- **The price is right!**
  - No upfront cost or licensing fees
  - Big thanks to the Hydronic Industry Alliance
- **Full system comparison reports**
  - Energy cost and consumption data
  - Compare total system lifecycle costs
  - Geo is the clear winner

Initial Cost

- **Geo Economics Calculator**
- Developed by ClimateMaster and Comfortworks
- Compare the upfront economics of Geothermal vs traditional HVAC systems
- Take advantage of all the geo incentives available!

Download Here!

https://www.climatemaster.com/commercial/tax-credit

Federal GEO Incentives

CLIMATEMASTER
A NIBE GROUP MEMBER

IRA 2023
COMMERCIAL GEOTHERMAL
Tax Guide 2023

- Geothermal is now on renewable energy credits equal to wind and solar
- This is not product or brand specific
- 10 Year 30% Credit through 2032
- 10% Domestic Content
- Direct IRS Pay for NFP & Govt Bldgs
- 179D increases from $1.80 to $5.00/sqft

GEO ECONOMICS TOOL - IRA

How it Works

ClimateMaster Geothermal HVAC Economics - using Special Depreciation Allowance

Updated 9-20-23 based on current data
This is an estimating tool only. Click Here for Disclaimer, Terms & Conditions

Project Name: **Example Office Building**

Conditioned Area (sq ft): **50,000** | Vertical Market: **Office** | State: **Oklahoma**
sq ft per ton: **400** — *Tip: 400 sq ft per ton is a typical rule of thumb for commercial buildings. Variables that effect this include glass area and type, insulation values, lighting and plug load, etc.*
Calculated HVAC Tons: 125 | Brief Description: **i.e. 3 Story Structure** | Business Type: Pass-through Entities

Geothermal Costs			vs.	Conventional Costs		
Geothermal HVAC Cost	$32.00	per sq ft		Conventional HVAC Cost	$22.00	per sq ft
	$12,800	per ton			$8,800	per ton
	$ 1,600,000	Total Geothermal HVAC Cost			$ 1,100,000	Total Conventional HVAC Cost
Describe your Geothermal System	i.e. 30 EER geothermal heat pumps			*Describe your Conventional HVAC System:*	i.e. Rooftop single-duct VAV with electric terminal reheat	

Additional Cost: $ 500,000
Utility Rebate* $ (25,000)
Net Additional Cost: $ 475,000

$200 per ton estimate of utility geo rebate — *Tip: Varies based on region and incentives. Consult your local energy program specialist for insight.*

Other Installation Costs**: **$ 125,000** portion of electrical, plumbing and GC fees related to HVAC system (for either system) — *Tip: Rely on your experience / cost quotes to estimate this number*

Income Tax Rate: **34%** | Corporate / Federal: **29.60%** | State: **4.00%** — *Based on business type and state table in Input Data Tab*
Energy Credit: **30%** | Domestic Content Credit: **10%** | Energy Community Credit: **10%** — *Tip: Choose applicable credit rate % under IRA Guidelines*
Energy Inflation: **5%** — *Tip: This number typically follows economic inflation trends. Generally between 2% to 5%*
Savings per sq ft: **$0.75** in energy and maintenance — *Tip: Lean on the experience of your trusted HVAC professional to estimate this savings vs. alternative systems*
Annual Cost Savings: $ 37,500 calculated
Project Completion Year: **2023** | Project Completion Quarter: **3**

YEAR	GEO DEPREC ALLOWANCE Special	GEO DEPREC ALLOWANCE 5 Yr MACRS	GEO DEPREC DEDUCTION Special	GEO DEPREC DEDUCTION 5 Yr MACRS	GEO TAX SAVINGS*** Tax Credits	GEO TAX SAVINGS*** Depreciation	GEO CASH FLOW Addtl Cost	GEO CASH FLOW Tax Savings	GEO CASH FLOW O&M Savings	GEO CASH FLOW Total	CONV CASH FLOW Depr Ded	CONV CASH FLOW Tax Savings	GEO NET CASH FLOW Annual	GEO NET CASH FLOW Cumulative
2023	80%	15.00%	$ 1,020,000	$ 38,250	$ 850,000	$ 355,572	$ (475,000)	$ 1,205,572	$ 9,375	$ 739,947	$ 31,410	$ 10,554	$ 729,393	$ 729,393
2024		34.00%		$ 86,700		$ 29,131		$ 29,131	$ 39,375	$ 68,506	$ 31,410	$ 10,554	$ 57,952	$ 787,346
2025		20.40%		$ 52,020		$ 17,479		$ 17,479	$ 41,344	$ 58,822	$ 31,410	$ 10,554	$ 48,269	$ 835,614
2026		12.24%		$ 31,212		$ 10,487		$ 10,487	$ 43,411	$ 53,898	$ 31,410	$ 10,554	$ 43,344	$ 878,958
2027		11.30%		$ 28,815		$ 9,682		$ 9,682	$ 45,581	$ 55,263	$ 31,410	$ 10,554	$ 44,709	$ 923,668
2028		7.06%		$ 18,003		$ 6,049		$ 6,049	$ 47,861	$ 53,910	$ 31,410	$ 10,554	$ 43,356	$ 967,024
2029									$ 50,254	$ 50,254	$ 31,410	$ 10,554	$ 39,700	$ 1,006,723
2030									$ 52,766	$ 52,766	$ 31,410	$ 10,554	$ 42,212	$ 1,048,936
2031									$ 55,405	$ 55,405	$ 31,410	$ 10,554	$ 44,851	$ 1,093,787
2032									$ 58,175	$ 58,175	$ 31,410	$ 10,554	$ 47,621	$ 1,141,408
2033									$ 61,084	$ 61,084	$ 31,410	$ 10,554	$ 50,530	$ 1,191,937

Geothermal HVAC systems are classified as "Energy Property" which are eligible for 5 yr MACR depreciation and a special depreciation allowance
Conventional HVAC systems are generally only eligible for 39 yr (27.5 yr residential) straightline depreciation under tax code with no special depreciation allowance
Analysis assumes a mid-quarter depreciation convention based on the substantial completion quarter
Tax credits may be carried back up to 3 years for credits arising in tax years beginning after 12/31/22
Tax credits may be transferred (generally sold at some discount) to an unrelated party beginning in 2023
Energy credit limited to 10% and domestic content and energy community tax credits are not available for projects placed in service before 1/1/23

Simple Payback Years: 0
Internal Rate of Return: infinite

Installation Comparison

Traditional HVAC	$1,700,000
Geothermal	$2,200,000

Geothermal Savings

IRA Tax Credit	$860,000
Savings per Sq Ft	.75

Geo Cumulative Savings

Year 1	$787,346
Year 5	$967,024
Year 10	$1,191,937

PRE- IRA REAL ECONOMICS

Non-Taxable Entity

ClimateMaster Geothermal HVAC Economics - using Special Depreciation Allowance

Updated 3-22-23 based on current data
This is an estimating tool only. Click Here for Disclaimer, Terms & Conditions

CLIMATEMASTER

Project Name:	Catholic Charities				
Conditioned Area (sq ft):	34,000	Vertical Market:	Aerospace	State:	Oklahoma
sq ft per ton:	300	*Tip: 400 sq ft per ton is a typical rule of thumb for commercial buildings. Variables that effect this include glass area and type, insulation values, lighting and plug load, etc.*			
Calculated HVAC Tons:	113	Brief Description:	i.e. 3 Story Structure	Business Type:	Non-Taxable Entities

Geothermal Costs			vs.	Conventional Costs		
Geothermal HVAC Cost	$21.68	per sq ft		Conventional HVAC Cost	$14.96	per sq ft
	$6,523	per ton			$4,501	per ton
	$ 737,120	Total Geothermal HVAC Cost			$ 508,640	Total Conventional HVAC Cost
Describe your Geothermal System	i.e. 30 EER geothermal heat pumps			*Describe your Conventional HVAC System:*	i.e. Rooftop single-duct VAV with electric terminal reheat	

Additional Cost:	$ 228,480				
Utility Rebate*	$ (16,950)				
Net Additional Cost:	$ 211,530	$150	per ton estimate of utility geo rebate	*Tip: Varies based on region and incentives. Consult your local energy program specialist for insight.*	
Other Installation Costs**:	$ 125,000	portion of electrical, plumbing and GC fees related to HVAC system (for either system)		*Tip: Rely on your experience / cost quotes to estimate this number*	
Income Tax Rate:	0%	Corporate / Federal	0.00%	State 0.00%	*Based on business type and state table in Input Data Tab*
Energy Credit:	0%	Domestic Content Credit:	0%	Energy Community Credit: 0%	*Tip: Choose applicable credit rate % under IRA Guidelines*
Energy Inflation:	3%	*Tip: This number typically follows economic inflation trends. Generally between 2% to 5%*			
Savings per sq ft	$1.00	in energy and maintenance		*Tip: Lean on the experience of your trusted HVAC professional to estimate this savings vs. alternative systems*	
Annual Cost Savings	$ 34,000	calculated		Project Completion Year 2023	Project Completion Quarter 3

YEAR	GEO DEPREC ALLOWANCE		GEO DEPREC DEDUCTION		GEO TAX SAVINGS***		GEO CASH FLOW				CONV CASH FLOW		GEO NET CASH FLOW	
	Special	5 Yr MACRS	Special	5 Yr MACRS	Tax Credits	Depreciation	Addtl Cost	Tax Savings	O&M Savings	Total	Depr Ded	Tax Savings	Annual	Cumulative
2023	0%	0.00%	$ -	$ -	$ -	$ -	$ (211,530)	$ -	$ 8,500	$ (203,030)	$ -	$ -	$ (203,030)	$ (203,030)
2024		0.00%		$ -		$ -		$ -	$ 35,020	$ 35,020	$ -	$ -	$ 35,020	$ (168,010)
2025		0.00%		$ -		$ -		$ -	$ 36,071	$ 36,071	$ -	$ -	$ 36,071	$ (131,939)
2026		0.00%		$ -		$ -		$ -	$ 37,153	$ 37,153	$ -	$ -	$ 37,153	$ (94,787)
2027		0.00%		$ -		$ -		$ -	$ 38,267	$ 38,267	$ -	$ -	$ 38,267	$ (56,519)
2028		0.00%		$ -		$ -		$ -	$ 39,415	$ 39,415	$ -	$ -	$ 39,415	$ (17,104)
2029									$ 40,598	$ 40,598	$ -	$ -	$ 40,598	$ 23,494
2030									$ 41,816	$ 41,816	$ -	$ -	$ 41,816	$ 65,309
2031									$ 43,070	$ 43,070	$ -	$ -	$ 43,070	$ 108,380
2032									$ 44,362	$ 44,362	$ -	$ -	$ 44,362	$ 152,742
2033									$ 45,693	$ 45,693	$ -	$ -	$ 45,693	$ 198,435

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Simple Payback Years:	5.4
Internal Rate of Return:	14%

Installation Comparison

Traditional HVAC	$845,170
Geothermal	$1,073,650

Geothermal Savings

IRA Tax Rebate	$0
Savings per Sq Ft	1.00

Geo Cumulative Savings

Year 1	($168,010)
Year 5	($37,04)
Year 10	$198,435

IRA ECONOMICS

Non-Taxable Entity

ClimateMaster Geothermal HVAC Economics - using Special Depreciation Allowance

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CLIMATEMASTER

Project Name: Catholic Charities

Conditioned Area (sq ft): 34,000 | Vertical Market: Aerospace | State: Oklahoma
sq ft per ton: 300 — *Tip: 400 sq ft per ton is a typical rule of thumb for commercial buildings. Variables that effect this include glass area and type, insulation values, lighting and plug load, etc.*
Calculated HVAC Tons: 113 | Brief Description: i.e. 3 Story Structure | Business Type: Non-Taxable Entities

Geothermal Costs			vs.	Conventional Costs		
Geothermal HVAC Cost	$21.68	per sq ft		Conventional HVAC Cost	$14.96	per sq ft
	$6,523	per ton			$4,501	per ton
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Describe your Geothermal System	i.e. 30 EER geothermal heat pumps			*Describe your Conventional HVAC System:*	i.e. Rooftop single-duct VAV with electric terminal reheat	

Additional Cost: $ 228,480
Utility Rebate* $ (16,950)
Net Additional Cost: $ 211,530
$150 per ton estimate of utility geo rebate — *Tip: Varies based on region and incentives. Consult your local energy program specialist for insight.*

Other Installation Costs**: $ 125,000 portion of electrical, plumbing and GC fees related to HVAC system (for either system) — *Tip: Rely on your experience / cost quotes to estimate this number*

Income Tax Rate: 0% | Corporate / Federal 0.00% | State 0.00% — *Based on business type and state table in Input Data Tab*
Energy Credit: 30% | Domestic Content Credit: 10% | Energy Community Credit: 10% — *Tip: Choose applicable credit rate % under IRA Guidelines*
Energy Inflation: 3% — *Tip: This number typically follows economic inflation trends. Generally between 2% to 5%*
Savings per sq ft $1.00 in energy and maintenance — *Tip: Lean on the experience of your trusted HVAC professional to estimate this savings vs. alternative systems*
Annual Cost Savings $ 34,000 calculated
Project Completion Year 2023 | Project Completion Quarter 3

YEAR	GEO DEPREC ALLOWANCE		GEO DEPREC DEDUCTION		GEO TAX SAVINGS***		GEO CASH FLOW				CONV CASH FLOW		GEO NET CASH FLOW	
	Special	5 Yr MACRS	Special	5 Yr MACRS	Tax Credits	Depreciation	Addtl Cost	Tax Savings	O&M Savings	Total	Depr Ded	Tax Savings	Annual	Cumulative
2023	0%	0.00%	$ -	$ -	$ 422,585	$ -	$ (211,530)	$ 422,585	$ 8,500	$ 219,555	$ -	$ -	$ 219,555	$ 219,555
2024		0.00%		$ -		$ -		$ -	$ 35,020	$ 35,020	$ -	$ -	$ 35,020	$ 254,575
2025		0.00%		$ -		$ -		$ -	$ 36,071	$ 36,071	$ -	$ -	$ 36,071	$ 290,646
2026		0.00%		$ -		$ -		$ -	$ 37,153	$ 37,153	$ -	$ -	$ 37,153	$ 327,798
2027		0.00%		$ -		$ -		$ -	$ 38,267	$ 38,267	$ -	$ -	$ 38,267	$ 366,066
2028		0.00%		$ -		$ -		$ -	$ 39,415	$ 39,415	$ -	$ -	$ 39,415	$ 405,481
2029									$ 40,598	$ 40,598	$ -	$ -	$ 40,598	$ 446,079
2030									$ 41,816	$ 41,816	$ -	$ -	$ 41,816	$ 487,894
2031									$ 43,070	$ 43,070	$ -	$ -	$ 43,070	$ 530,965
2032									$ 44,362	$ 44,362	$ -	$ -	$ 44,362	$ 575,327
2033									$ 45,693	$ 45,693	$ -	$ -	$ 45,693	$ 621,020

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Simple Payback Years: 0
Internal Rate of Return: infinite

Installation Comparison

Traditional HVAC	$845,170
Geothermal	$1,073,650

Geothermal Savings

IRA Tax Rebate	$422,585
Savings per Sq Ft	1.00

Geo Cumulative Savings

Year 1	$254,575
Year 5	$366,066
Year 10	$621,020

Key Takeaways

- **Take advantage of the incentives!**
  - Up to 50% **installed** cost of the entire system
  - Non-taxable entities are now eligible
- **Geo is no longer the higher upfront cost**
  - Less expensive than traditionally "low cost" alternatives
- **We're here to help**
  - Contact ClimateMaster directly
  - Contact one of our local manufacturer representatives

Alternative Geo

- **HyGCHP – Hybrid Ground-Coupled Heat Pumps**

- Developed by UW Madison and Energy Center of WI

- Compare upfront and lifecycle costs of Hybrid vs Traditional Geo systems

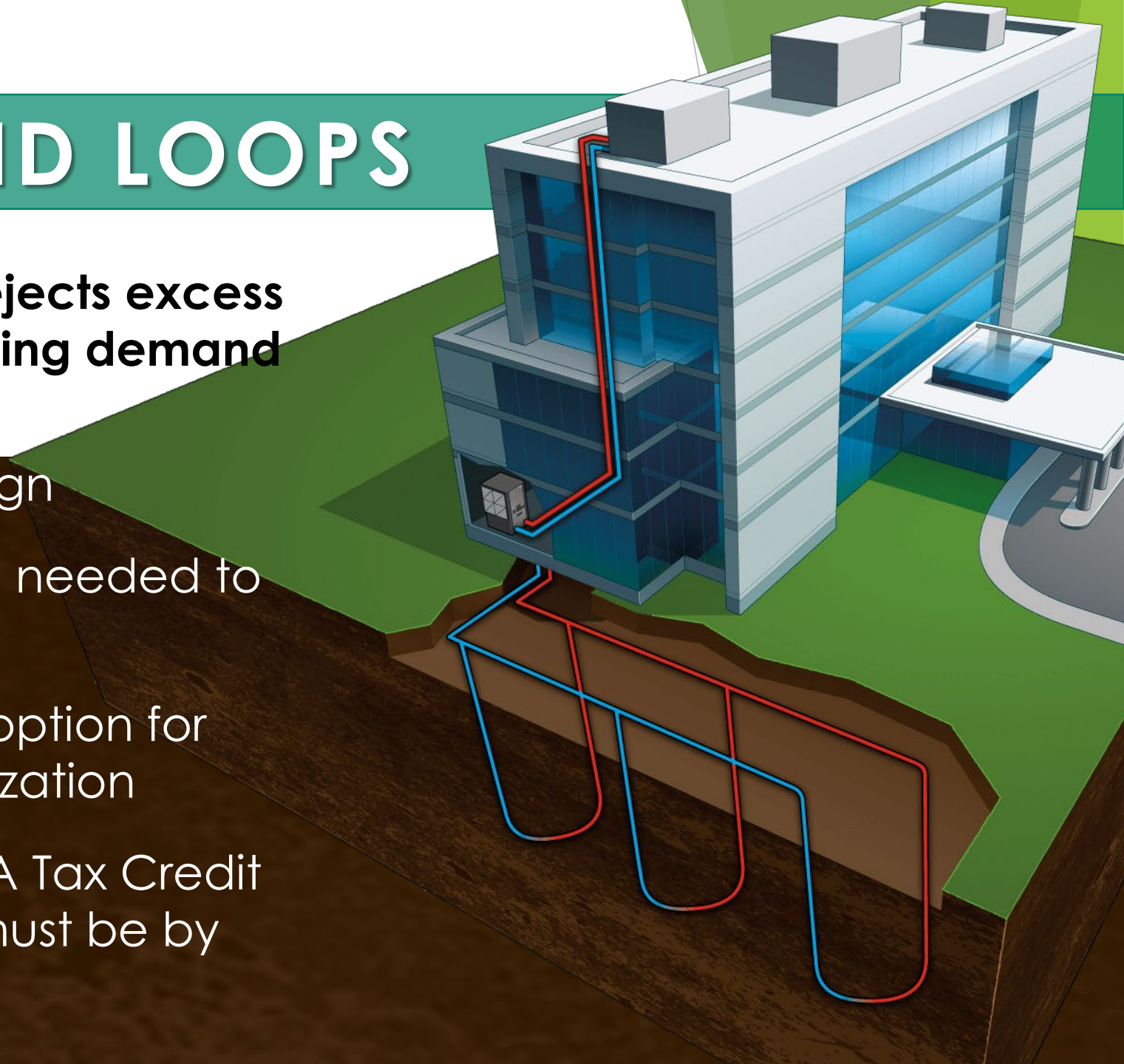
Download Here!

https://slipstreaminc.org/tools/hygchp-modeling-tool

HYBRID GROUND LOOPS

Cooling tower or dry cooler rejects excess system heat during peak cooling demand

- Strategic ground loop design
- Provides heat of extraction needed to handle entire heating load
- Provides heat of rejection option for cooling load design optimization
- Optimal for use with the IRA Tax Credit program. 50% of heating must be by geothermal



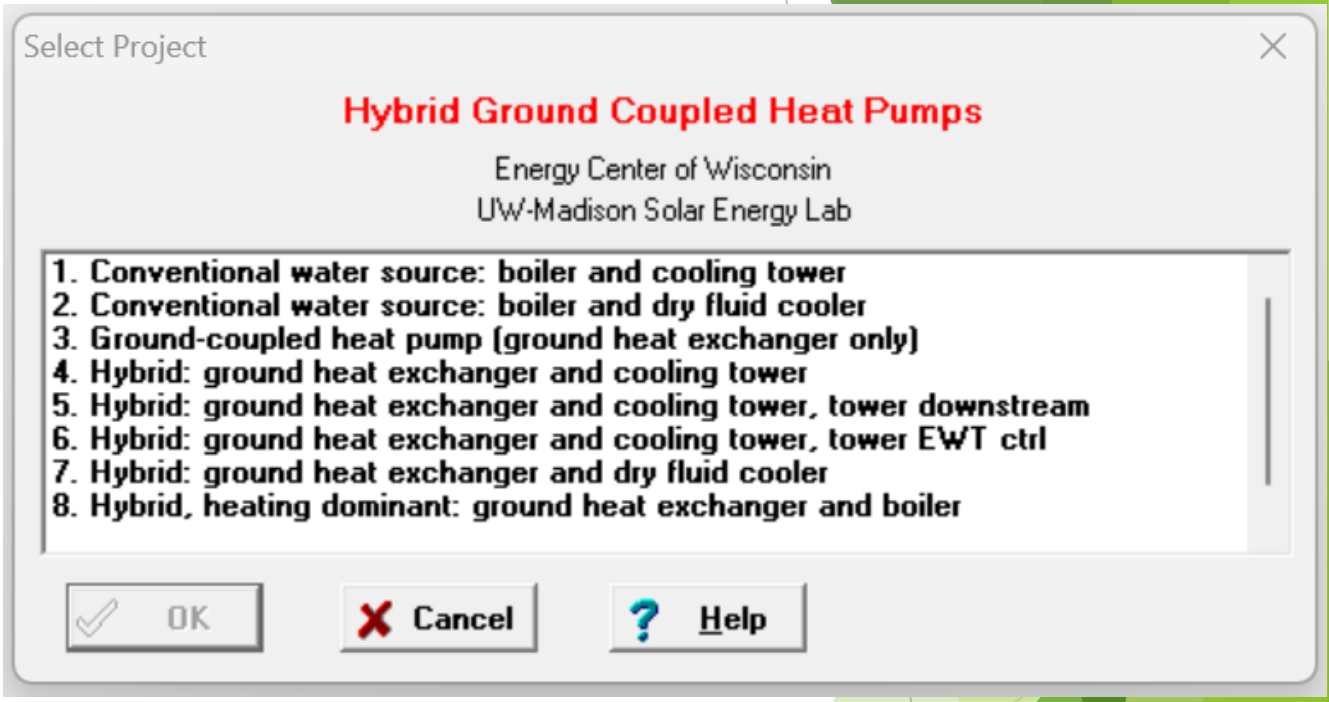
Alternative Geo

Pros:

- Customizable equipment inputs
- Customizable loop inputs
- Simulates 20 year lifecycle costs for comparison

Cons:

- Only has loaded ARI data for three cities
- Only compares with condenser water or traditional geo systems



Specific Case Results

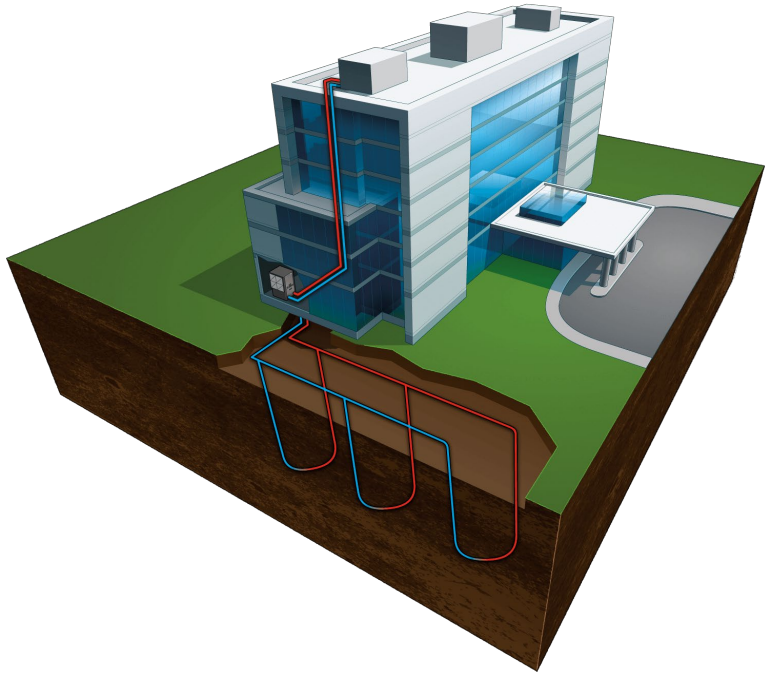
Specific Case Results - Hybrid

See hourly results in ../HyGCHP/Results (Press F1 for other info about results)
Select Primary or Secondary units from the Calculate menu to change results' units.

20-yr. Life Cycle Cost* (real $)	714.79	k$
Equipment Cost (nominal $)		
Total	320.84	k$
GHX cost	258.75	k$
Operating Costs (nominal $)		
Electricity - consumption	423.56	k$
Electricity - demand	51.44	k$
Maintenance cost	12.67	k$
Water cost	22.03	k$
Gas cost	0.00	k$

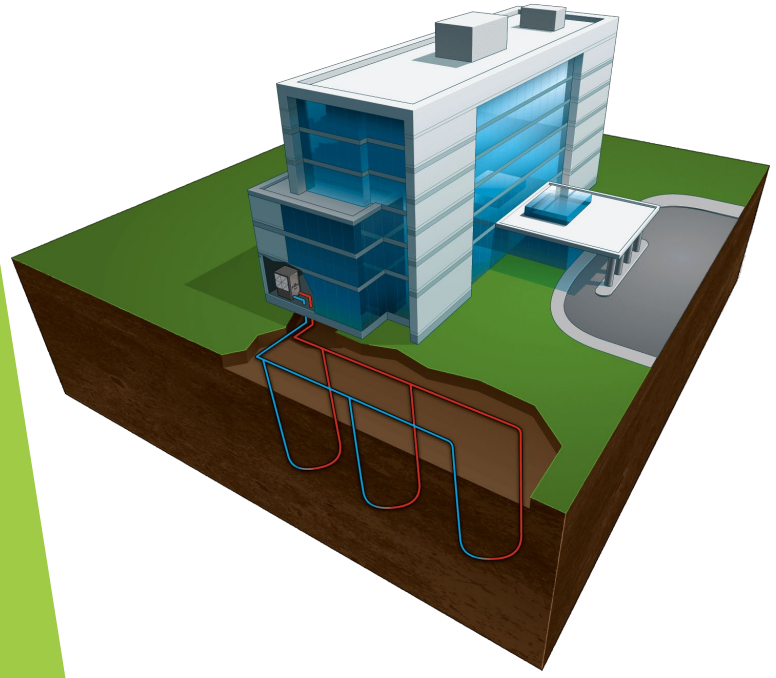
Quiz Time!

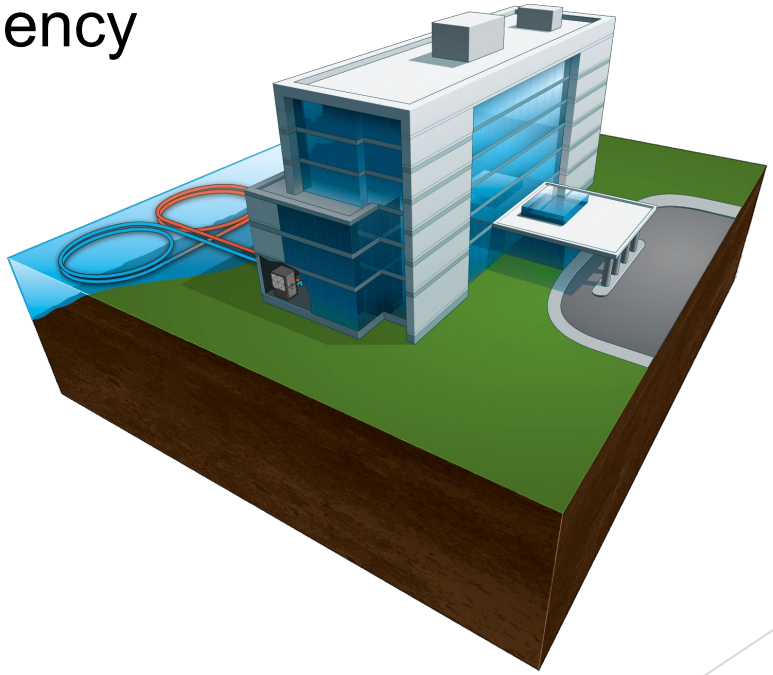
- True or False, geothermal heat pump systems have the lowest total lifecycle costs?
- Up to what % of the installed cost of a geothermal system can qualify for IRA tax credits?
- Does an organization need to pay taxes to take advantage of the IRA tax incentives?
- What percentage of annual heat load must be from geothermal for a hybrid system to qualify for the IRA incentives?



“Geo exchange systems are the most energy-efficient, environmentally clean and cost-effective space conditioning system available today”

- United States Environmental Protection Agency





Thank you

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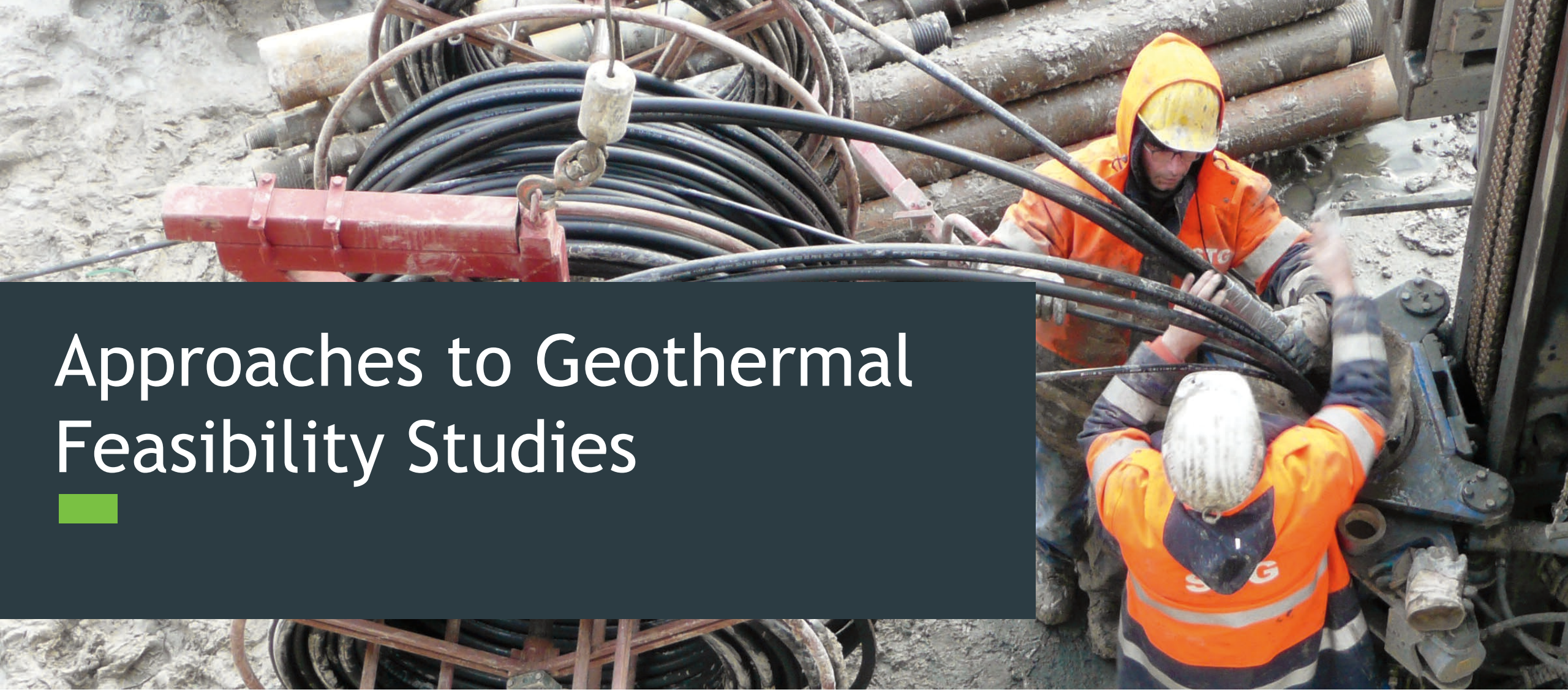
Feasibility Studies: Approaches & Tools

Tim Ashmore / *CDM Smith*



Approaches to Geothermal Feasibility Studies

Tim Ashmore

October 2024

CDM Smith

Learning Objectives

01 Elements of a quality feasibility study

02 Differences between standalone building systems and geothermal networks

03 Important tools

Study Phase Lays the Foundation for Future Phases

FEL 1	FEL 2	FEL 3		
Feasibility	Selection	Definition	Design	Construction
Feasibility • Permitting • Technical Feasibility • Cost/Schedule Analysis	**Selection** • Select Project Approach • Establish Design Criteria • Identify Equipment and any Long Lead	**Defining the Project** • Finalize P&ID • Finalize Scope • Perform Engineering	**Engineering Documents** • Solicit Stakeholder Feedback • Obtain Permits	**Project Implementation** • Purchase LLE • Develop / Maintain Construction Schedule

Project Purpose

Why is the Owner doing the project?

What 2-3 elements will make/break feasibility?

How does geothermal fit into its pro forma?

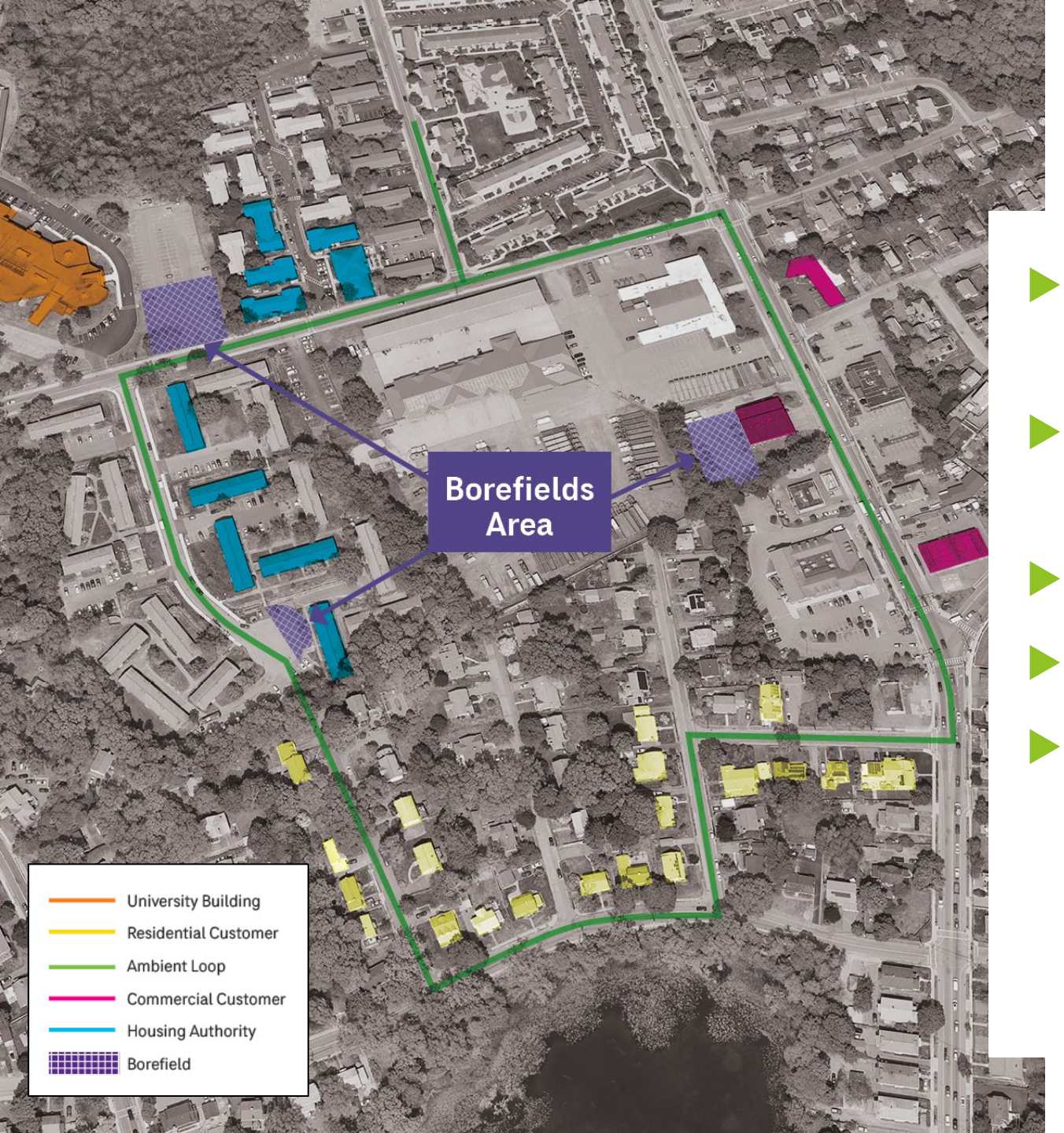
What end point creates a smooth transition into design?

Common Evaluation Elements

- Review geology and hydrogeology
- Evaluate permitting pathway and establish strategy
- Perform initial test fit
- Perform building energy model
- Update borefield sizing
- Evaluate tradeoffs of thermal conductivity testing
- Establish preliminary budget and schedule
- Identification of incentives
- Perform initial cost-benefit analysis

- Evaluate stakeholder acceptance
- Determine “offtake” potential
- Consider conversion complexity
- Review potential for utility / infrastructure conflicts
- Identify space for energy center equipment
- Evaluate environmental conditions

Framingham Pilot



- One main and two recharge borefields
- Primarily Environmental Justice Community
- Mix of loads for system balancing
- 1+ mile of ambient loop piping
- Six outside stakeholders to integrate

Utility Network Geothermal: Finding your starting point

Selecting a Site

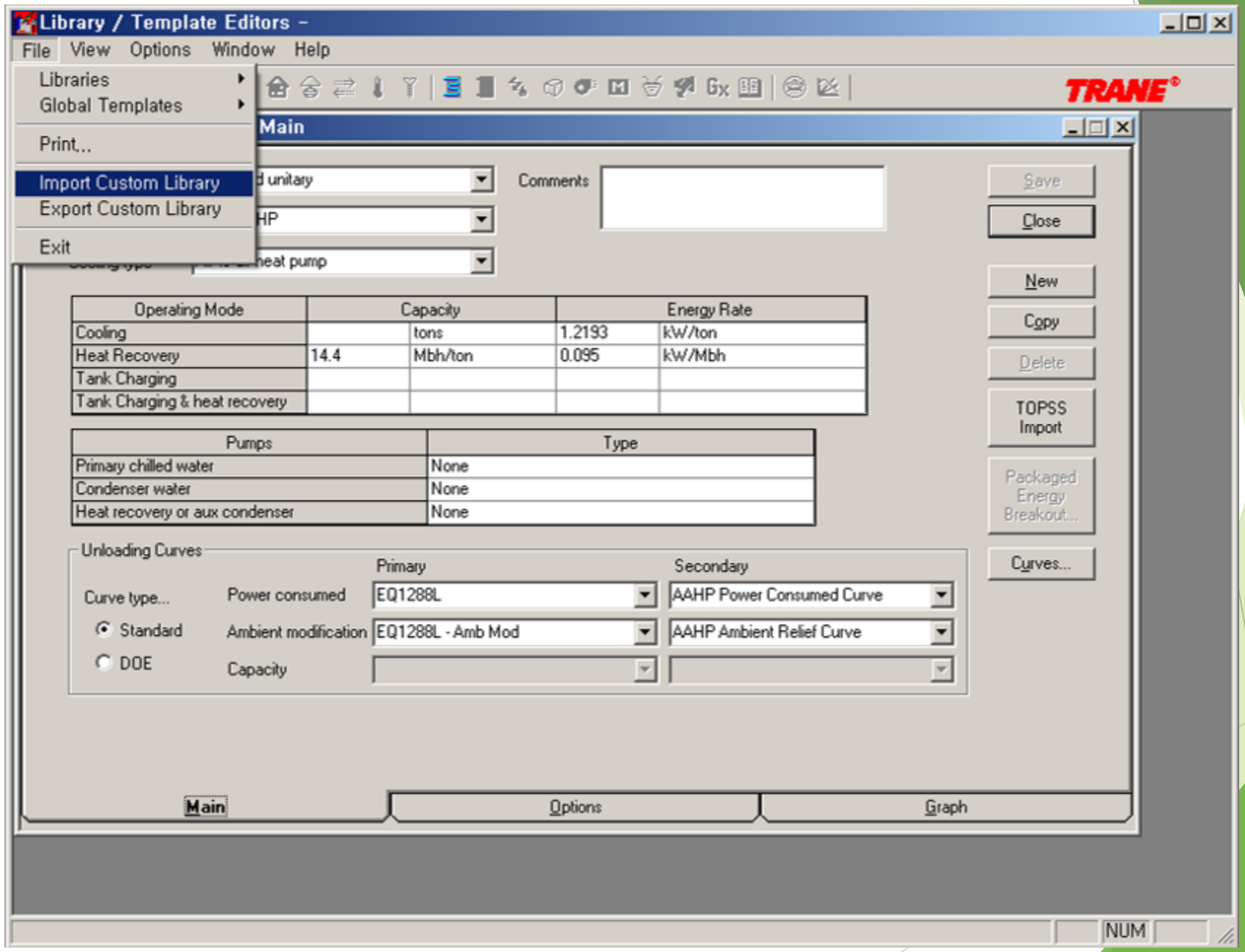
Resource Management

Connecting with Stakeholders

Feasibility

Education

Tools


Library / Template Editors -
File
View
Options
Window
Help
Libraries
Global Templates
Print...
Import Custom Library
Export Custom Library
Exit
TRANE
Main
Comments
Save
Close
New
Copy
Delete
TOPSS Import
Packaged Energy Breakout...
Curves...
Operating Mode
Capacity
Energy Rate
Cooling
Heat Recovery
Tank Charging
Tank Charging & heat recovery
14.4
Mbh/ton
tons
1.2193
kW/ton
0.095
kW/Mbh
Pumps
Type
Primary chilled water
Condenser water
Heat recovery or aux condenser
None
Unloading Curves
Curve type...
Standard
DOE
Power consumed
Ambient modification
Capacity
Primary
Secondary
EQ1288L
EQ1288L - Amb Mod
AAHP Power Consumed Curve
AAHP Ambient Relief Curve
Main
Options
Graph
NUM

Tools

Monthly Load Data

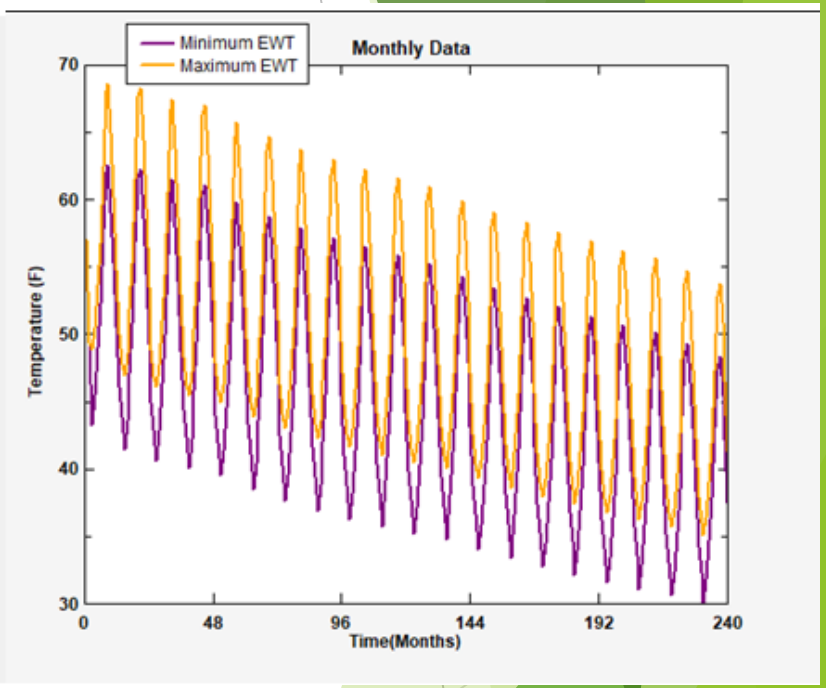
Update | Cancel

	Cooling Total (kBtu)	Cooling Peak (kBtu/hr)	Heating Total (kBtu)	Heating Peak (kBtu/hr)
January	1804	34	2278697	9975
February	416	28	2121224	9060
March	15676	1442	1743004	6573
April	85668	1953	1121420	5266
May	305959	3639	667389	3259
June	998451	6040	422178	1916
July	1614522	6311	368986	1260
August	1492854	6270	349074	1170
September	718432	4630	394460	1852
October	226948	2696	628128	3637
November	12681	382	1321971	6508
December	4620	35	1971595	7056
Total:	5478030	3.0 Hours at Peak	13388127	3.0 Hours at Peak

Flow Rate: 3.0 gpm/ton

Unit Inlet (°F): 90.4 | 35.4

	COOLING Design Day	COOLING Monthly	COOLING Hourly	HEATING Design Day	HEATING Monthly	HEATING Hourly
Total Bore Length (ft):	200000.0	200000.0	--	200000.0	200000.0	--
Borehole Number:	400	400	--	400	400	--
Borehole Length (ft):	500.0	500.0	--	500.0	500.0	--
Ground Temperature Change (°F):	-1.2	--	--	-1.2	--	--
Peak Unit Inlet (°F):	76.2	68.6	--	36.2	30.0	--
Peak Unit Outlet (°F):	85.6	74.2	--	30.8	24.6	--
Total Unit Capacity (kBtu/Hr):	8832.0	6310.6	--	9974.7	9974.7	--
Peak Load (kBtu/Hr):	6310.6	6310.6	--	9974.7	9974.7	--
Peak Demand (kW):	371.7	301.2	--	950.1	1063.2	--
Heat Pump EER/COP:	18.2	22.7	--	3.2	2.8	--
System (Seasonal) EER/COP	17.0	122.4	--	3.1	3.6	--
Avg. Annual Power (kWh):	--	4.48E+4	--	--	1.09E+6	--
Equip. Flow Rate (gpm):	2208.0	1577.6	--	2493.7	2493.7	--
System Flow Rate (gpm):	1577.6	1577.6	--	2493.7	2493.7	--



Decision Analysis Tool

Criteria and Metrics[1,4]	Criteria Weights[2]	Metric Weights[3]	Site 1			Site 3A			Site 10		
			Metric Score	Weighted Metric Score	Weighted Criteria Score	Metric Score	Weighted Metric Score	Weighted Criteria Score	Metric Score	Weighted Metric Score	Weighted Criteria Score
Existing Electrical Territory	5%	100%	1	1	1	10	10	5	10	10	5
Viability for Future System Expansion	5%	100%	10	10	5	10	10	5	0	0	0
Customer Participation and Willingness	20%			6.7	13		5.85	12		0.7	1
Relative level of community interest in geothermal		10%	7	0.7		6	0.6		7	0.7	
At least one government/municipal official has issued a letter of support for the project		30%	10	3		7.5	2.25		0	0	
At least one customer has issued a letter of support for the project		30%	0	0		5	1.5		0	0	
At least one community organization has issued a letter of support for the project		30%	10	3		5	1.5		0	0	
Geological Conditions & Thermal Conductivity	20%			7	14		7.6	15		2.8	6
Depth to Bedrock		40%	7	2.8		7	2.8		3	1.2	
Bedrock Conditions/Drillability		20%	10	2		10	2		3	0.6	
Groundwater-Producing Formation(s)		20%	5	1		7	1.4		0	0	
Overburden Type Drillability		10%	7	0.7		7	0.7		3	0.3	
Thermal Conductivity		10%	5	0.5		7	0.7		7	0.7	
Environmental Justice Impacts	10%			10	10		7.5	8		5	5
Presence on Site on GIS Mapping		100%	10	10		7.5	7.5		5	5	
Right of Way (ROW) for Accessibility and Construction	20%			2.9	6		6.4	13		7.5	15
Borefield Work Area Accessibility		30%	0	0		5	1.5		10	3	
Concentration of Utilities (Buried/Overhead)		20%	5	1		5	1		5	1	
Buildings Adjoining or Separated		20%	0	0		10	2		10	2	
Density of Pedestrian Usage		10%	5	0.5		5	0.5		0	0	
Ease of Procuring Easement (if required)		10%	6	0.6		8	0.8		6	0.6	
No. of Building Owners for Negotiation		10%	8	0.8		6	0.6		9	0.9	
Building Loads	15%			1.5	2		10	15		0.5	1
Additional Land Area Required		50%	0	0		10	5		0	0	
Load Size		50%	3	1.5		10	5		1	0.5	
Environmental Impacts	5%			8	4		5.5	3		7	4
Proximity to Wetlands / Permitted Jurisdictions		40%	10	4		5	2		10	4	
Proximity of Borefield Areas to Subsurface Environmental Contamination (Federal/State Superfund or Brownfield Sites, etc.)		40%	5	2		5	2		5	2	
Proximity to Classified Aquifers or Regulated Surface Water Bodies		10%	10	1		5	0.5		10	1	
Proximity to Municipal / Private Drinking Water Supply Wells and/or Associated Regulated Areas		10%	10	1		10	1		0	0	
			Site Score		55	**Site Score**		75	**Site Score**		36

Notes: 1) Criteria are in bold, Metrics are in italics, 2) Green cells potentially large cost impacts to project.

Decis

Geological Conditions & Thermal Conductivity

Depth to Bedrock

Bedrock Conditions/Drillability

Groundwater-Producing Formation(s)

Overburden Type Drillability

Right of Way (ROW) for Accessibility and Construction

Borefield Work Area Accessibility

Concentration of Utilities (Buried/Overhead)

Buildings Adjoining or Separated

Building Loads

Additional Land Area Required

Load Size

Environmental Impacts

Proximity to Wetlands / Permitted Jurisdictions

											10	
											ghted tric ore	Weighted Criteria Score
Existing Electrical											0	5
Viability for Futur											0	0
Customer Particip											.7	1
Relative level of c											.7	
At least one goveri for the project											0	
At least one custom											0	
At least one comm for the project											0	
Geological Condit											2.8	6
Depth to Bedrock											1.2	
Bedrock Condition											0.6	
Groundwater-Proc											0	
Overburden Type											0.3	
Thermal Conducti											0.7	
Environmental Ju											5	5
Presence on Site o											5	
Right of Way (ROV											7.5	15
Borefield Work Ar											3	
Concentration of Utilities (Buried/Overhead)			20%								1	
Buildings Adjoinin											2	
Density of Pedestr											0	
Ease of Procuring											0.6	
No. of Building Ow											0.9	
Building Loads											0.5	1
Additional Land A											0	
Load Size											0.5	
Environmental Im											7	4
Proximity to Wetl											4	
Proximity of Borefield Areas to Subsurface Environmental Contamination (Federal/State Su											2	
Proximity to Class											1	
Proximity to Mun Associated Regul											0	
Notes: 1) Criteria large cost impacts												36

Learning Assessment

- How can the study phase set a project up for success?
- What areas of study are most important to a feasibility study?
- What additional areas of study are critical when considering geothermal as part of a district or network?
- What materials will support the final decision-makers best?

Thank you

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