Leveraging Groundwater for High Performance

Presented Live at the NY-GEO 2023 Conference Albany, New York on April 27, 2023

Moderator:
Aaron Schauger / *LaBella Associates*
Panel:
Roshan Revankar / *Genesis CLAD*
Andrew Steiner / *Darcy Solutions*
Tim Schultz / *Terra Caloric, LLC*

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Leveraging Groundwater for High Performance

4/27/2023

Who's here today

Moderator:

Aaron Schauger, LaBella Associates

Panelists:

Roshan Revankar, Genesys

Andrew Steiner, Darcy Solutions

Tim Schultz, Well-Connect

GENESYS

Net Zero Energy Building Possible

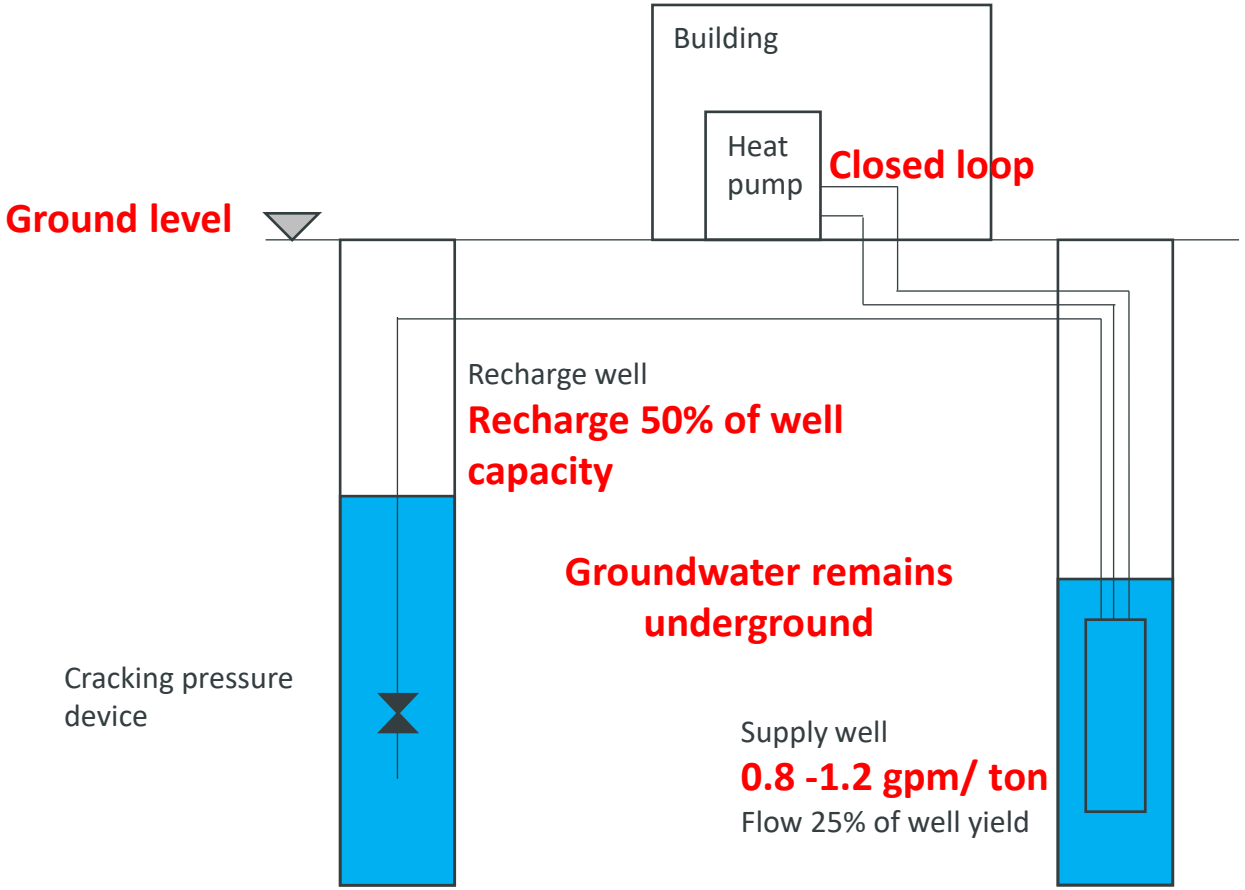
CLAD

CLOSED LOOP ADVECTION DEVICE

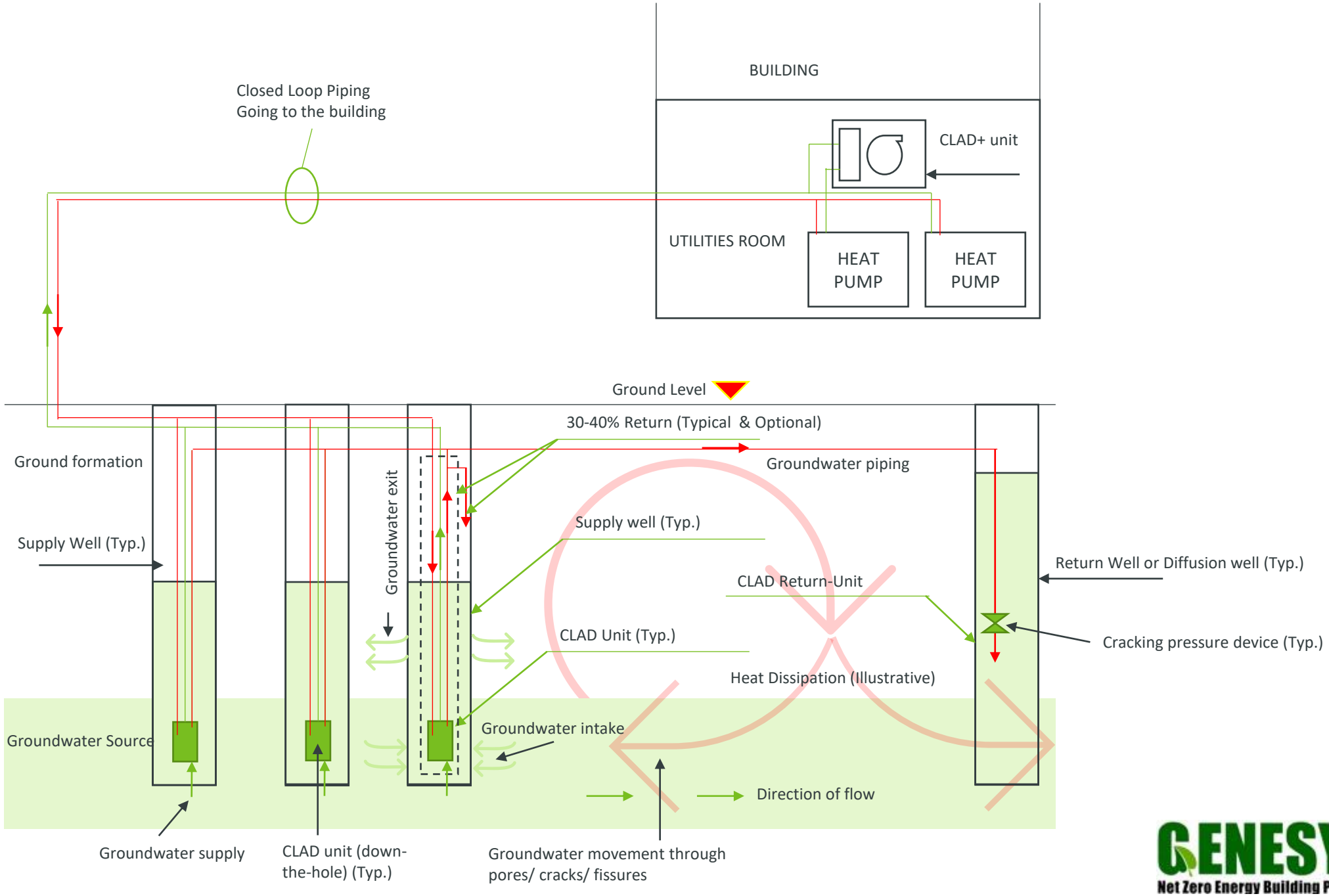
50% less expensive | 90% smaller land | 50% more efficient

Roshan Revankar
(roshan@genesysnze.com)

CLAD Concept

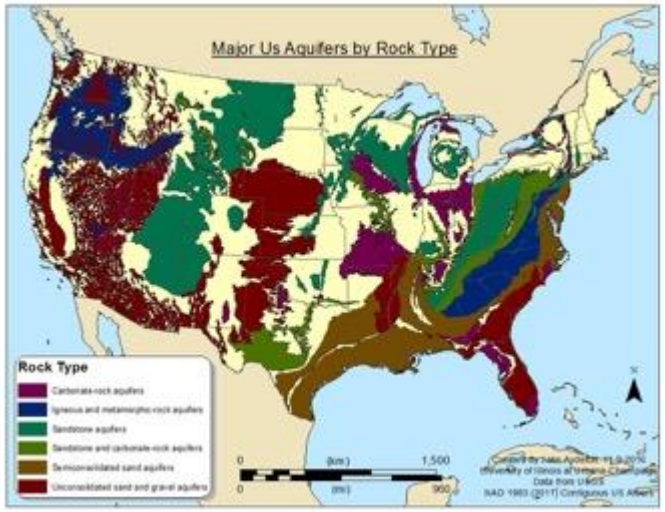


GENESYS
Net Zero Energy Building Possible

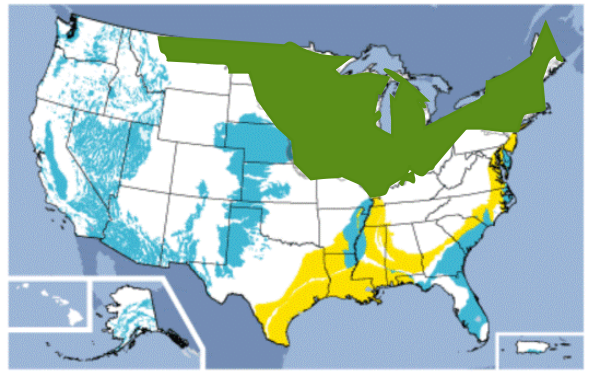


GENESYS
Net Zero Energy Building Possible

US Aquifers



PRINCIPAL UNCONSOLIDATED AND SEMICONSOLIDATED SAND AND GRAVEL AQUIFERS

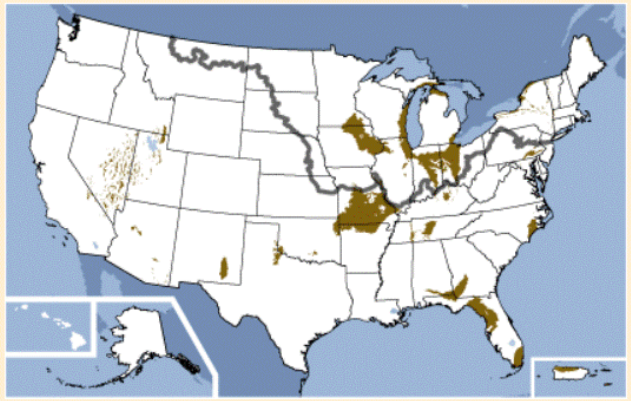


Unconsolidated sand and gravel aquifers at or near the land surface.

Semiconsolidated sand and gravel aquifers.

Sand and gravel aquifers of alluvial and glacial origin are north of the line of continental glaciation.

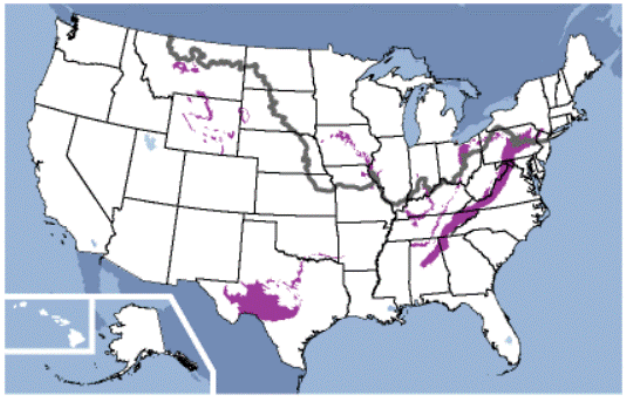
PRINCIPAL CARBONATE-ROCK AQUIFERS



Carbonate-rock aquifers at or near the land surface

Limit of continental glaciation. North of this line, glacial sand and gravel aquifers overlie bedrock aquifers in many places

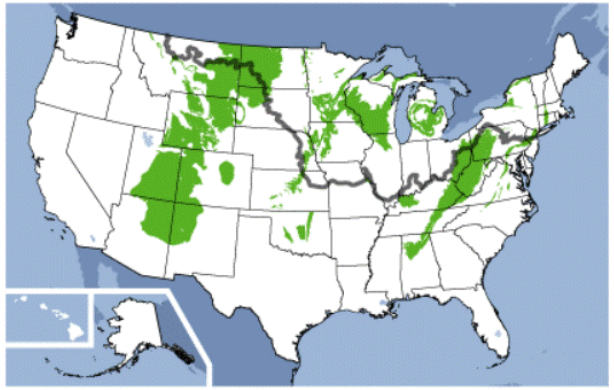
PRINCIPAL SANDSTONE AND CARBONATE-ROCK AQUIFERS



Sandstone and carbonate-rock aquifers at or near the land surface

Limit of continental glaciation. North of this line, glacial sand and gravel aquifers overlie bedrock aquifers in many places

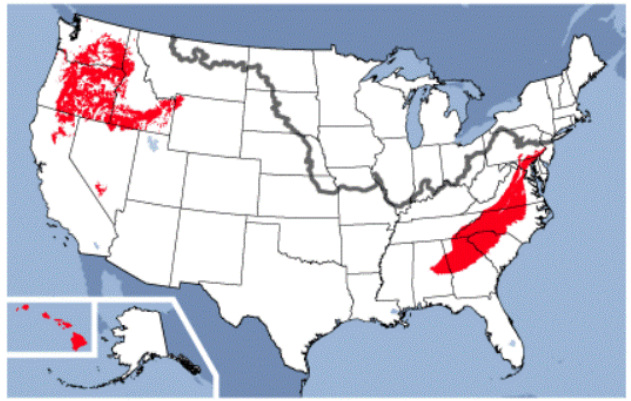
PRINCIPAL SANDSTONE AQUIFERS



Sandstone aquifers at or near the land surface.

Limit of continental glaciation. North of this line, glacial sand and gravel aquifers overlie bedrock aquifers in many places.

PRINCIPAL IGNEOUS AND METAMORPHIC-ROCK AQUIFERS



Igneous and metamorphic-rock aquifers at or near the land surface.

Limit of continental glaciation. North of this line, glacial sand and gravel aquifers overlie bedrock aquifers in many places.

GENESYS
Net Zero Energy Building Possible

Standard Efficiency

Model	Ton	EWT (°F)	
		Cooling	Heating
CLAD-6	6	80	43
CLAD-20	20	80	43
CLAD-100	100	80	43

High Efficiency

Model	Ton	EWT (°F)	
		Cooling	Heating
CLAD-6 HE	6	70	45
CLAD-20 HE	20	70	45
CLAD-100 HE	100	70	45

Ultra High Efficiency

Model	Ton	EWT (°F)	
		Cooling	Heating
CLAD-6 UHE	6	60	47
CLAD-20 UHE	20	60	47
CLAD-100 UHE	100	60	47

The capacities and entering water temperatures are based on a nominal ground temperature of 56 ° F.

Design & Sales Tools

- CLAD Sizer
  - Inputs
    - Hydraulic conductivity
    - Hydraulic gradient
    - Radius of influence
  - Output
    - Capacity per production well
    - Capacity per diffusion well
    - Pump selection parameters – flow/ total head

- Cost estimator & proposal builder
  - Database
    - Component cost tables
  - Inputs
    - Number of wells
    - Editable pipe lengths
  - Output
    - Bill of quantities (BOQ)
    - Standard editable proposal

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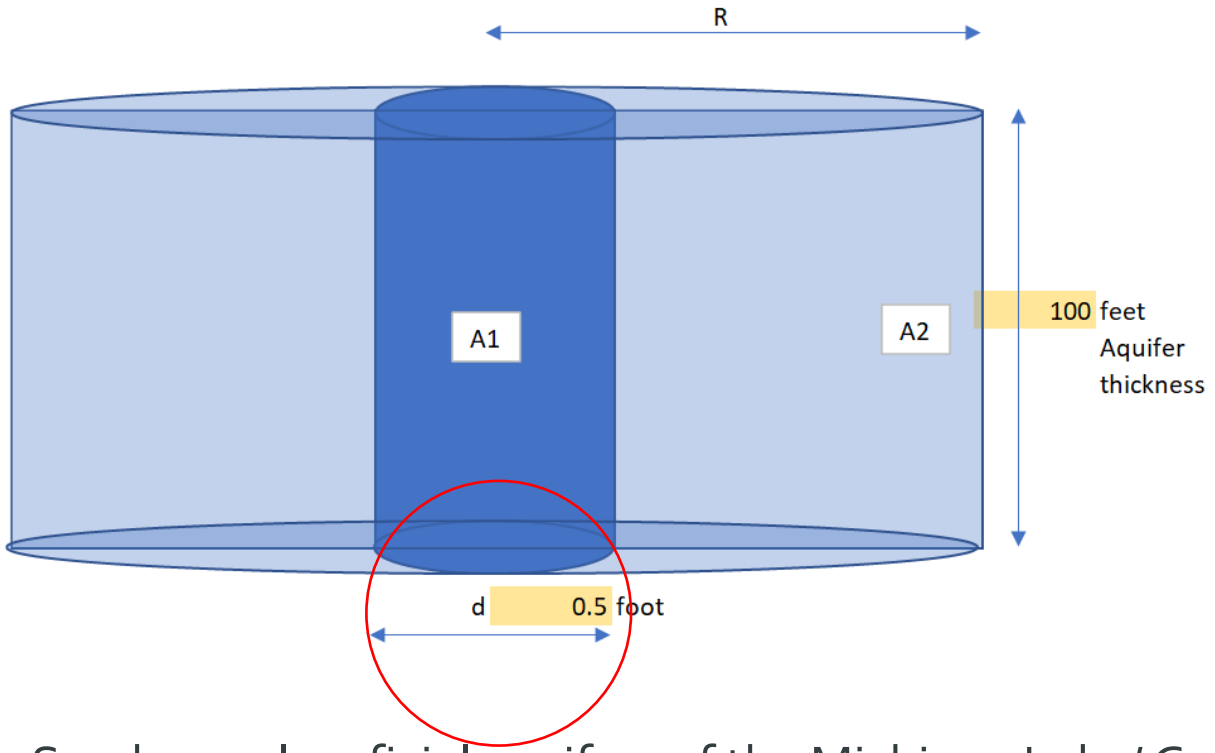
Net Zero Energy Building Possible

Targeting & Qualifying Examples

Forced-Draft Sizer



K	7500	gpd/ sqft/ unit gradient or 5.21 gpm/ sqft, gpm/ sqft/ unit gradient
h-grad	30	feet/ mile or 0.01 per foot
flow	50	gpm
R	5.0	feet 176?
f	42.6	gpd/ sqft or 0.03 gpm/ sqft - (Actual ground water flow)

A1	157.1	sqft
A2	3,141.6	sqft
Flow/ A1	0.3	gpm/ sqft
Flow/ A2	0.0	gpm/ sqft
PD (A1)	0.7	feet
PD (A2)	-	feet
Total H	1.8	feet
	0	0.00%

Hydraulic conductivity conversions			
0.00055	m/s	11,662	gpd/sqft
1	cm/s	21,204	gpd/sqft
30	m/d	7,363	gpd/sqft
100	ft/d	7,482	gpd/sqft

Hydraulic Transmissivity conversions			
15000	ft2/d	112207.5	gpd/foot
Hydraulic conductivit		1,122	gpd/sqft

Sand gravel surficial aquifers of the Michigan Lake/ Great Lake basins

- High hydraulic conductivity (7500-15000 GDP/sq ft/unit gradient)
- Thickness (100-300 feet)
- Hydraulic gradient of 30 feet/ mile

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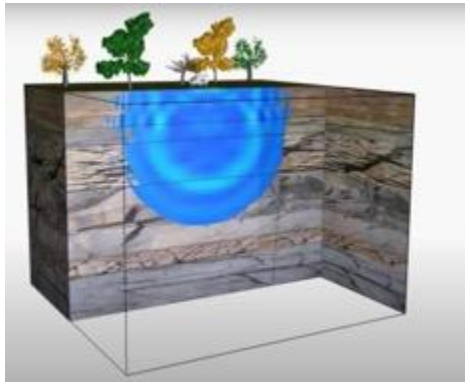
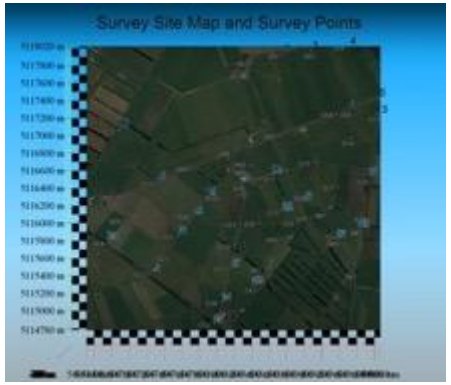
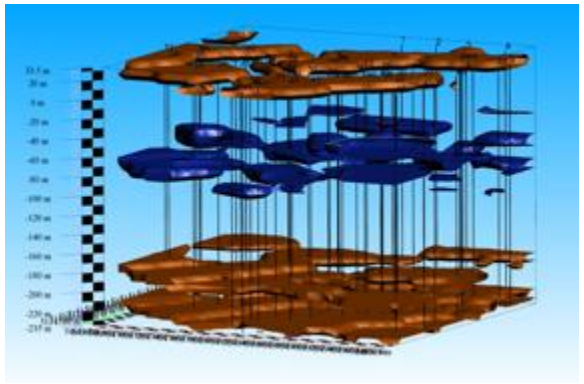
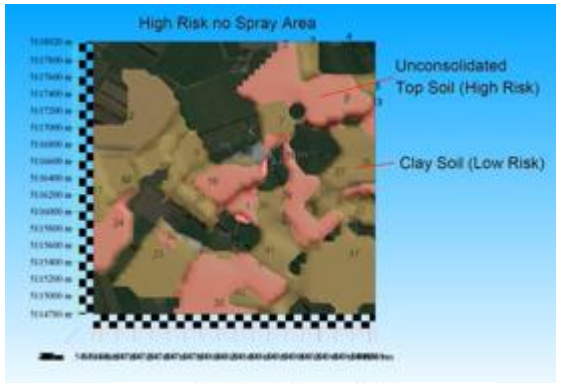
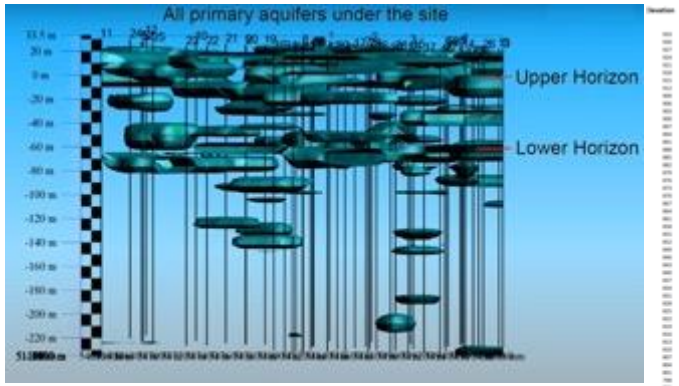
Site Survey Tools

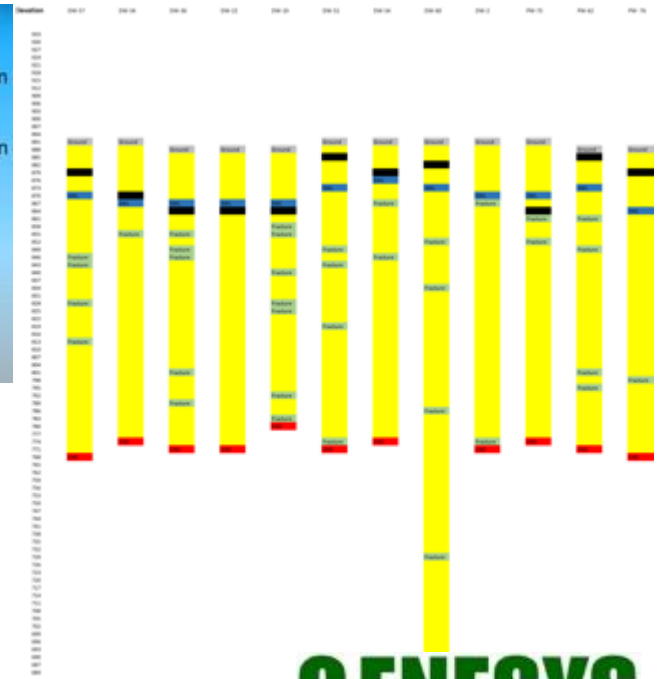


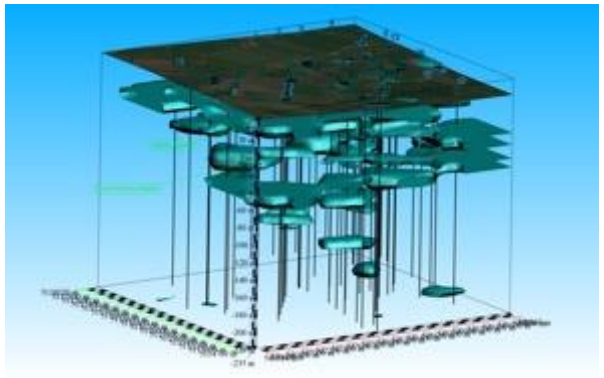


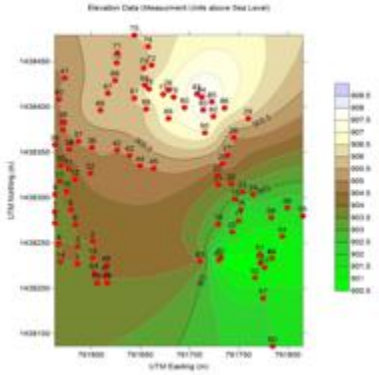












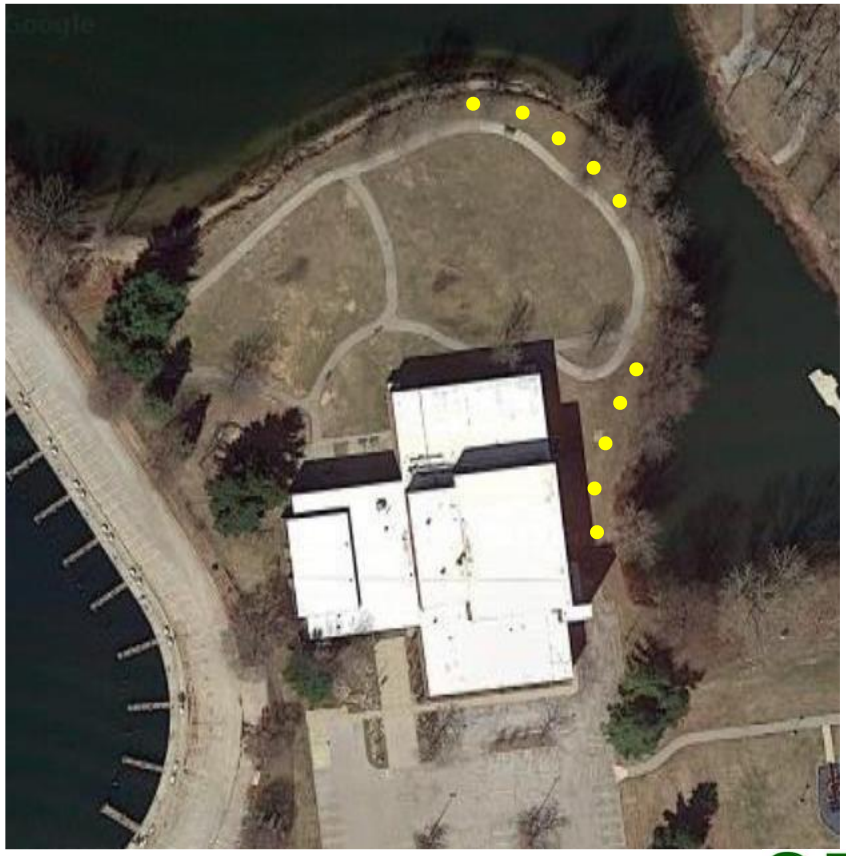
GENESYS
Net Zero Energy Building Possible

Full Scale Project Site ..

150 ton project

Closed-loop layout
72 Boreholes @400ft
$800K

CLAD
8 (+2) production@60 ft
$390K



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Full Scale Project Site ..

Closed-loop layout

CLAD layout

GENESYS
Net Zero Energy Building Possible

Summary ….

- Building loop is a closed loop
- Use of glycol possible
- 10 times more efficient than closed loop – 90% less ground area
- Assures scalability
- No thermal build-up
- No abandoning of wells due to underground leakages
- Product readiness
- Component reliability – HXs are field tested in critical applications
- Standardized design and sizing tools

GENESYS
Net Zero Energy Building Possible

FAQ's ….

1. How much water do you need for a 6 ton unit?
   - 7.2 GPM (~1.2gpm/ton)

2. What size diameter well and how deep?
   - 5″, 6″ and 12″ casing for 6, 20 and 100 tons…Typically 50 –70 ft .

3. How many supply wells per diffusion well?
   - 2-3 depending on ground conditions. Can also discharge into surface water, storm drain etc.

4. Any water quality issues? How is it handled?
   - Material, surface finish, no O2 exposure, turbulent flow in HX

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FAQ's ….

5. What about pressure drops and pump energy?
   - High turbulence BUT only in a short length. Cracking pressure device.

6. Is the well pump always turned on? How is it controlled?
   - No. Temp controlled and variable speed. Passive heat transfer possible.

7. Issues with permit? What has been your experience?
   - Show all your cards!!

8. Can I order a few today?
   - Absolutely!

GENESYS
Net Zero Energy Building Possible

DARCY®

Hello

Darcy Solutions Introduction

Buildings are an Emissions Problem without Easy Solutions.

Only sector growing in emissions since 2005.

80% of existing buildings still standing in 2050.

Building stock expected to double by 2060.

1

INDIRECT EMISSIONS

Emissions associated with electricity generation to operate a building.

2

DIRECT EMISSIONS

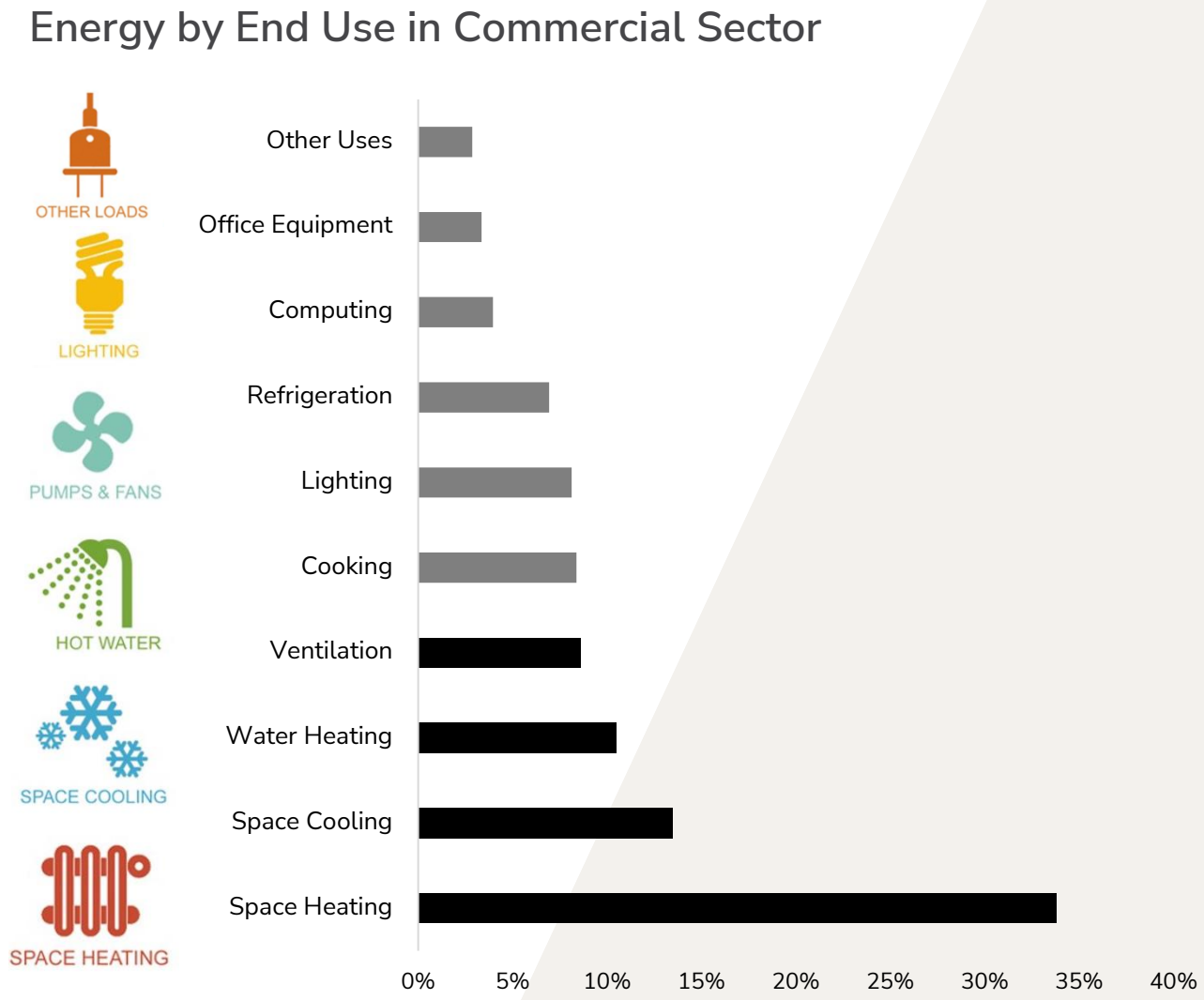
Fossil fuels used directly on site for end use operations.

3

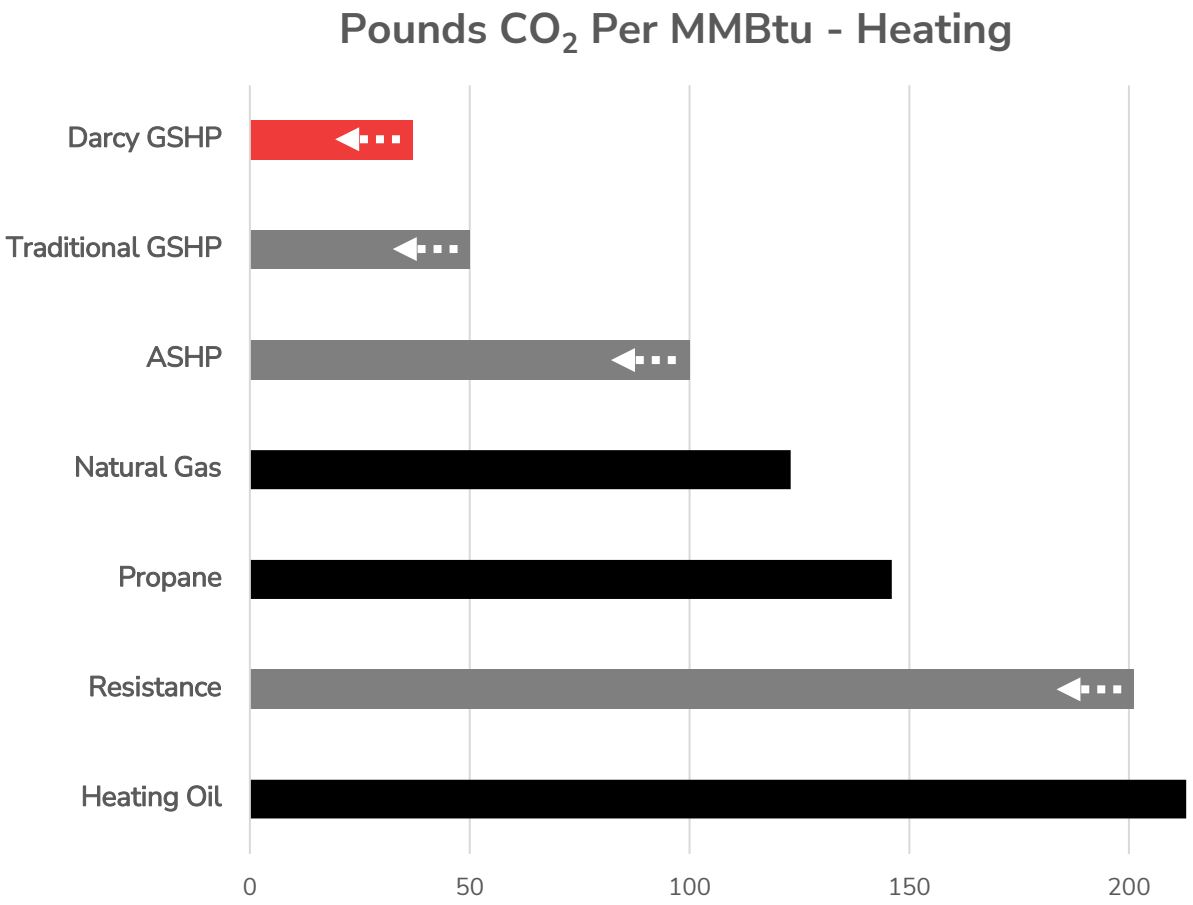
OTHER EMISSIONS

Emissions associated with other various on-site activities.

Eliminating Emissions in Buildings means Solving for Heating and Cooling



HVAC systems represent 60-75% of building energy use



arrows represent decreasing emissions with the greening of electricity sources

Note: Xcel MW - 12% natgas, 30% coal, 29% nuclear and 29% renewables

Sources: EIA, energysavers.gov, Energy.gov

Darcy Wins on Efficiency

With the greatest operating efficiency and lowest emissions profile, Darcy enables building owners to achieve:

- Fully electric heating and cooling
- Net Zero corporate goals
- Energy efficiency regulations and code

In addition:

- Darcy geothermal is eligible for the 30-50% Investment Tax Credit enabled by the Inflation Reduction Act
- Electric utilities enthused about Darcy efficiency as demand on the grid grows

The Darcy Team

Brian Larson
CEO

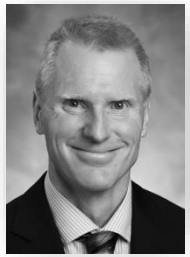
Andrew Steiner
Development

Scott Alexander
Chief Geologist

Suzanne Magdalene, PhD
Senior Geologist

Alex Martell
Regulatory

Ryan Martin-Wagar
Technology



Mike Lavoie
System Engineering

Robert Ed
Marketing Strategy

Jack Henrich
Drilling Ops

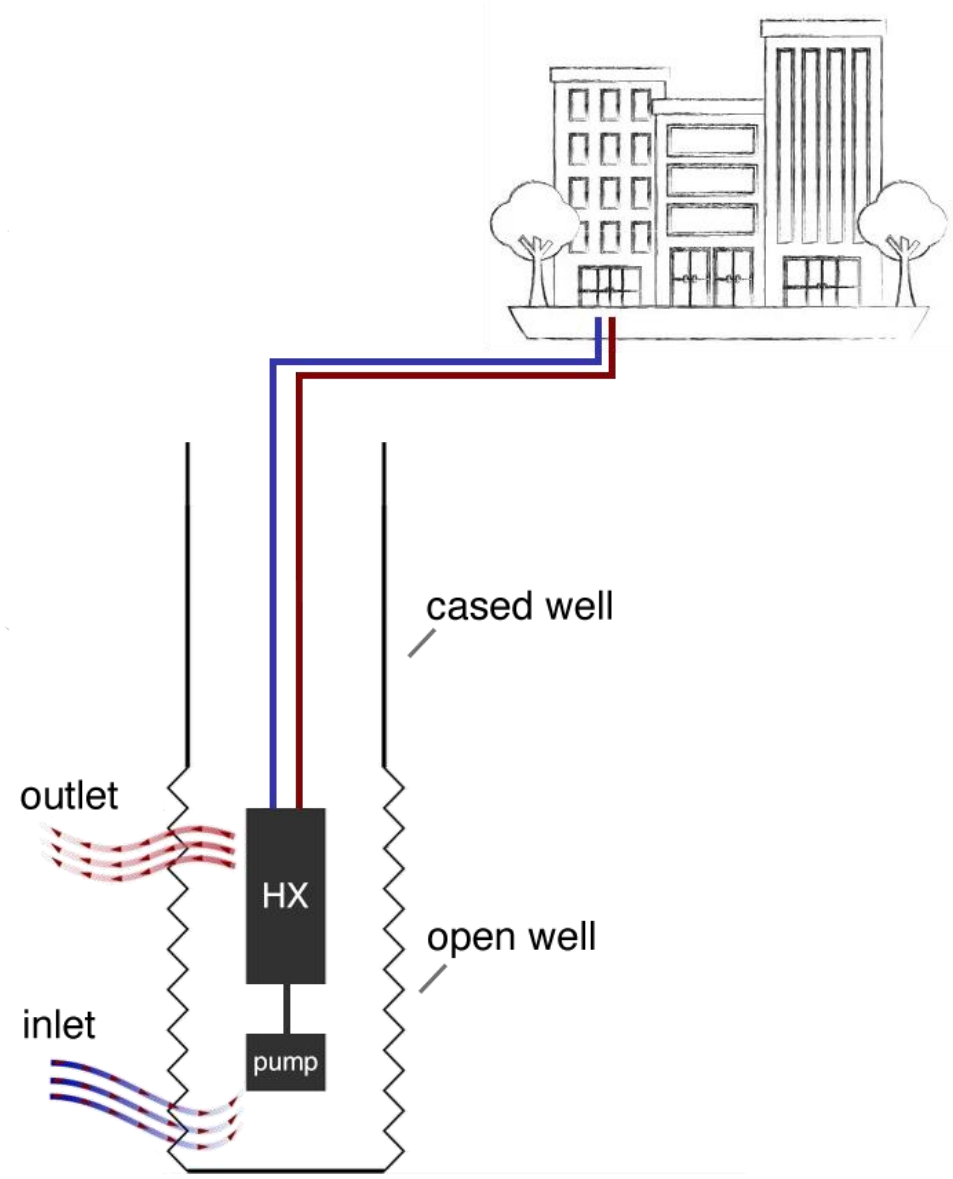
Ben Barnard
Construction

- **Focus:** decarbonizing buildings for a sustainable, equitable economy
- **Expertise:** geology, engineering, construction, regulatory, and business leadership professionals

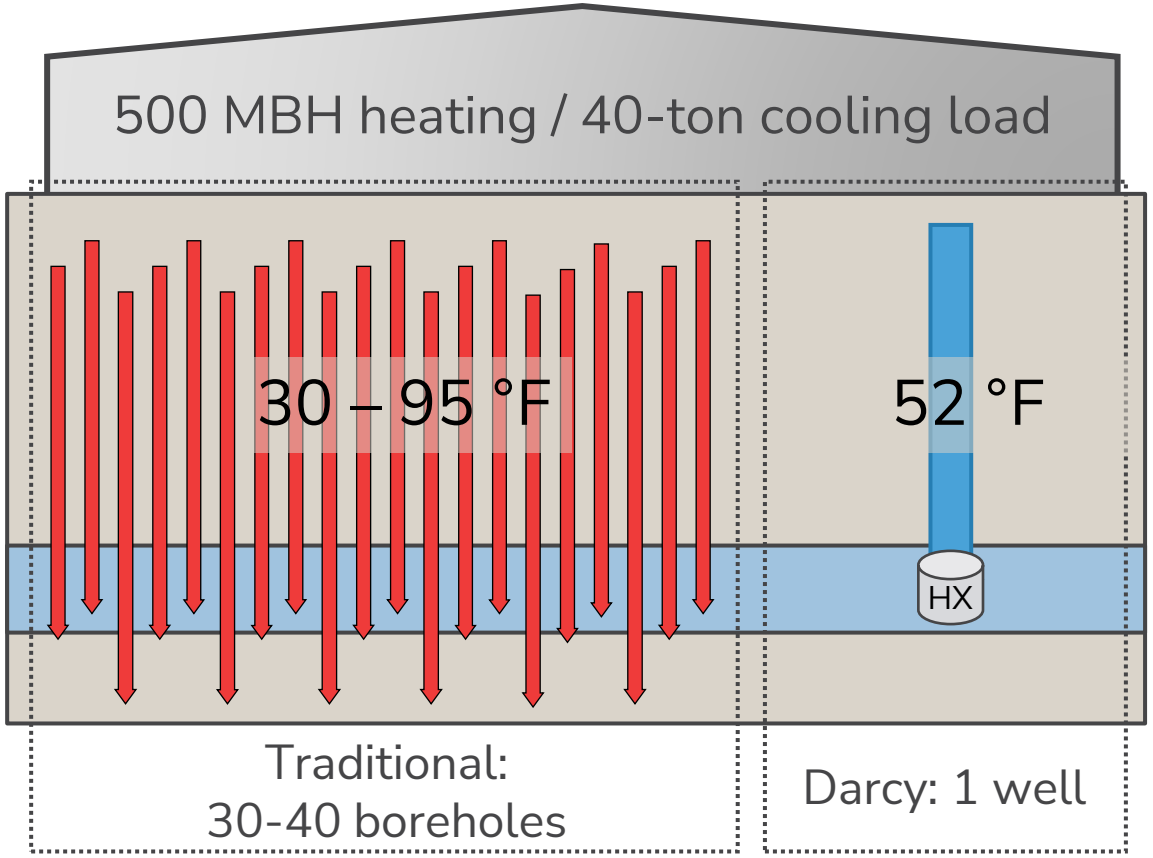
We founded Darcy Solutions to make a meaningful impact on **improving the health of our communities and planet**

The Darcy System

- A Darcy-designed heat exchanger and submersible pump are installed into a purpose-built water-supply well
- **Standard water well** utilizing approved construction materials
- Groundwater remains in the ground for **zero water consumption**
- Building side loop utilizes **potable water**
- Number of wells scales to meet heating & cooling needs, **50+ Tons per well**



Viable for Sites Unable to Utilize Geo Today

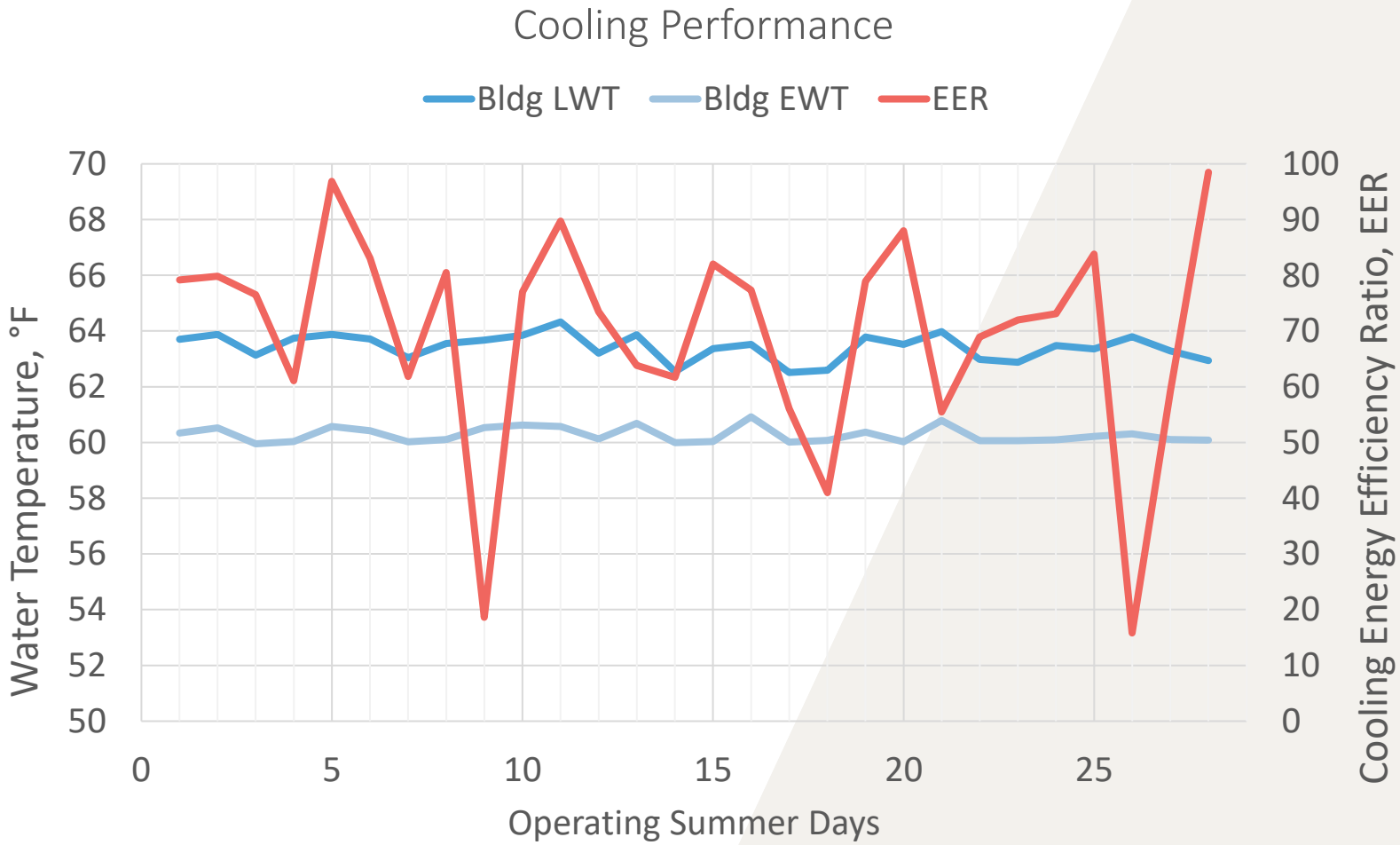


Generate 50+ tons of capacity per well vs. 1-2 tons for traditional geothermal

- 95% footprint reduction: especially suitable for sites that are constrained, minimizing site disruption and installation time
- Stable groundwater temperatures enable year-round efficiencies and unbalanced loads
- Reduces 1st cost. Higher efficiencies accelerate payback.
- Strong growth opportunity for well drilling partners

Real World System Performance

- Entering water temperatures are **maintained throughout the season**
- Cooling performance averages **77 EER** vs a traditional water-cooled chiller 20-25 EER
- This customer enjoying a **78% reduction in energy costs** for cooling



Darcy integrates hydrogeologic expertise, product design, system engineering, construction management, and commissioning

Integrated solution results in higher performance, greater system longevity, and owner satisfaction

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Questions?

Thank You.

DARCY®

NY-GEO

NY-GEO 2023 Conference:

Leveraging Groundwater for Rural Homeowners

April 27, 2023
Albany, New York

TERRA CALORIC
EARTH ENERGY

Hybrid Geothermal
WELLCONNECT

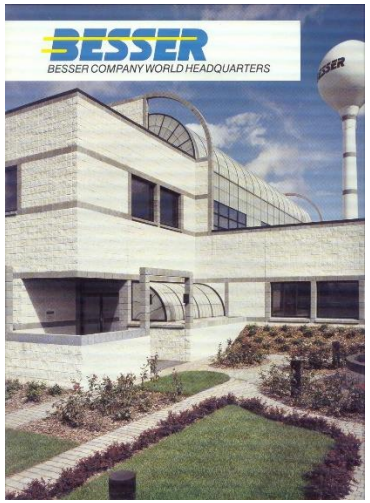
Agenda

1. Background
2. The Problem
3. Our Observations
4. Solution: Hybrid Geothermal
5. Results

BACKGRO

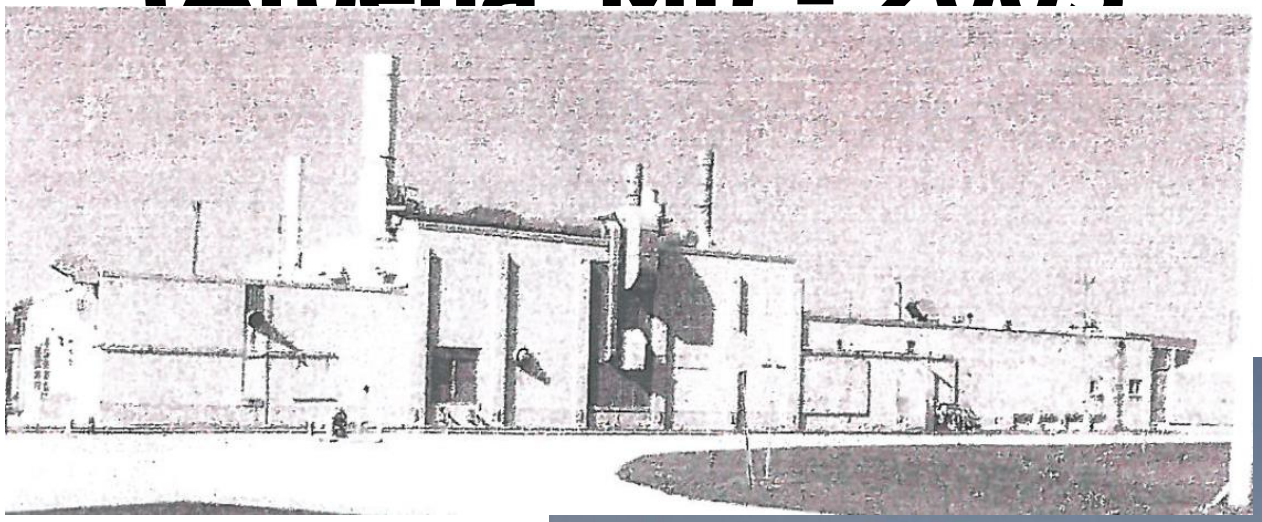
TIMM CONSTRUCTION

Celebrating 75 Years



NOAA Facility

(Alpena, MI) - 2005



Papermill converted into shipwreck museum

Open Loop System
44 Ton, 105 gpm
8 Water Furnace Units
Leed Certified (Gold)

THE PROBLEM

Rural Homeowners Pay 2X to Heat their Homes

- Those heating with propane, fuel oil, electric (no nat. gas)
- Many live in cold, uncomfortable homes to keep cost down
- Many are tired of burning wood or wood pellets to save money
- [illegible]

In Michigan = $1 Billion Premium

Household Energy Use in New York

A closer look at residential energy consumption

All data from EIA's 2009 Residential Energy Consumption Survey
www.eia.gov/consumption/residential/

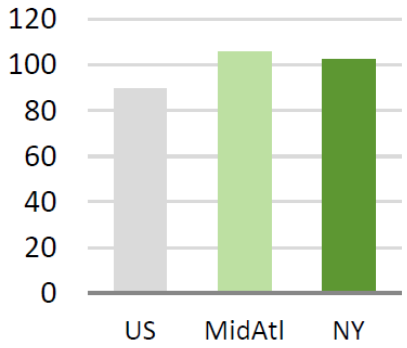
- New York households consume an average of 103 million Btu per year, 15% more than the U.S. average.
- Electricity consumption in New York homes is much lower than the U.S. average, because many households use
  heating, water heating, and coo
  average due to higher than ave
- New York homes are typically o
  are smaller on average than ho

New York households consume an average of 103 million BTU/year.

In Michigan the average is 77 million BTU/year

ALL ENERGY *average per househ*

Site Consumption
million Btu



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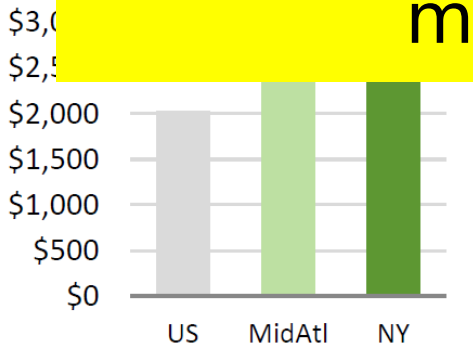
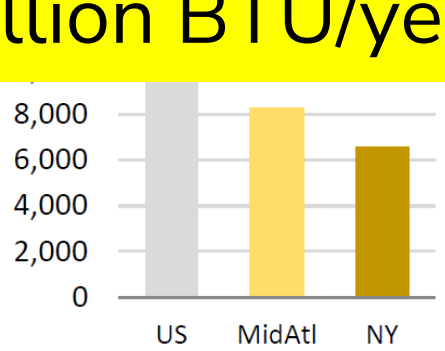
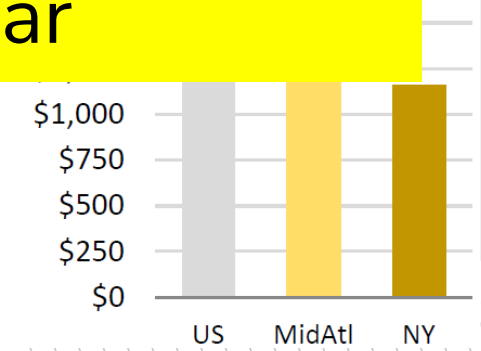


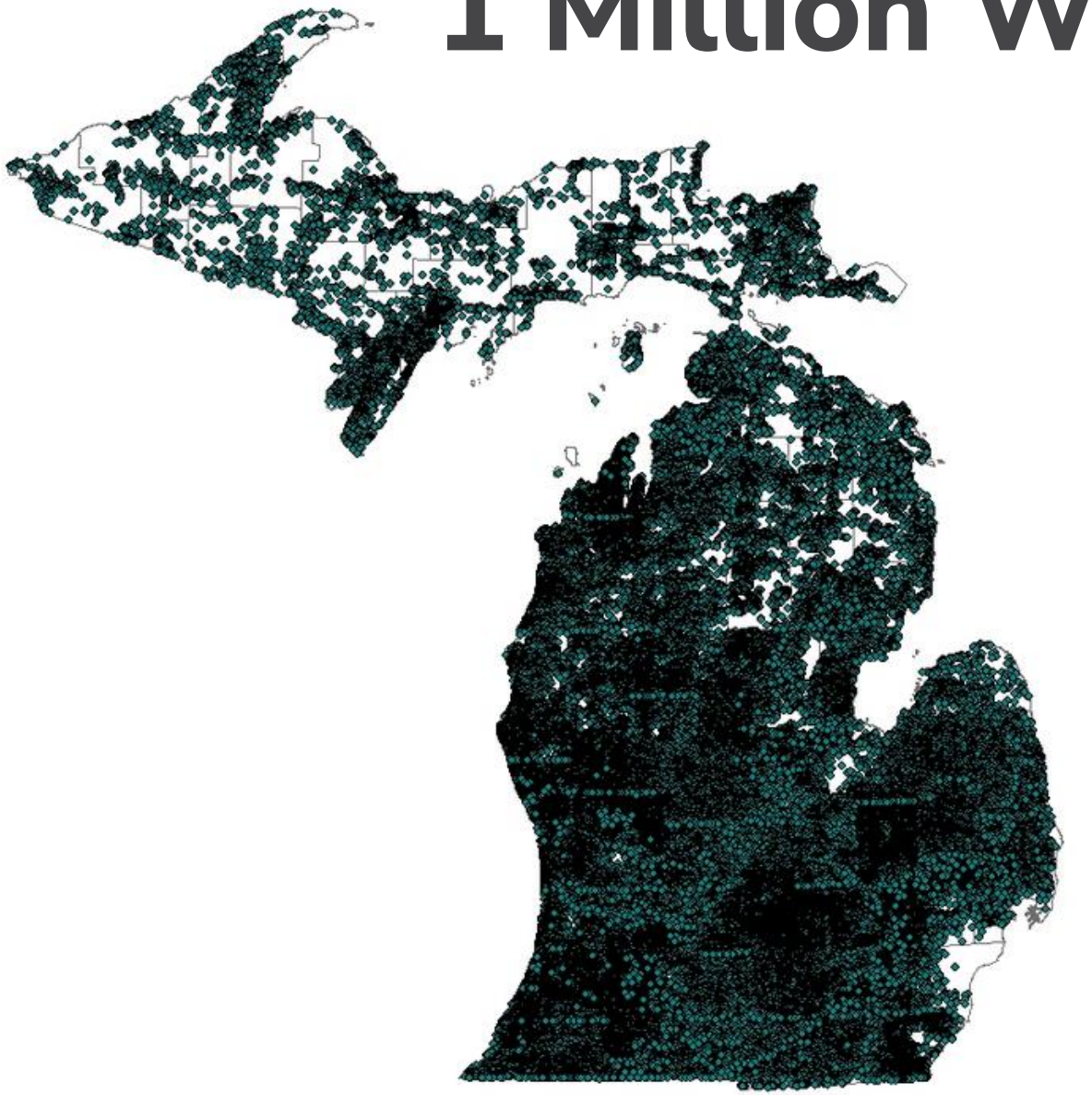




Typical Rural Homes

(70M to 100M Annual BTU on average)

1 Million Wells

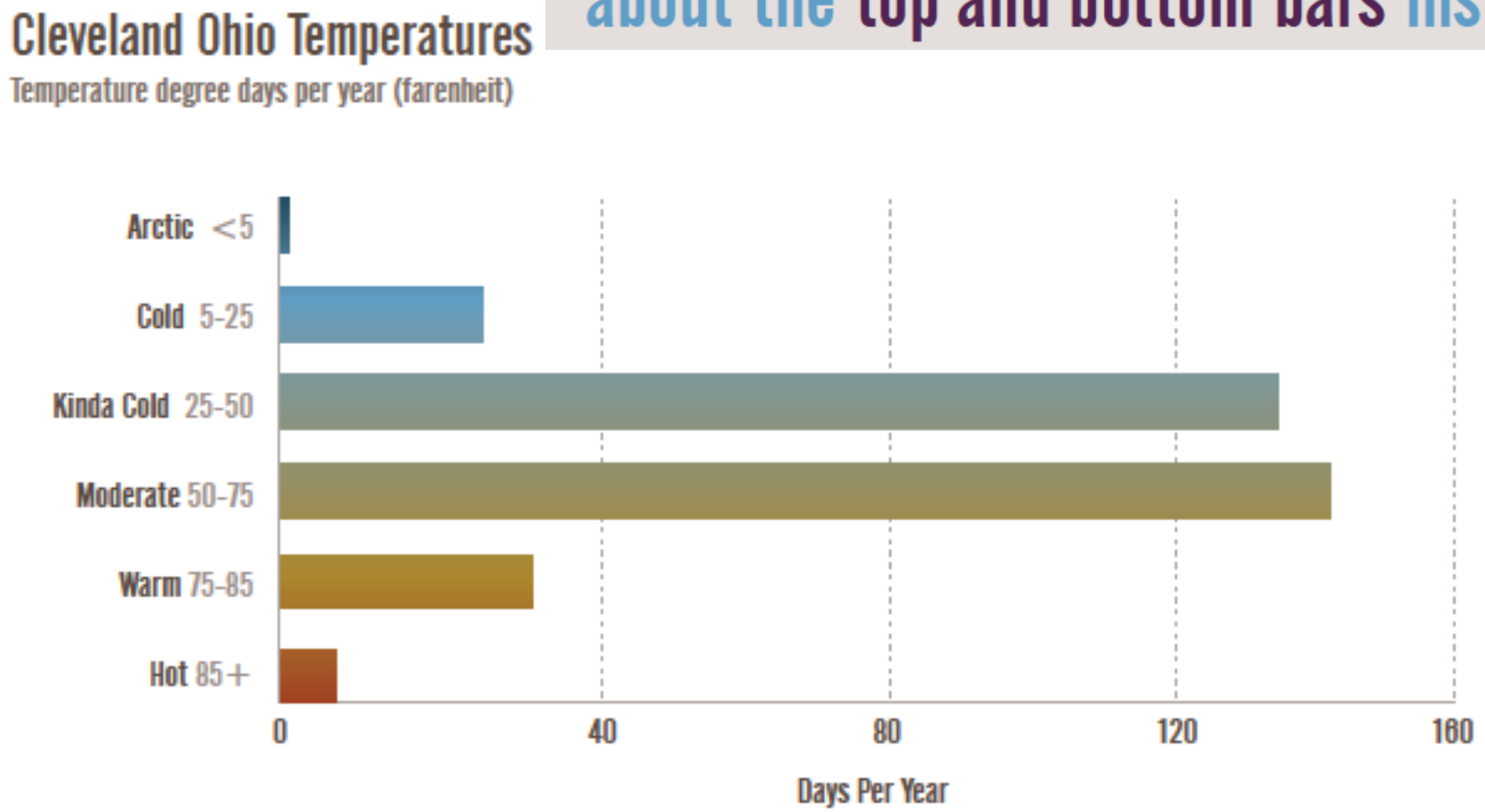


1 Million Free Clean Renewable Energy Sources

Hybrid Geothermal WellCONNECT

Well-Connect is "Right-Sized" for the Big Bars

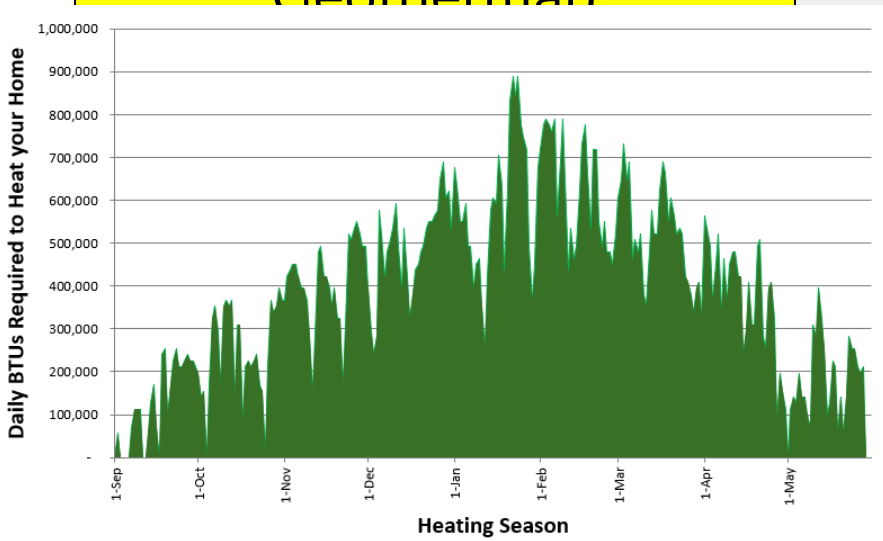
We SHOULD care about the **Big Bars** but we WIG OUT about the top and bottom bars instead.



Source: Nate Adams', The Home Comfort Book

Hybrid Geothermal WellCONNECT

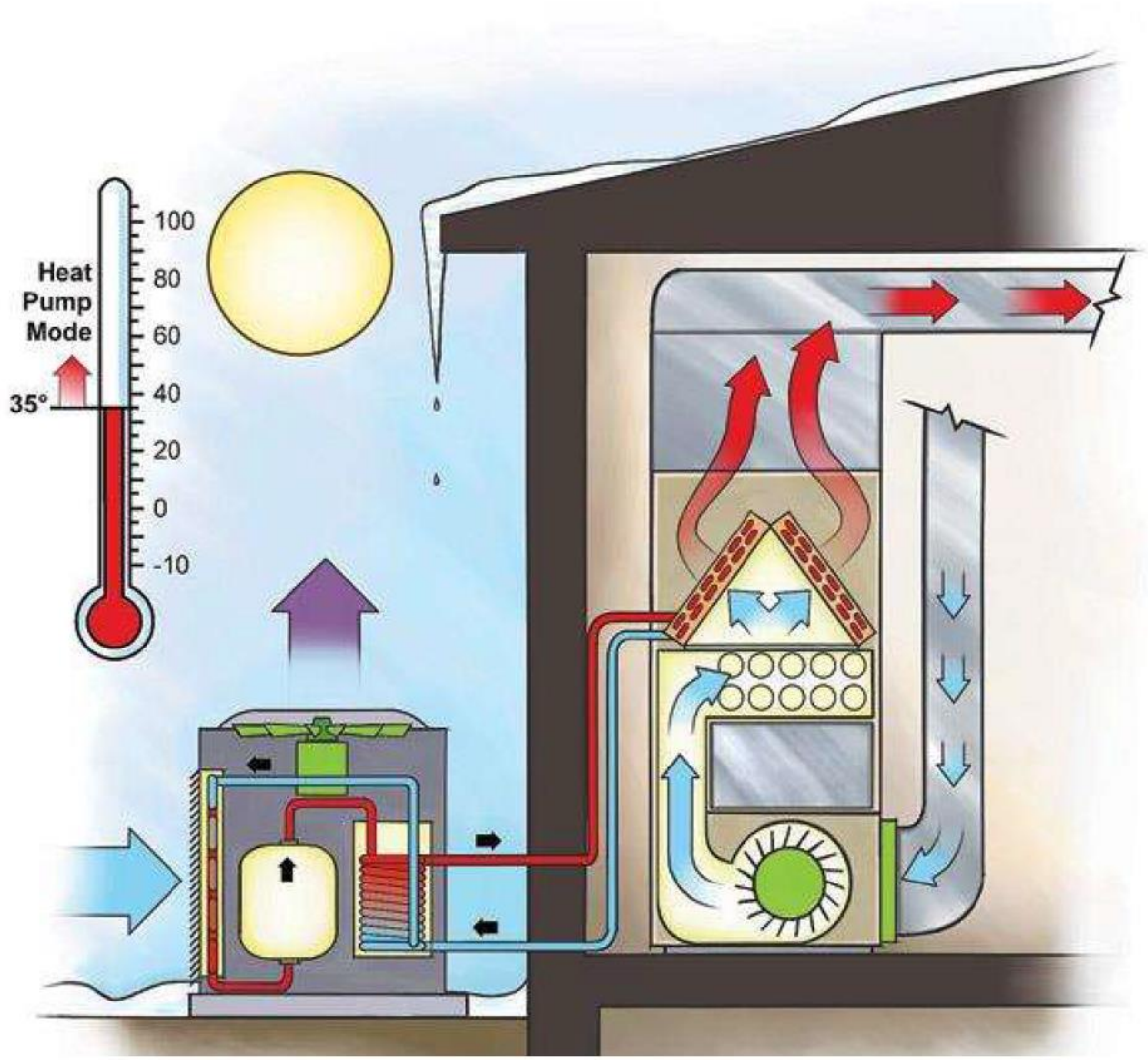
Simply Applying the Pareto Principle to Already Proven Technology (Decades of Open Loop Geothermal)



Conventional “Either - Or” Dual Fuel Heating System

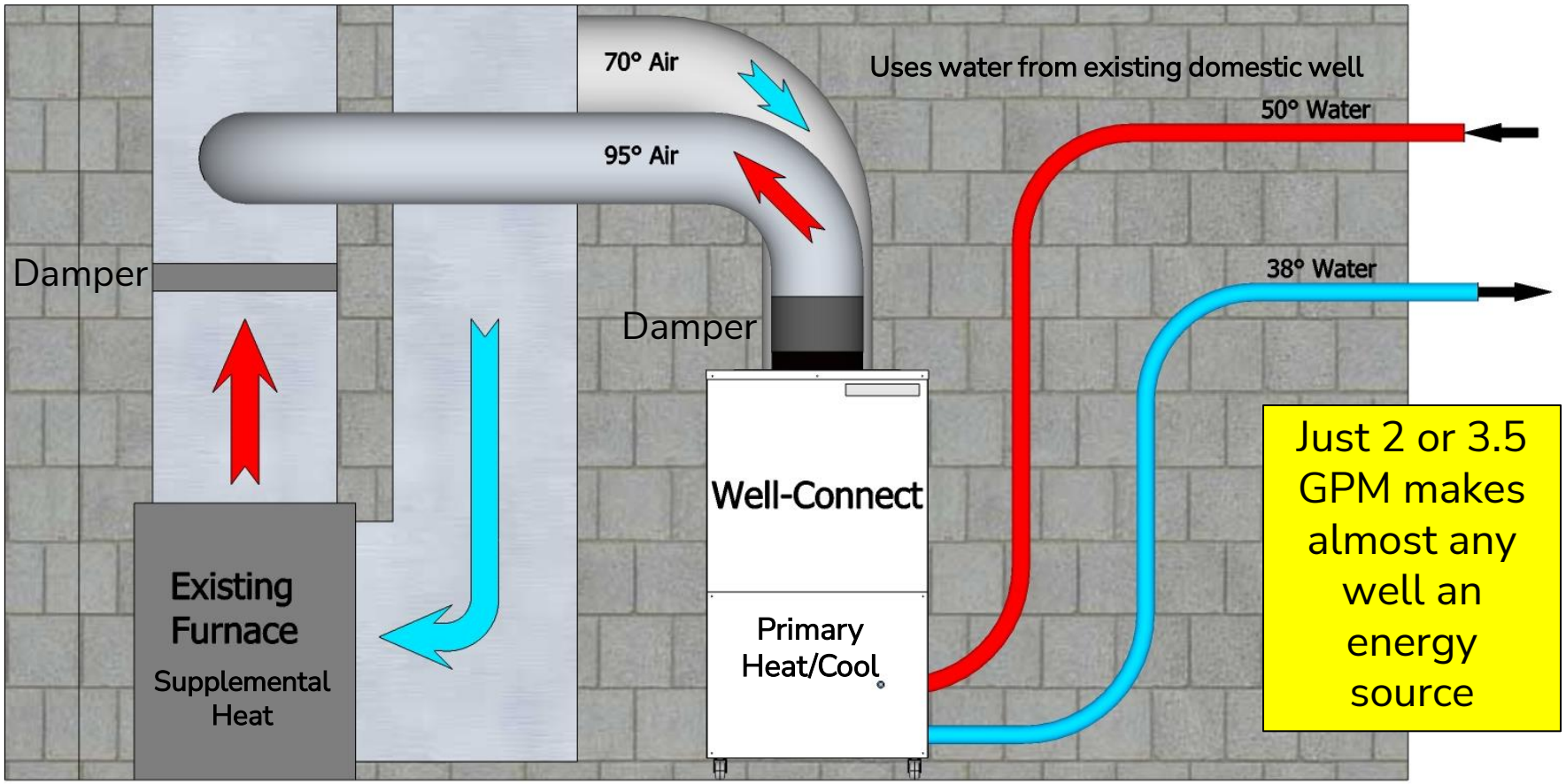
Either the heat pump is running (in moderate weather), or the gas furnace is running (in cold weather).

They MUST NOT run simultaneously.



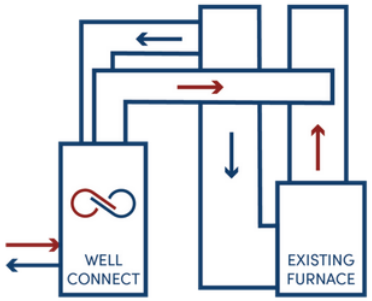
Well-Connect Hybrid Geothermal System

The Well-Connect maintains full capacity and efficiency at all outdoor temperatures.
The furnace runs SIMULTANEOUSLY and *only as needed* for supplemental heat.



Hybrid Geothermal WELL CONNECT

What Makes Well Connect Unique?



HYBRID OPERATION

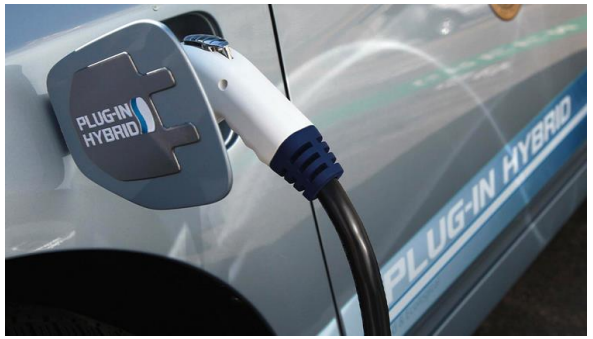
CONNECTS TO YOUR EXISTING FURNACE GIVING YOU MAXIMUM COMFORT YEAR ROUND

WATER EFFICIENT

MINIMAL WATER FLOW REQUIRED MAKING ALMOST EVERY WELL CAPABLE OF HEATING & COOLING YOUR HOME

EASY INSTALLATION

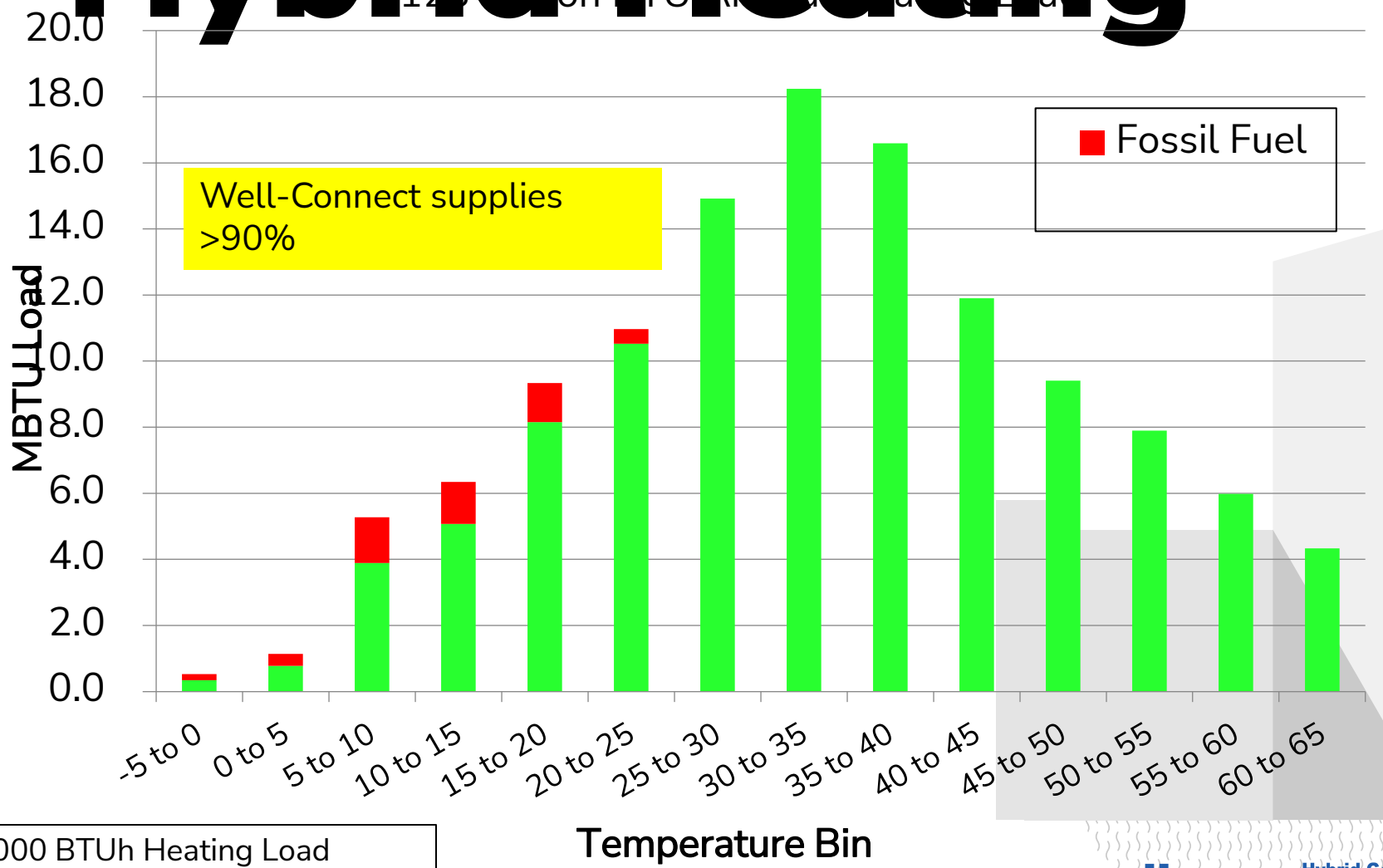
INSTALL IT YOURSELF OR HAVE IT PROFESSIONALLY INSTALLED IN 1 DAY



Well-Connect:
The “PHEV” of Geothermal

Hybrid Geothermal
WELL CONNECT

Well-Connect: Hybrid Heating



50,000 BTUh Heating Load
29,000 BTUh Well-Connect

Hybrid Geothermal
WELL CONNECT

Hybrid Geothermal
WELLCONNECT

Water Discharge

Hybrid Geothermal
WELLCONNECT

2.5 Ton Well-Connect

Bob Chapin - Unit 20-183, 2.5t

LAST UPDATED
Time: 18:09:16 EDT
Date: 12-31-2021

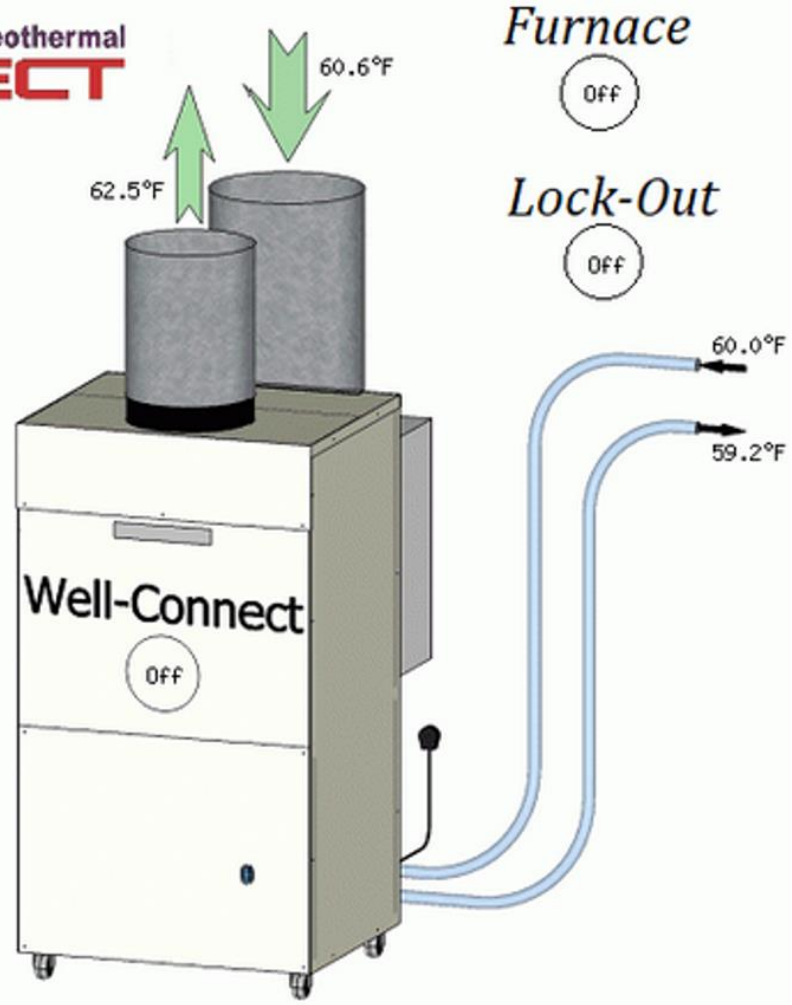
Hybrid Geothermal
WELL CONNECT

HEATING			
	Today	This Month	This Year
Well-Connect	6.3 Hours	301.5 Hours	2005 Hours
Well-Connect	11.9 kWhrs	573.0 kWhrs	3806 kWhrs
LP Offset	2.1 Gals	98.9 Gals	657 Gals
LP Backup	0.0 Hours	2.9 Hours	12 Hours

COOLING			
	Today	This Month	This Year
Well-Connect	0.0 Hours	0.1 Hours	680 Hours
Well-Connect	0.0 kWhrs	0.1 kWhrs	1122 kWhrs

PUMP POWER			
	Today	This Month	This Year
Well Pump	1.9 kWhrs	90.5 kWhrs	805 kWhrs

TEMPERATURES			
	In	Out	Δ T
Air	60.6°F	62.5°F	1.9°F
Water	60.0°F	59.2°F	-0.8°F



Project Summary

General Project Information

Project Title:	Btu Comparison, Western NY
Project Date:	Friday, August 12, 2022

Design Data

Building Area:	2,000 sq.ft.	Cooling Load:	25,000 Btuh
People:	0	Heating Load:	50,000 Btuh
Occupancy:	0	Loads Adj. Factor:	0.77
		AC On Temp.:	0 °F
Actual City:	Buffalo, New York		
Weather Ref. City:	Buffalo, New York		
Summer Outdoor:	85 °F	Winter Outdoor:	6 °F
Summer Indoor:	75 °F	Winter Indoor:	72 °F
Cooling Hours:	812	Degree Days:	6,736

Annual Operating Cost Estimate

System Description	Fuel Rates Set	Total Heating Cost	Total Cooling Cost	Annual Service Charges	Total Oper. Cost	Average Monthly Cost
Fuel Oil + AC	1	$5,750	$264	$0	$6,014	$501
Standard 4t Geo System	1	$1,756	$179	$0	$1,934	$161
Fuel Oil + 2.5t Well-Connect	1	$1,964	$179	$0	$2,142	$179
Fuel Oil + 1.5t Well-Connect	1	$2,665	$179	$0	$2,843	$237

Range of Results from Data Loggers

Energy Saved (Eliminated by Well-Connect):

1.5 Ton WC	2.5 Ton WC
650 to 950 gallons of propane	950 to 1,400 gallons of propane
500 to 800 gallons of fuel oil	750 to 1,150 gallons of fuel oil
5 to 7 cords of wood	7 to 10 cords of wood
600 to 870 therms of natural gas	870 to 1,280 therms of natural gas

Energy Used (to operate Well-Connect & well pump):

1.5 Ton WC	2.5 Ton WC
4,200 kWh to 6,300 kWh	5,900 kWh to 9,200 kWh

Air Conditioning (Michigan):

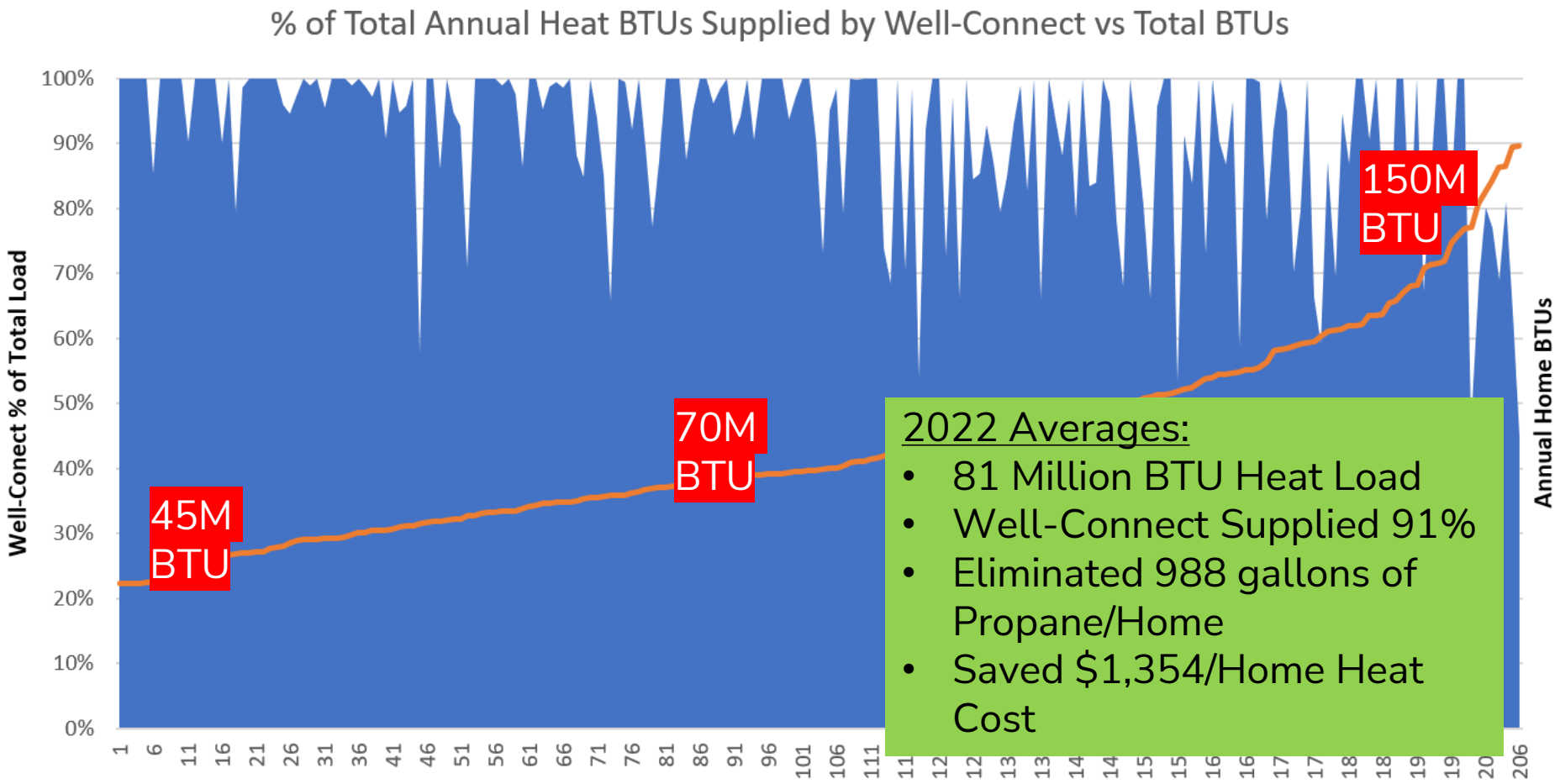
Annual kWh consumed ranges from 600 kWh to 1,600 kWh per Summer.

Size of Homes:

- Primary Range is 1,500 to 2,500 sf on average
- Full range 1,200 to 3,500

Hybrid Geothermal WELL CONNECT

Well-Connect Supplies >90%



2022 Averages:

- 81 Million BTU Heat Load
- Well-Connect Supplied 91%
- Eliminated 988 gallons of Propane/Home
- Saved $1,354/Home Heat Cost

Hybrid Geothermal WELL-CONNECT

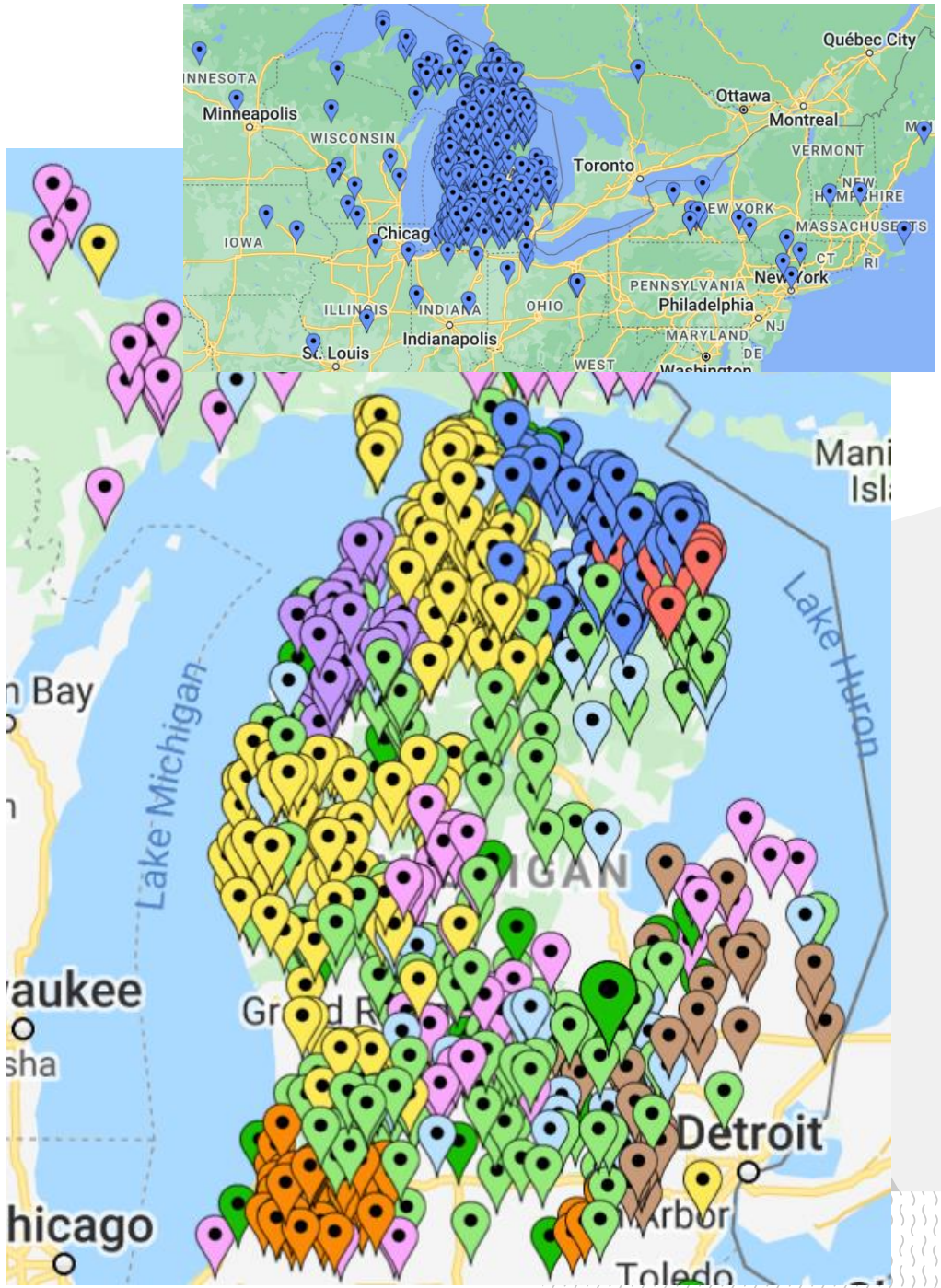
Hybrid Geothermal
WELL CONNECT

Installed Systems >1,300

2012 to 2017: 100 Units

2018 to 2022: >1,200 Units

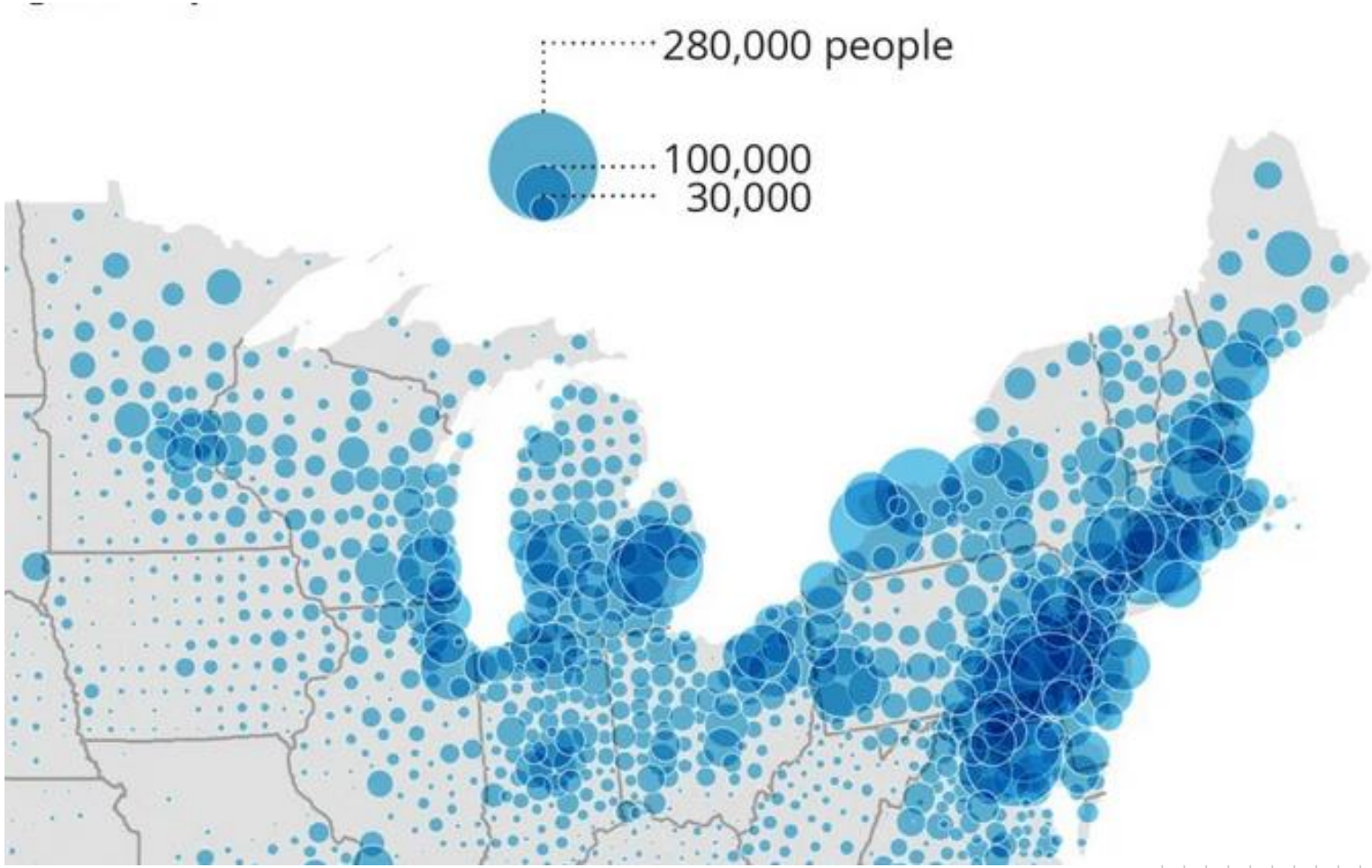
Since 2018, 2 out of 3 Residential Geothermal Systems Sold in Michigan were Well-Connects*



* Per Energy Optimization & MI Saves data

Number of People in each County who use Household Wells
(Domestic, self-supplied population)

Source: U.S. Geological Survey



Accomplishments

GOVERNOR'S ENERGY EXCELLENCE AWARDS

INNOVATOR OF THE YEAR

ENERGY STAR

U.S. & Canadian Patents

Canada Patents and Trademarks

INTERTEK ETL CM LISTED C US

TERRA CALORIC
EARTH ENERGY

Hybrid Geothermal

- Rural Homeowners
- Existing Homes/Retrofit
- Supplies 80%+ of Heating
- Simultaneous Operation
- Added to Existing System
- Installs in 1 Day
- 2 gpm or 3.5 gpm Flow Rate

Terra Caloric Facility (10,000 s

Heated with 5 Well-Connects (9.5 Ton total) @ max 13 gpm

DARCY®

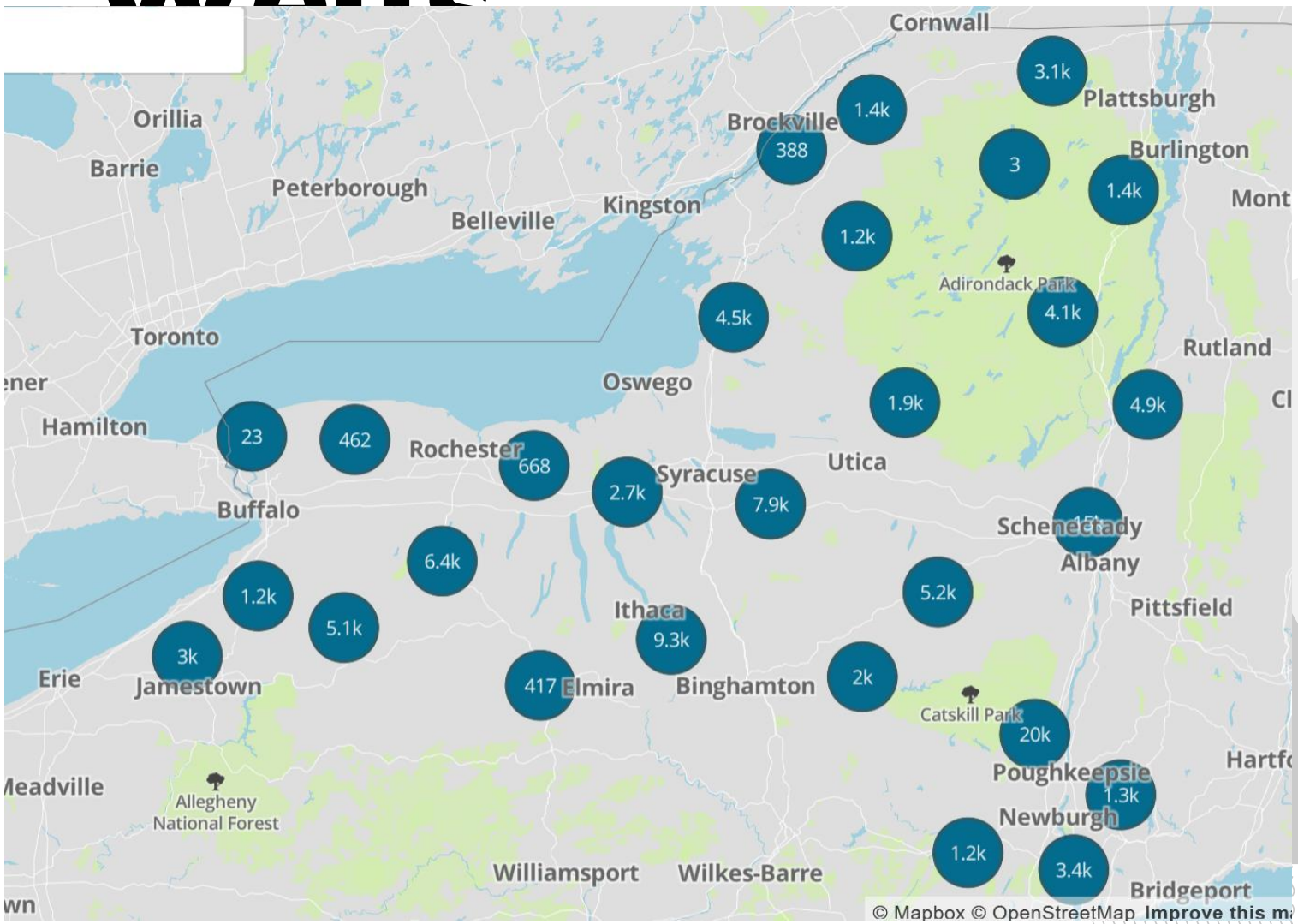
NY-GEO

THANK YOU

TERRA CALORIC
EARTH ENERGY

Hybrid Geothermal
WELL CONNECT

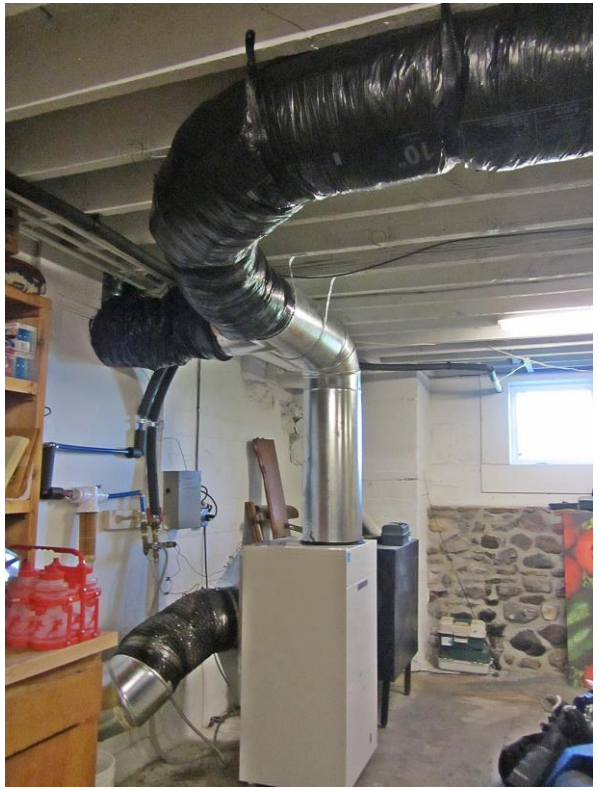
New York Water Wells



3 Installation Options

Integrated with Existing Furnace

Self-Ducted to Living Area



Ductless In Living Area

Hybrid Heating and Cooling
WellCONNECT

Integrated Installation

Hybrid Heating and Cooling
WELL CONNECT

Self-Ducted Installation

Supply Vents Added at 2 locations

Hybrid Heating and Cooling
WellCONNECT

Ductless Installation

Hooks up just like a washing machine.

Warm or Cool Air Discharge to Living Area

Hybrid Heating and Cooling
WellCONNECT

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Date: 03/17/2015

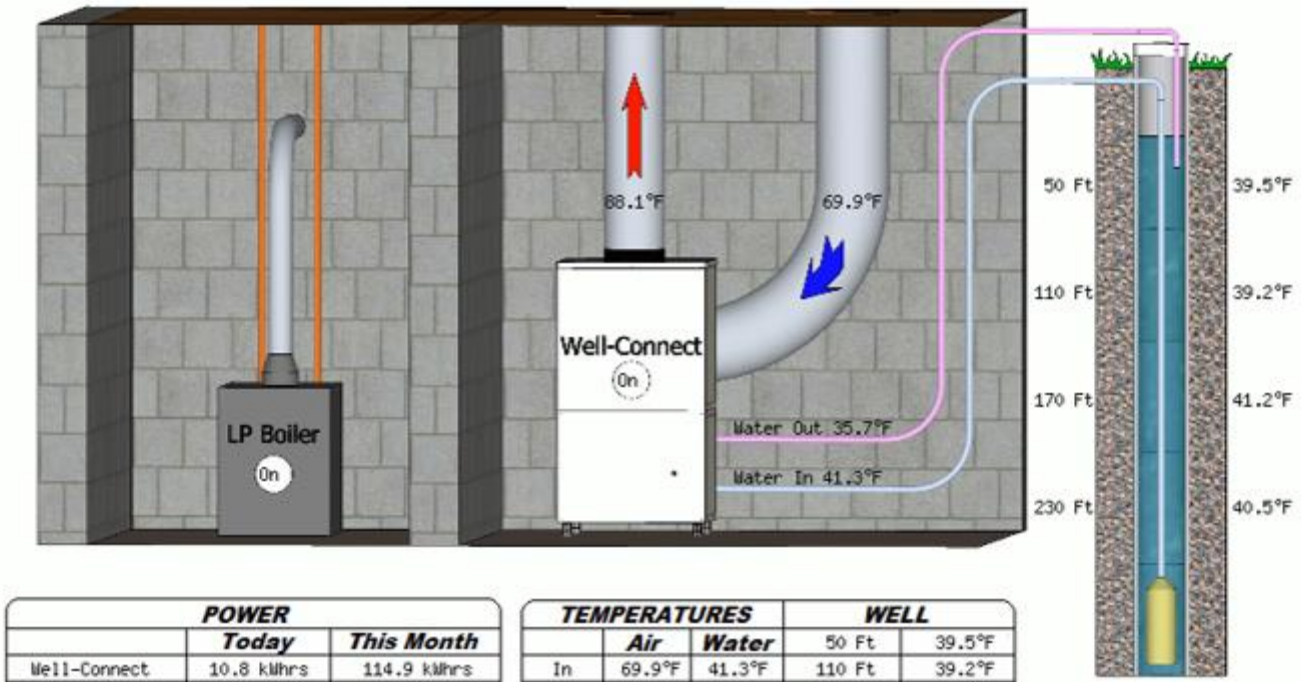
Well-Connect Standing Column Installation

49707

RUN TIMES			
	Now	Today	This Month
Well-Connect	On	6.5 Hours	69.6 Hours
Boiler	On	6.5 Hours	138.5 Hours

Outside
27.8°F

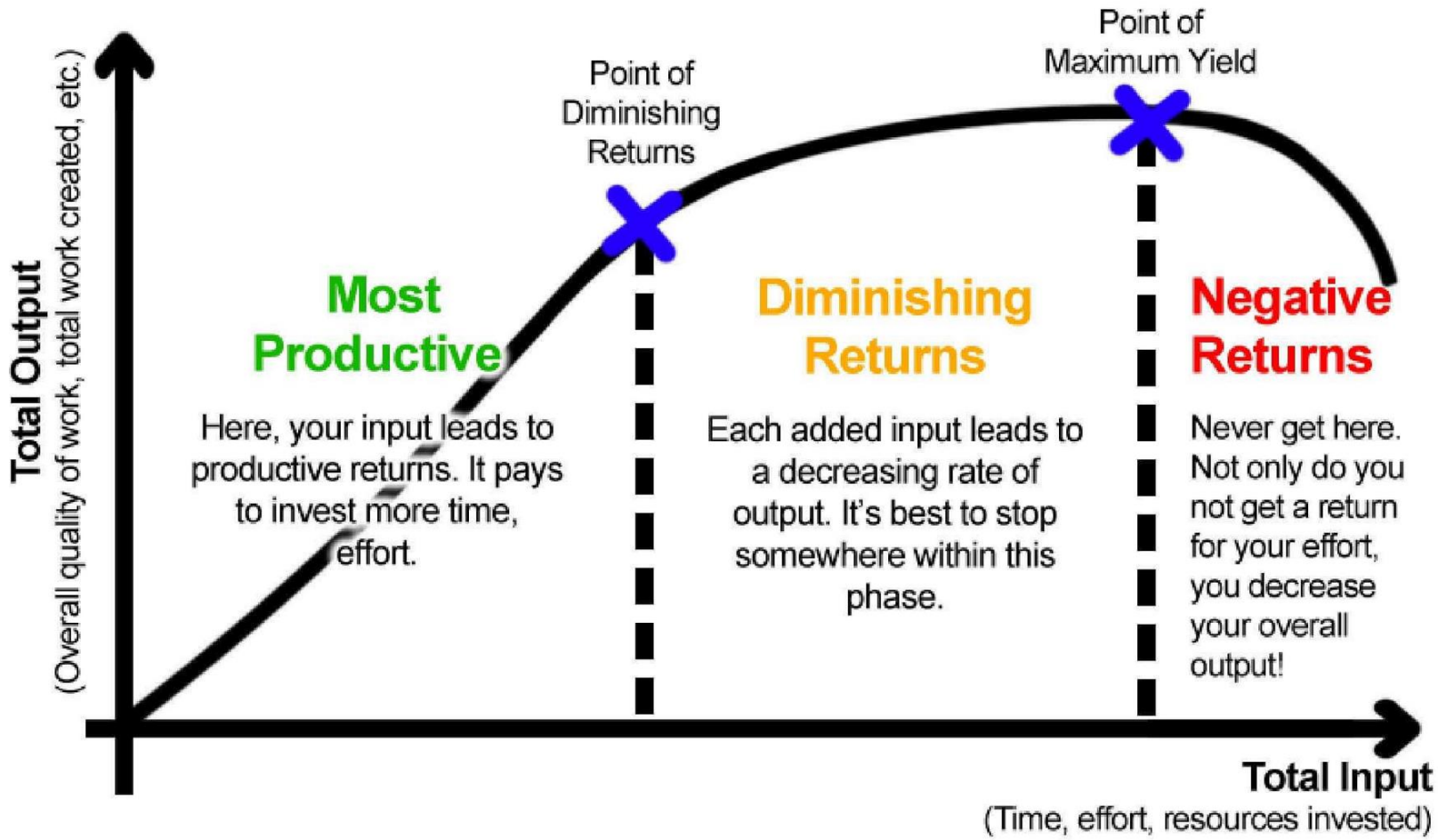
ENERGY		
	Today	This Month
Energy Delivered	78.8 kBtu	865 kBtu
Propane Avoided	0.96 Gals	10.5 Gals

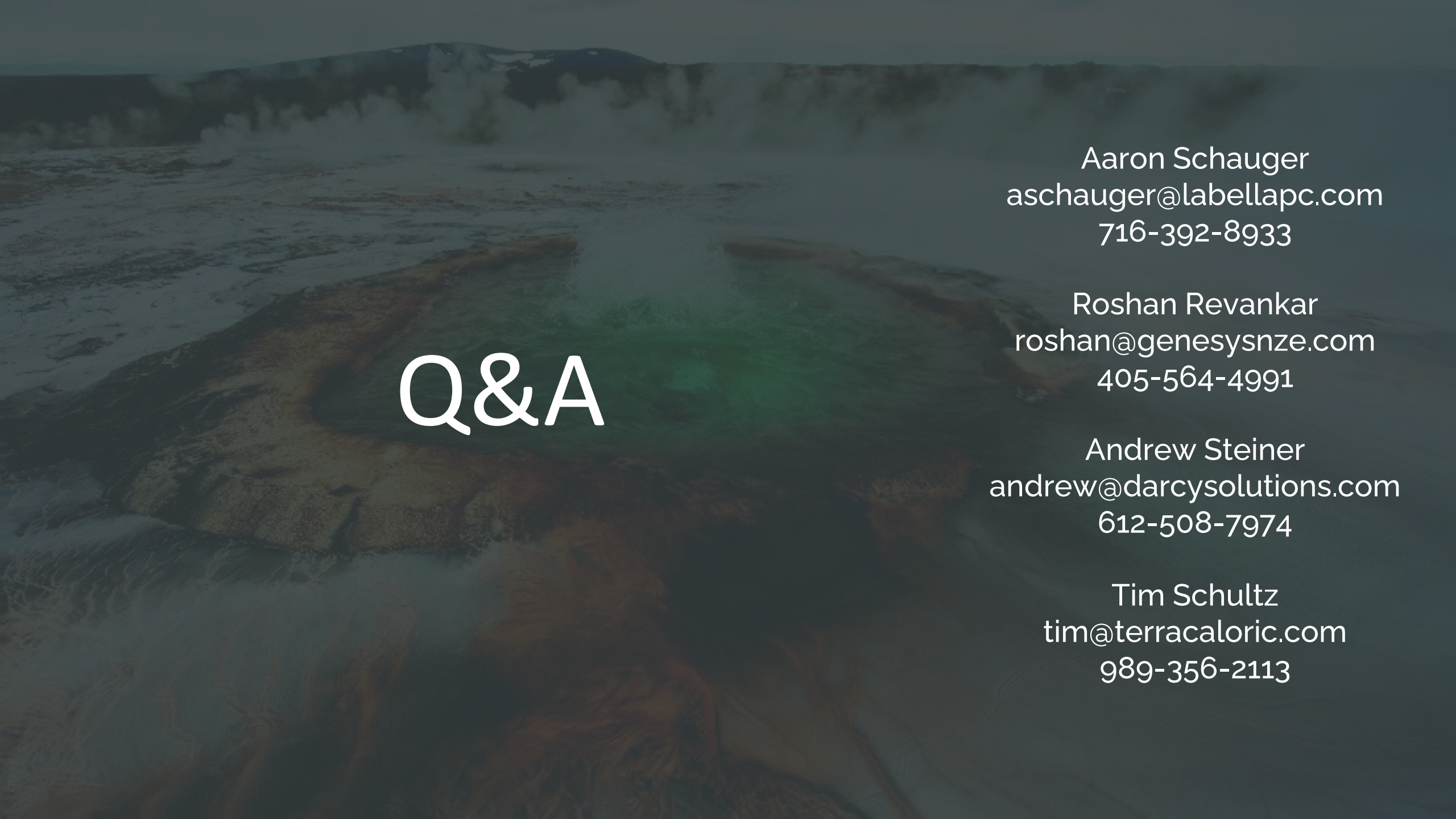


POWER		
	Today	This Month
Well-Connect	10.8 kWhrs	114.9 kWhrs
Well Water Pump	0.3 kWhrs	3.5 kWhrs
Total System	10.8 kWhrs	114.9 kWhrs

TEMPERATURES			WELL	
	Air	Water	50 Ft	39.5°F
In	69.9°F	41.3°F	110 Ft	39.2°F
Out	88.1°F	35.7°F	170 Ft	41.2°F
DeltaT	18.2°F	-5.6°F	230 Ft	40.5°F

Marginal Utility





Q&A

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