



FEBRUARY 5, 2020

Drill Baby Drill!

Residential Geothermal: Can it Scale?

Jake Marin – Efficiency Vermont

Ryan Dougherty – US GeoExchange

Gretchen Schimelpfenig – Burlington Electric Department

Kathy Hannun – Dandelion Energy



Our Panel



Ryan Dougherty
US GeoExchange



Gretchen
Schimelpfenig
Burlington Electric Dept



Kathy Hannun
Dandelion Energy



Why Geothermal?



Most Efficient HVAC System

- COP 3-5



Consistent Output/Efficiency

- Total fossil system replacement (no backup)



Long Life

- 25 yrs.



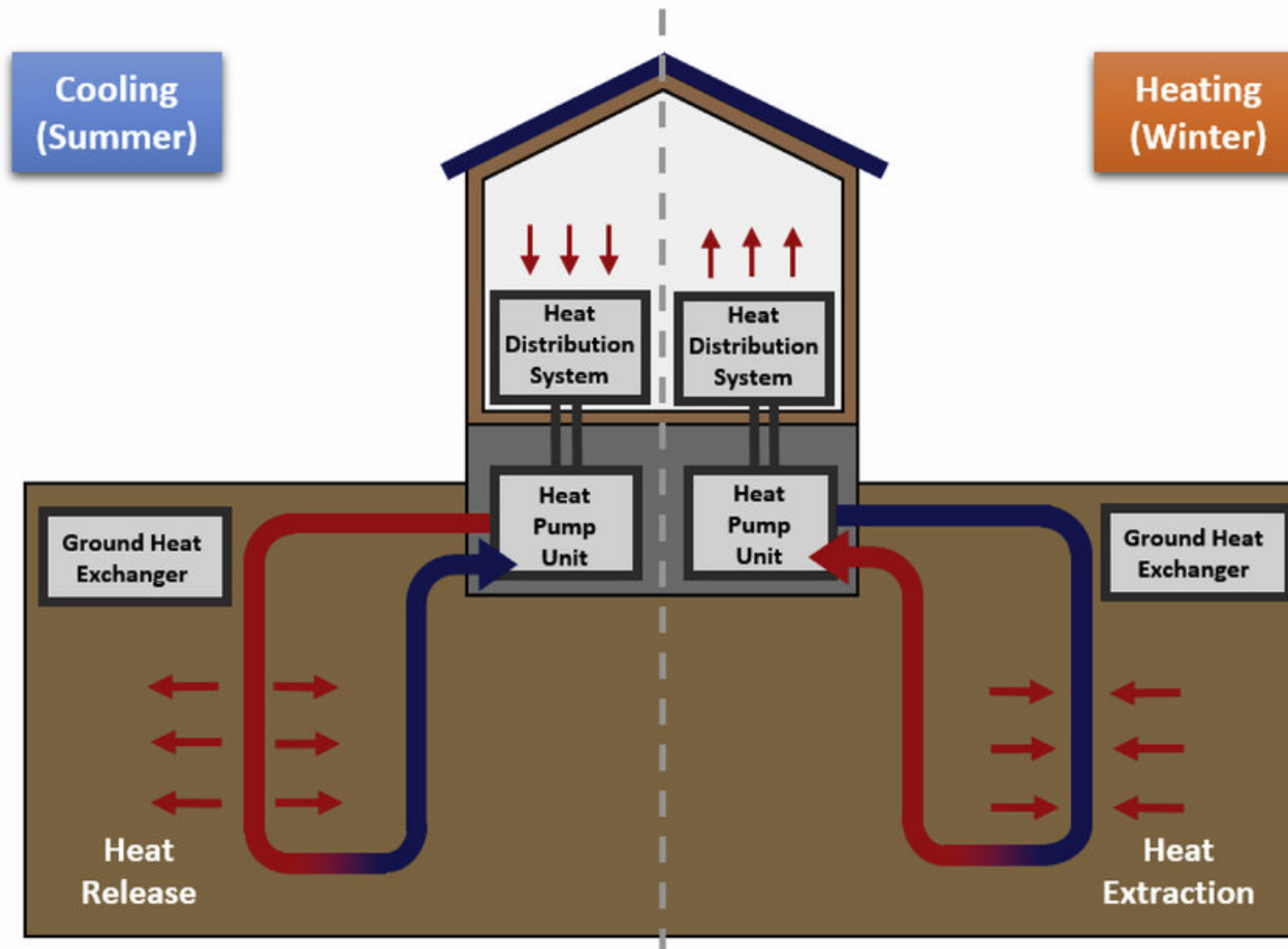
Fully Distributed

- Whole Building Heat Pump

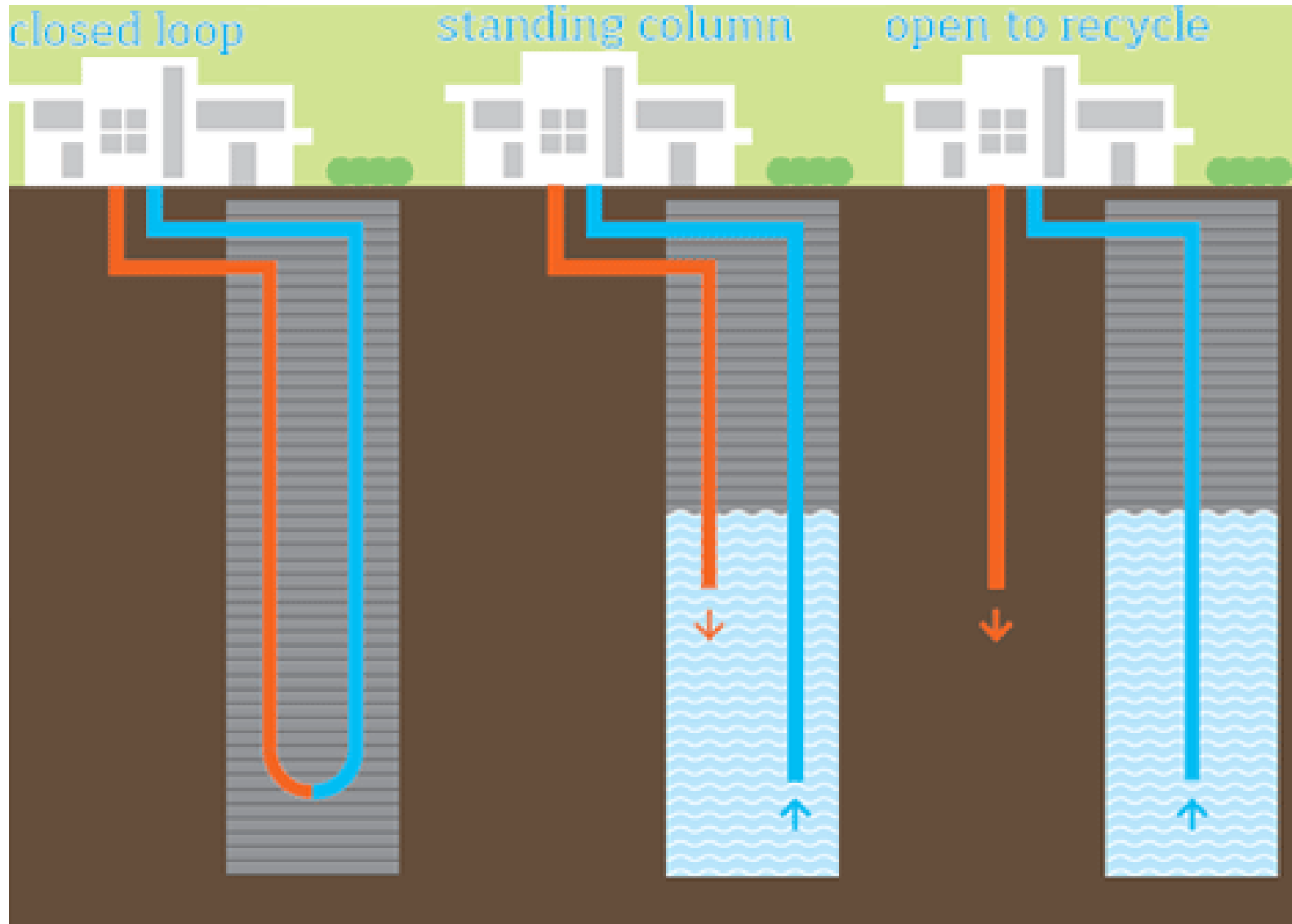
Why Now?

- Maturity of heat pump market
- Whole building solution
- Tier 3 – More \$\$\$ support
- Fossil Fuel reduction – increasing awareness
- Many lessons learned

GSHP – How it Works



Ground Loop – Open vs. Closed

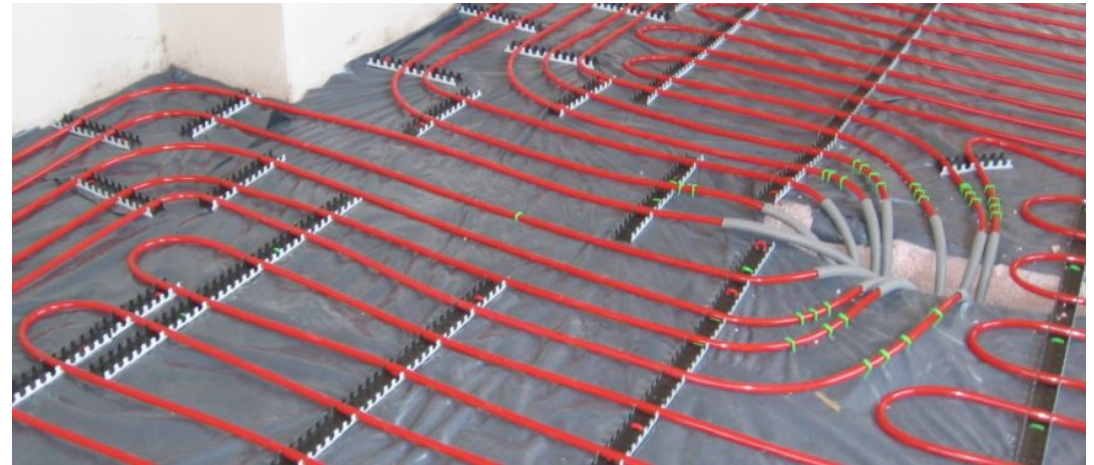


GSHP – Distribution

Water to Air
Into Ductwork



Water to Water
Hydronic Piping



Efficiency
Vermont

Program Support

- State-wide program in development!
- Efficiency Vermont and BED, in partnership with VT Distribution Utilities
- Extensive stakeholder input
- Highly collaborative approach



Drill, Baby, Drill! Residential Geothermal: Can it Scale?

Better Buildings by Design
February 5, 2020



Geothermal Exchange Organization

- Advocacy
- Public Outreach
- Partnerships
- Quality Standards

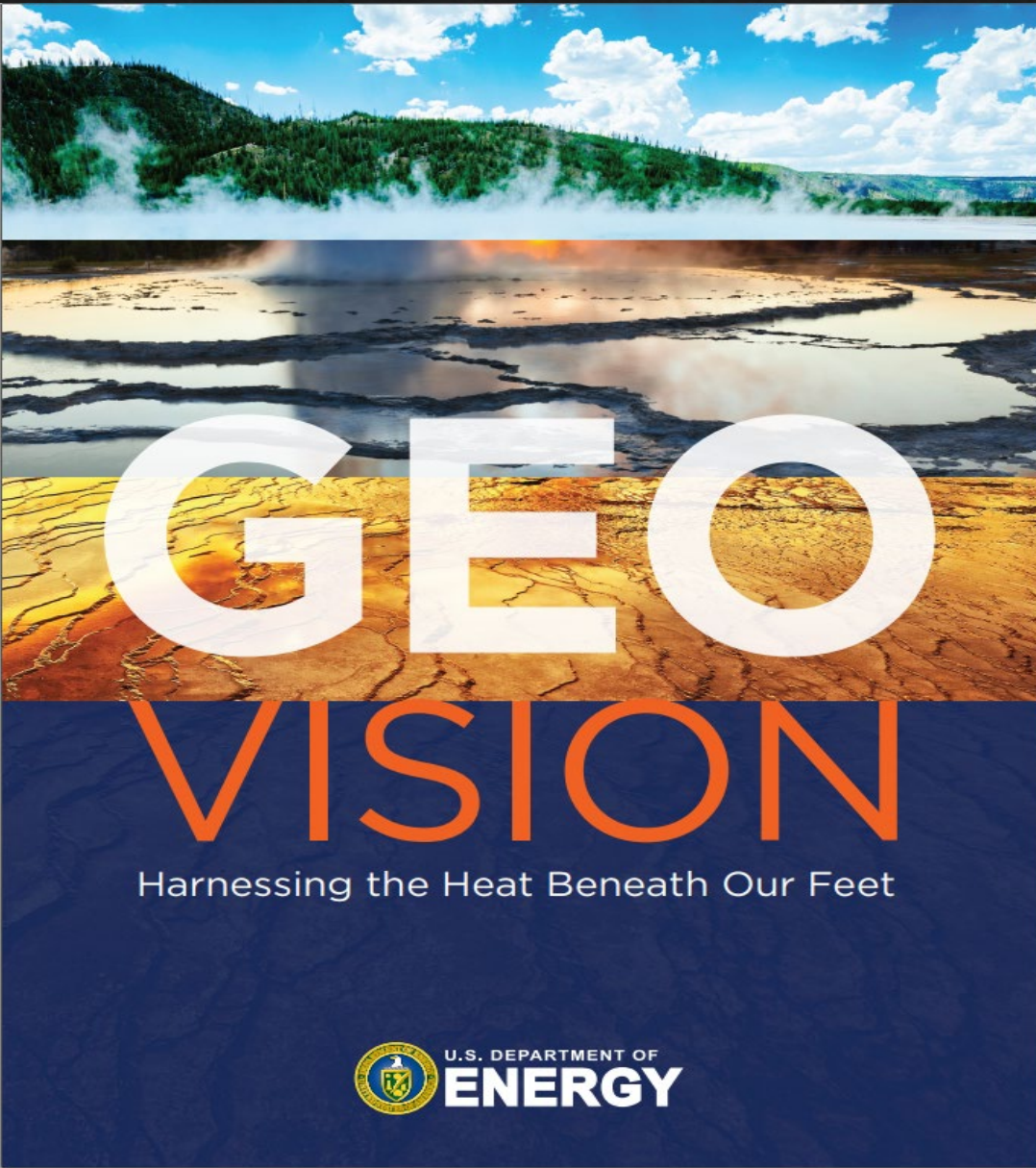
State of the U.S. Geothermal Heat Pump Industry

- Over 1 million systems in operation
- Capacity equal to 2M homes – 16,800 MWth
- Significant market growth in states focused on building decarb (but still ~1% HVAC)
- Increasing federal support – Residential tax credits currently 26% of total system cost

Current Federal Legislation

- HR 3961 – Renewable Energy Extension Act
- S 2289 – Renewable Energy Extension Act
- S 2657 – AGILE Act
- HR 5374 – Advanced Geothermal R&D Act

U.S. DOE GeoVision Report



- Outlines potential for 28 million residential geo installs by 2050
- Describes barriers to this goal
- Emphasizes the need for partnerships and improved stakeholder collaboration

Barriers to Geothermal Heat Pump Adoption

- Low Consumer Awareness
- High Up-Front Costs
- Low Natural Gas Prices
- Bad Apple Installs

The New York Model

[Services](#)[News](#)[Government](#)[Local](#)

NYSERDA

FUNDING OPPORTUNITY DETAIL

[Current Funding Opportunities](#)

Ground Source Heat Pump Rebate (PON 3620)

Due Date: Continuous

NYSERDA and NYPA Announce \$3.8 Million Available for Statewide Geothermal Clean Energy Challenge

Community Corner

Con Ed Pushes Geothermal Energy During Westchester Gas Moratorium

The moratorium on new natural gas hookups has been in place since March.

By Lanning Talliaferro, Patch Staff ✓
Jan 15, 2020 12:35 pm ET

Geothermal Pre-feasibility Tool

Welcome to the New York City Geothermal Pre-feasibility Tool. Use this tool to identify areas where ground source, or [geothermal heat pump systems](#) may be an option for retrofitting buildings' heating and cooling systems. View instructions for using this tool on our [Help](#) page.

In [One New York: The Plan for a Strong and Just City](#), the City committed to reducing greenhouse gas (GHG) emissions 80% by 2050. Reducing emissions in buildings, the largest source of GHG emissions in New York City, is key to reaching this goal. Geothermal heat pump systems are a promising way to reduce emissions from buildings and tap into a cleaner future grid.

Success of geothermal heat pump systems is dependent on a number of key variables, so building owners should still conduct a full feasibility study before installing them.

This tool was brought to you by the [New York City Mayor's Office of Sustainability](#) and the [New York City Department of Design and Construction](#), pursuant to [New York City Local Law 6 of 2016](#).

[Explore Feasibility](#)



NYSERDA

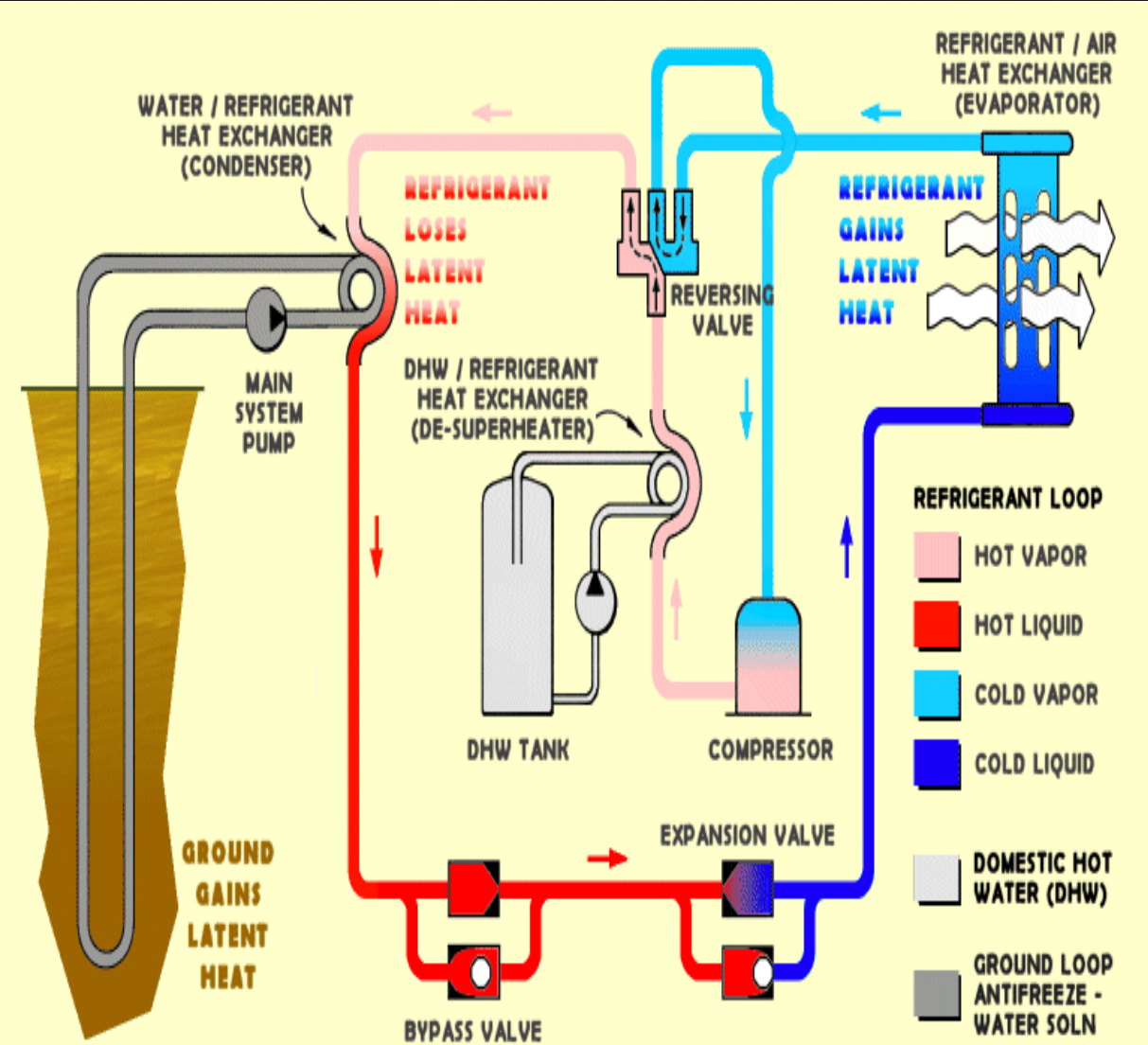


Keynote:
Alicia Barton
CEO,
NYSERDA

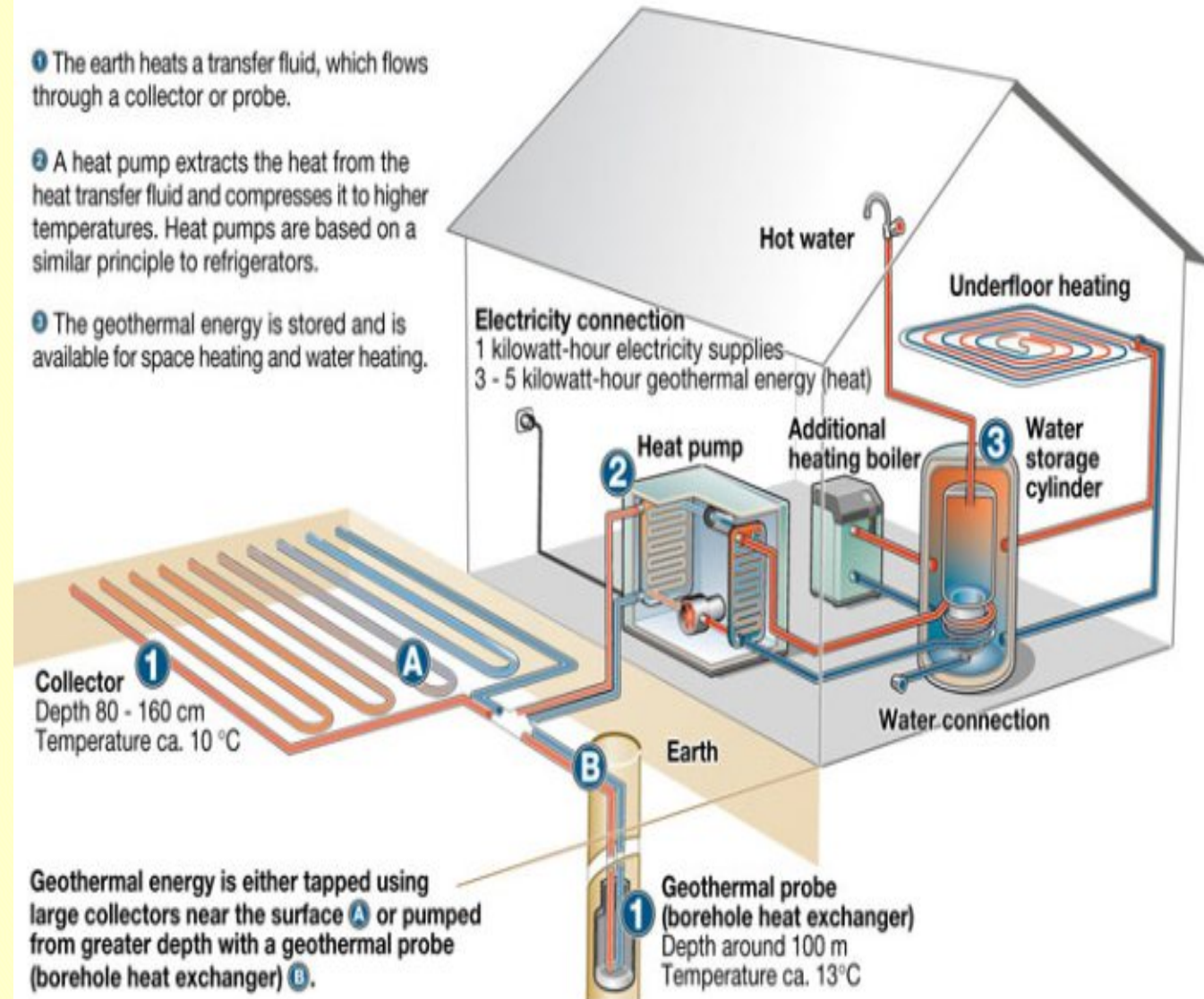
NY-GEO 2020
March 25th & 26th
To Be Held At: **Marriott**
Electrify! with Heat Pumps



Explaining how it works – The old way...



- 1 The earth heats a transfer fluid, which flows through a collector or probe.
- 2 A heat pump extracts the heat from the heat transfer fluid and compresses it to higher temperatures. Heat pumps are based on a similar principle to refrigerators.
- 3 The geothermal energy is stored and is available for space heating and water heating.

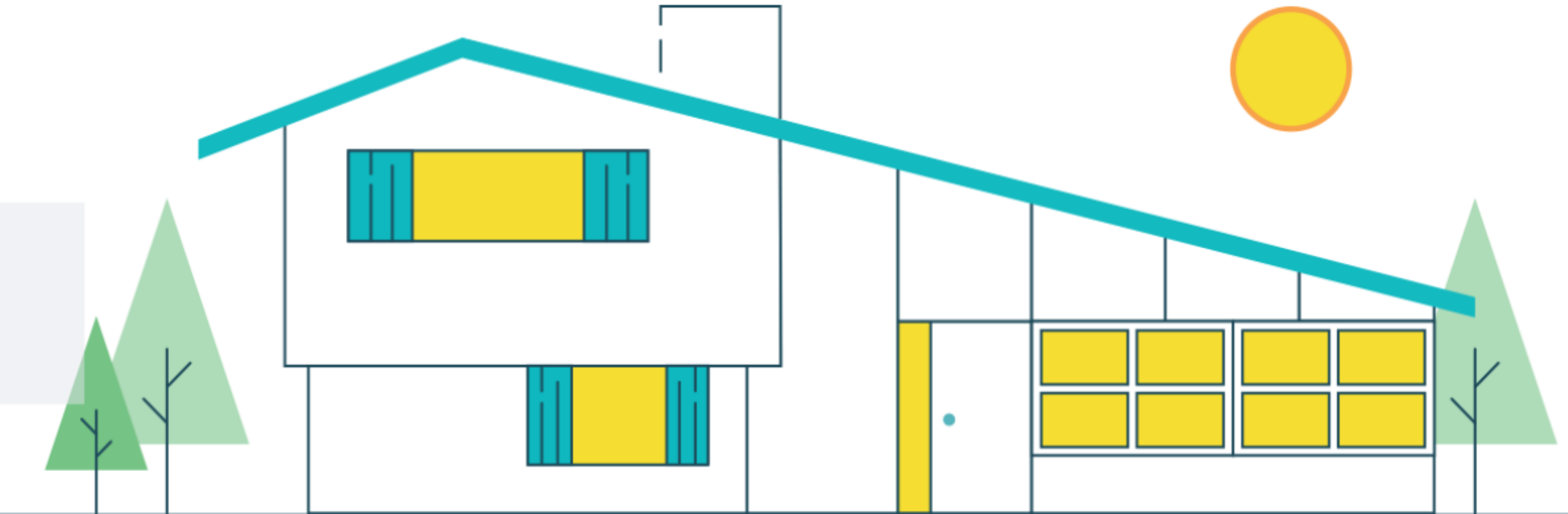


Geothermal energy is either tapped using large collectors near the surface A or pumped from greater depth with a geothermal probe (borehole heat exchanger) B.

A new approach

**Save Money. Save the Planet.
Be extremely comfortable doing both.**

We're living right on top of the most affordable, sustainable and comfortable energy source on earth: the earth itself.



Industry-Sponsored Consumer Awareness

geothermal
energy we can all agree on



Affordable

\$1,416 average per home
savings per year



Renewable

One geothermal system
= Planting 750 trees



The Rise of the All-Geothermal Community

[Life](#)

[Contact an agent](#)

PINENOOD FOREST

[Our Team](#)

[Media](#)

What is geothermal?

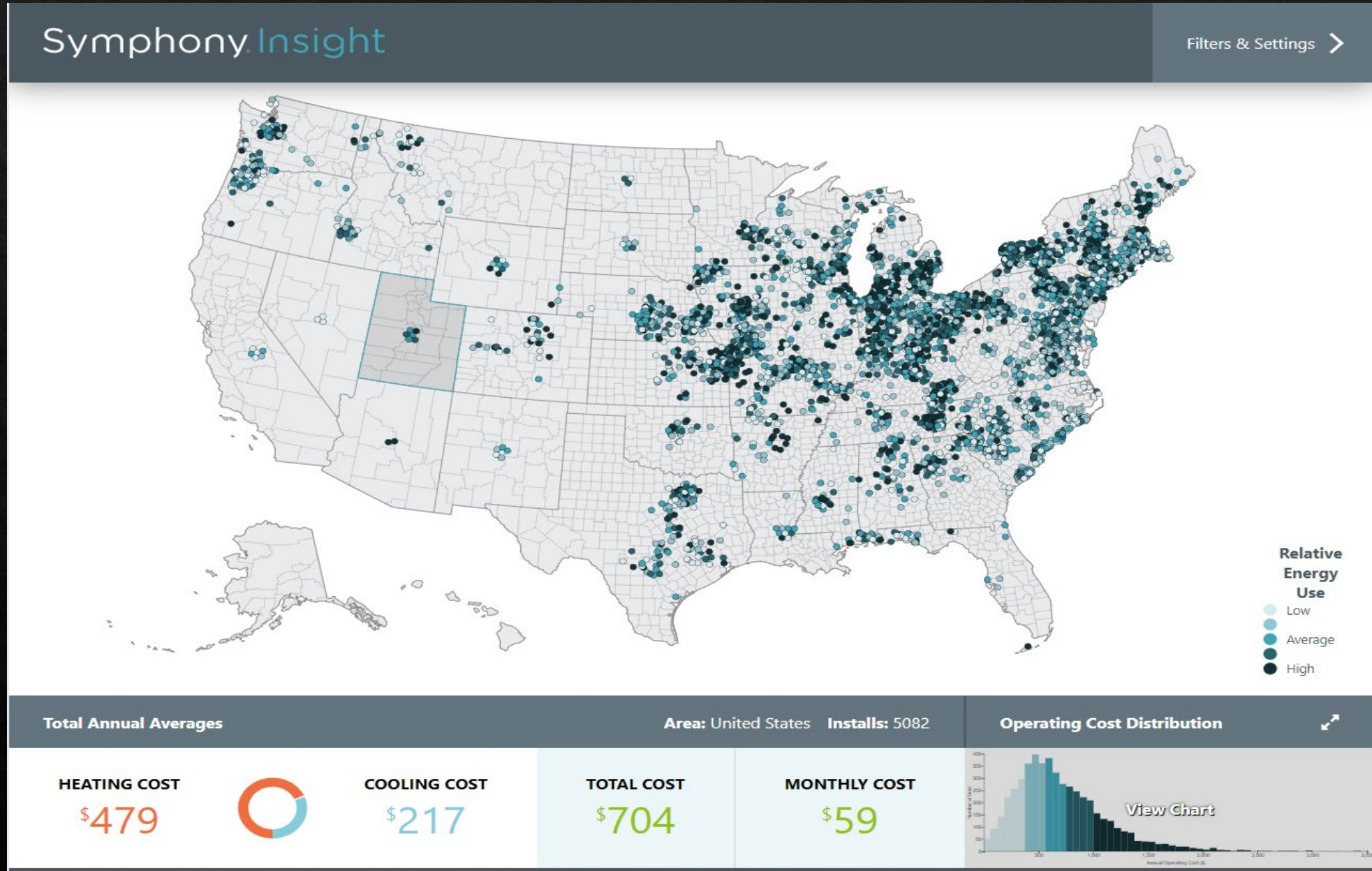


One of the ways we are leaning into environmental responsibility is by using geothermal energy. We root down into the earth to heat and cool the homes we are building.

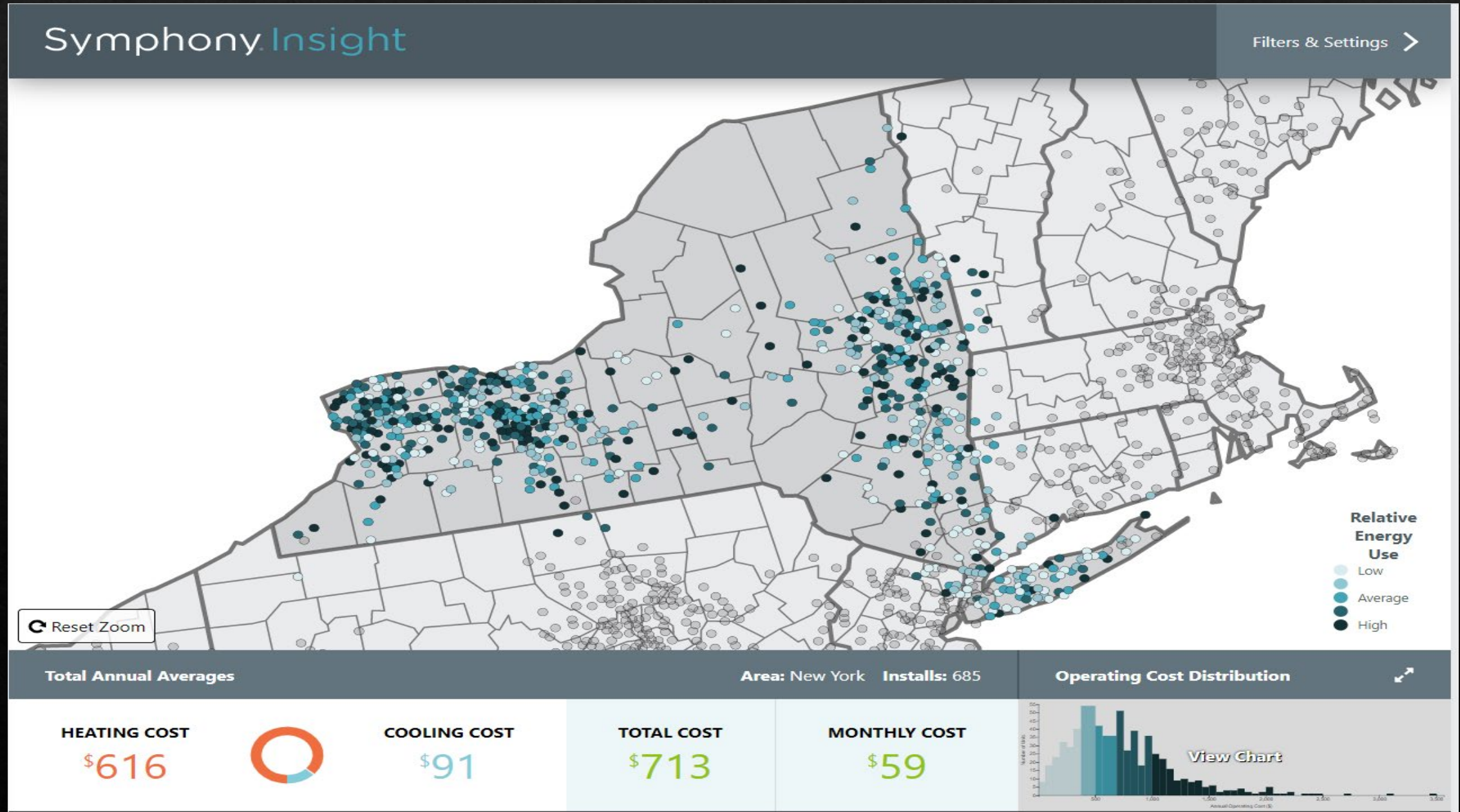
Phase 1-4



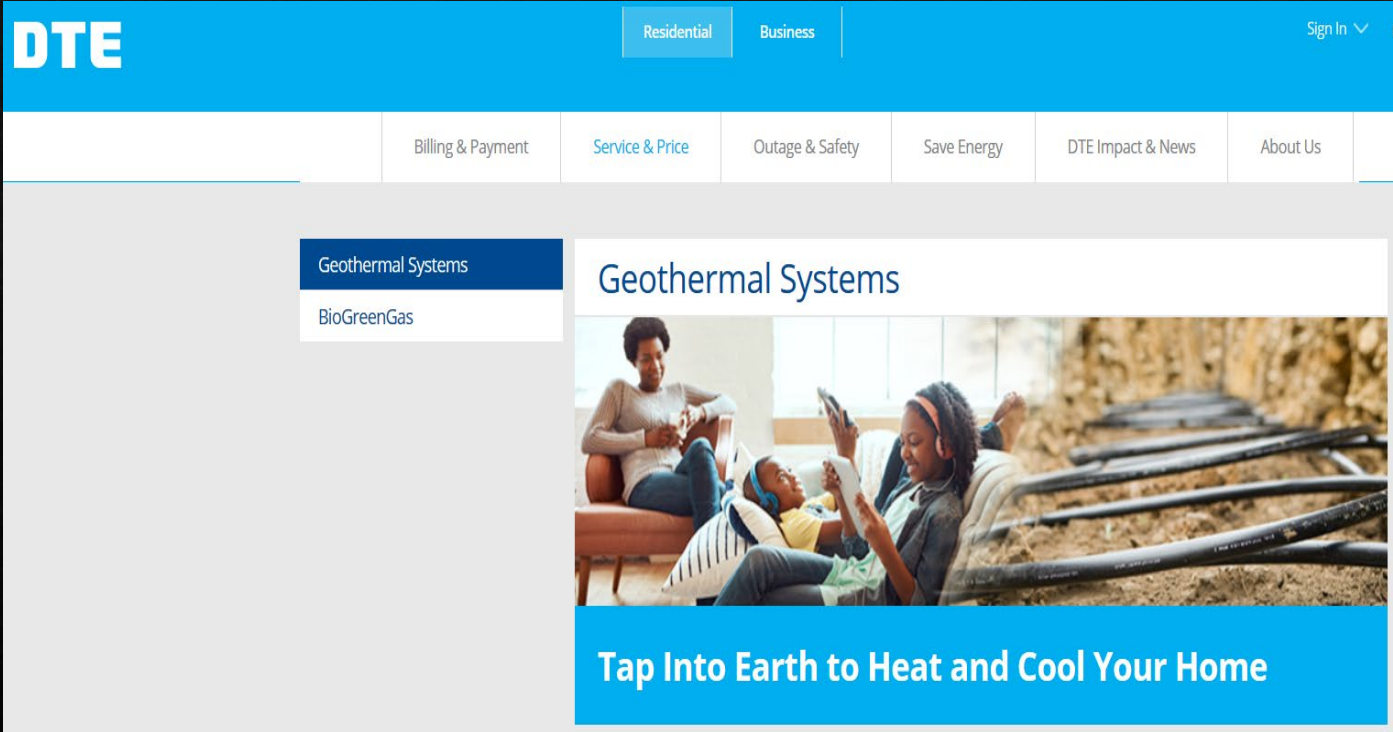
New technologies – WaterFurnace Symphony Insight



New technologies – WaterFurnace Symphony Insight



Increasing Utility Support



Accelerating Commercial and Institutional Adoption

The New York Times

The New, Green Pride of St. Patrick's Cathedral Is Underground



Jeffrey Murphy, who led the team overseeing the restoration of St. Patrick's Cathedral in Manhattan, in the geothermal plant under the church campus. James Estrin/The New York Times

NEWS

The former Blodgett Oven factory is on track to become Vermont's largest campus that cools and heats itself

Joel Banner Baird Burlington Free Press

Published 10:00 p.m. ET Apr. 21, 2019 | Updated 2:16 p.m. ET Apr. 22, 2019



Our Energy

Michigan Capitol Goes Green With Geothermal

March 2018

Accelerating Commercial and Institutional Adoption



Lady Bird Johnson Middle School
Irving, Texas

A screenshot of the IKEA website. The header includes the IKEA logo, navigation links for Offers, Products, Rooms, Ideas & Inspiration, and New at IKEA, and a search bar. The main content area features a news article titled "IKEA planning state's largest geothermal project for heating & cooling kansas city-area store..". Below the title is a sub-headline: "IKEA planning state's largest geothermal project for heating & cooling kansas city-area store opening Fall 2014 in Merriam, KS". The article is followed by a large headline: "Google's New Office Will Be Heated And Cooled By The Ground Underneath". The text of the article states: "The company's Bay View campus will have the largest ground-source heat pump system installation in North America, using the heat from the surrounding ground to power the building's climate control—and no fossil fuels." Below the text is a photograph of a large, modern building with a distinctive, angular, metallic roof structure, situated in a grassy field. The image is credited to Google.

IKEA Offers Products Rooms Ideas & Inspiration New at IKEA

Search for products

Home > This is IKEA > Newsroom > IKEA planning state's largest geothermal project for heating & cooling kansas city-area store..

IKEA planning state's largest geothermal project for heating & cooling kansas city-area store..

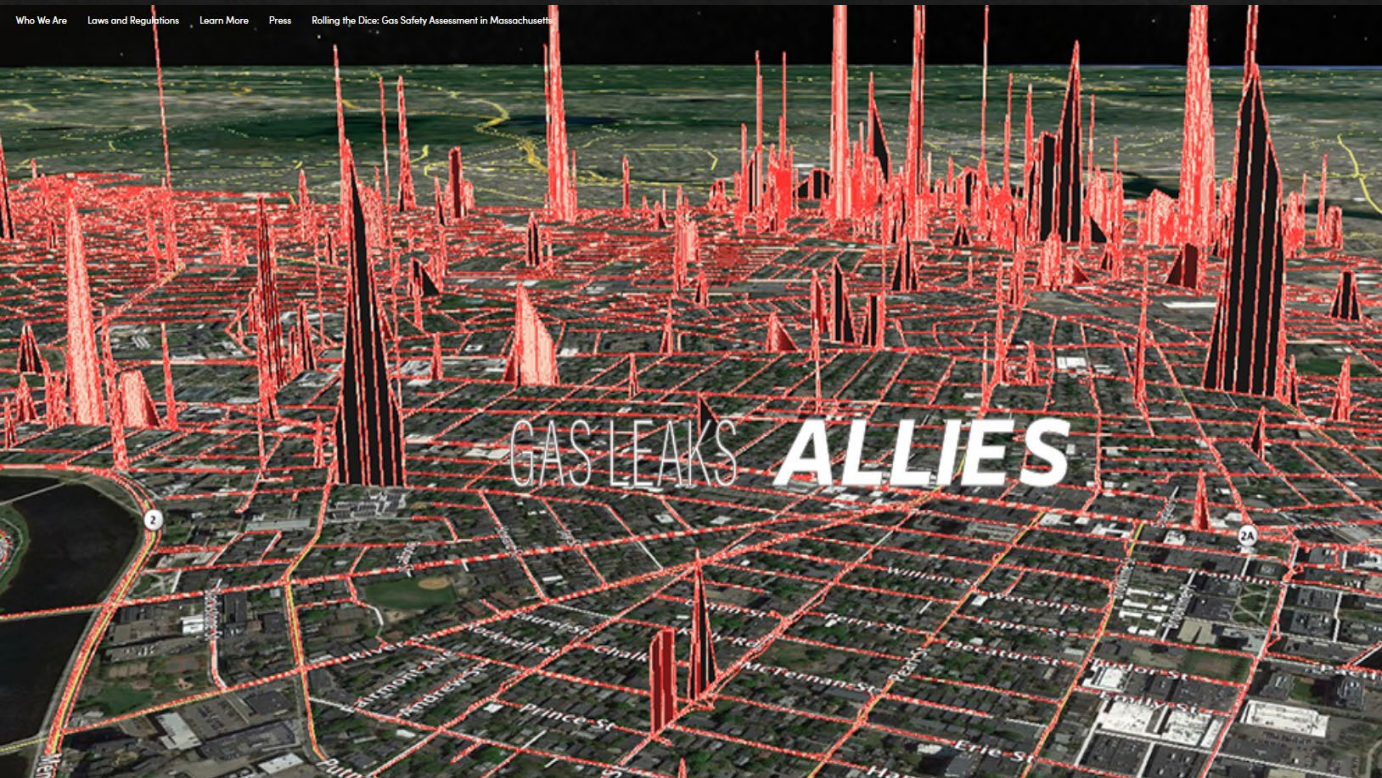
IKEA planning state's largest geothermal project for heating & cooling kansas city-area store opening Fall 2014 in Merriam, KS

Google's New Office Will Be Heated And Cooled By The Ground Underneath

The company's Bay View campus will have the largest ground-source heat pump system installation in North America, using the heat from the surrounding ground to power the building's climate control—and no fossil fuels.

The system uses geothermal heat pumps, relying on the steady 65-degree temperature of the ground to absorb and reject heat. [Image: Google]

What's Next?



GAS LEAKS **ALLIES**

A broad coalition of more than 25 organizations and researchers, the Gas Leaks Allies focus on reducing methane emissions from the natural gas distribution system while transitioning to fossil-free energy sources.

GEOCENTS
MAKING GEOTHERMAL AFFORDABLE

ALL THE BENEFITS NONE OF THE RISK

GEOTHERMAL SIMPLIFIED



DIVERSO ENERGY - A GEOTHERMAL UTILITY COMPANY

Thank you!!

Ryan Dougherty, Chief Operating Officer

Geothermal Exchange Organization

ryan@geoexchange.org



Net Zero Energy City & Strategic Electrification with Ground Source Heat Pumps



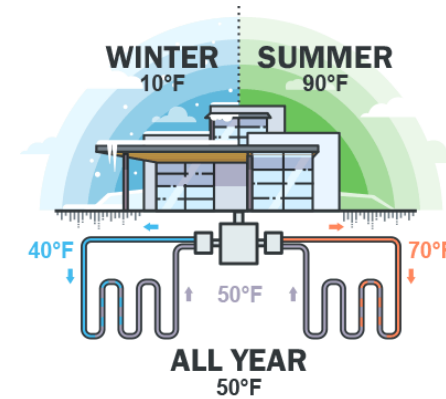
Our Strategic Direction

Mission: To serve the energy needs of our customers in a safe, reliable, affordable, and socially responsible manner.

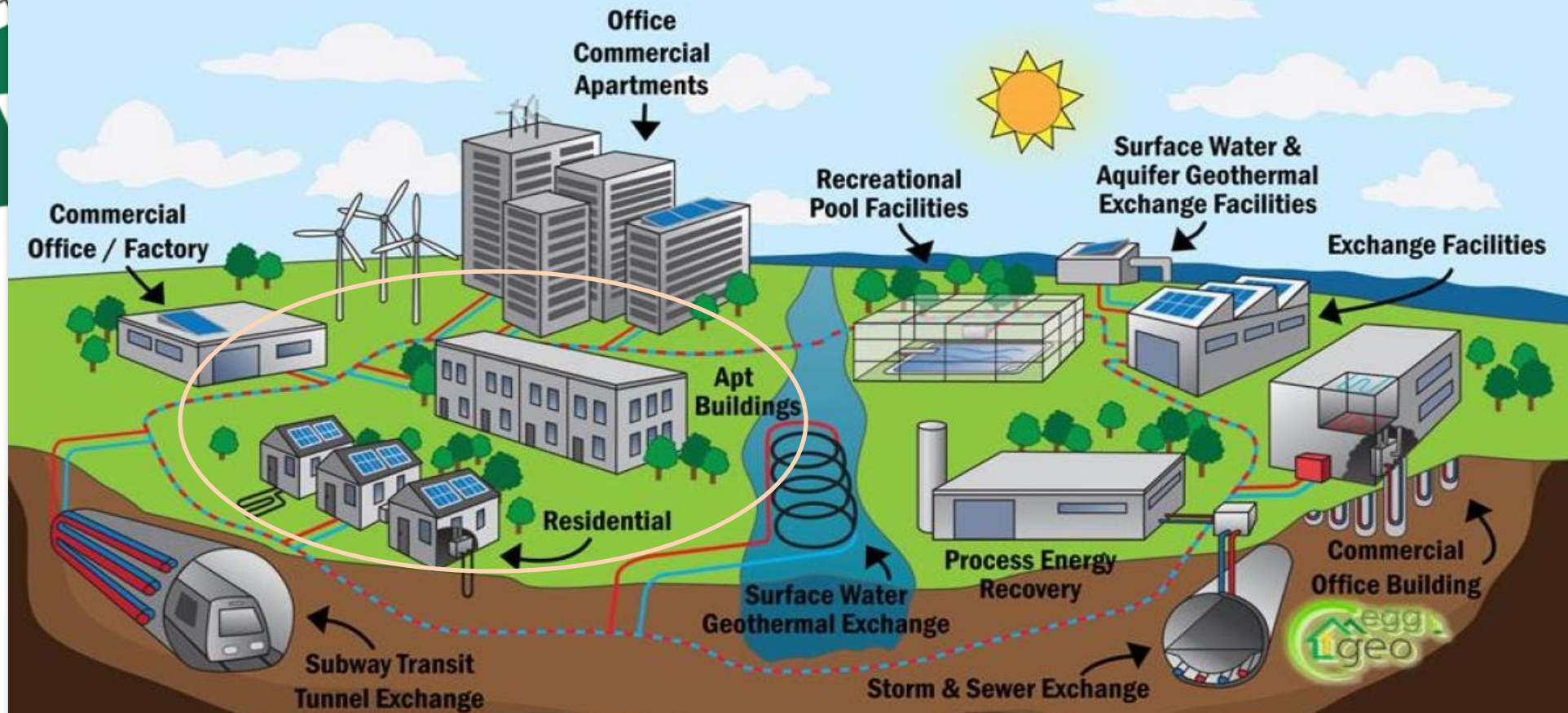
Values: Safety, Reliability, Community, Innovation

2030 Vision: Make Burlington a Net Zero Energy (NZE) city across electric, thermal, and ground transportation sectors by managing demand, realizing efficiency gains, and expanding local renewable generation, while increasing system resilience.

Customer Benefits



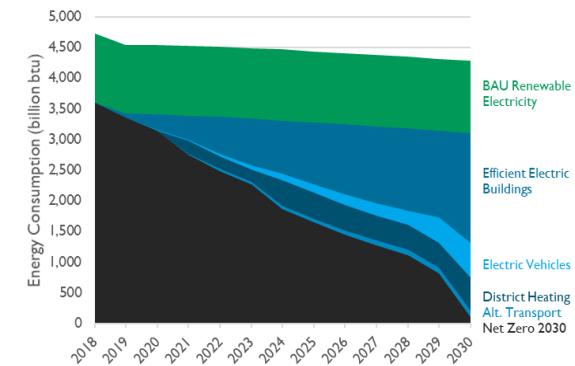
- Lower and more predictable annual energy bills,
- Central cooling and heating with both ducted and hydronic distribution options,
- Resilient and reliable comfort and efficient energy performance year-round,
- Fossil-free heating and cooling with no need for backup,
- Lowest environmental impact of any heat pump system,
- A low maintenance, long-term solution for HVAC and hot water needs
- A strategy for *decarbonization* of homes and businesses



Community Resilience via Geothermal Systems for both
Residential & Commercial Buildings



Utility Benefits



- Reduced summer peak demand from strategic electrification efforts
- Minimized increase in winter peak demand from high seasonal COP
- Cost-effective Tier III opportunity that can be incentivized below ACP
- Energy efficiency utility program opportunity to round out heat pump offerings
- Customizable solution for both residential and commercial customers
- Potential opportunity for utility to serve customers with community systems
- Potential opportunity for utility to own/manage ground loops for customers



**GSHPs can reduce
summer peak demand by
0.6 kW per ton**

1 ton = 12,000 Btu/hr



**Replacing 1,000 window AC units with
GSHP would reduce summer peak by
1 MW**

Our Winooski One hydroelectric power plant = 7.4 MW



1 Efficient
electric
buildings

60%

55% of commercial floor
space and 85% of
households are heated by
electric heat pump and
water heating systems

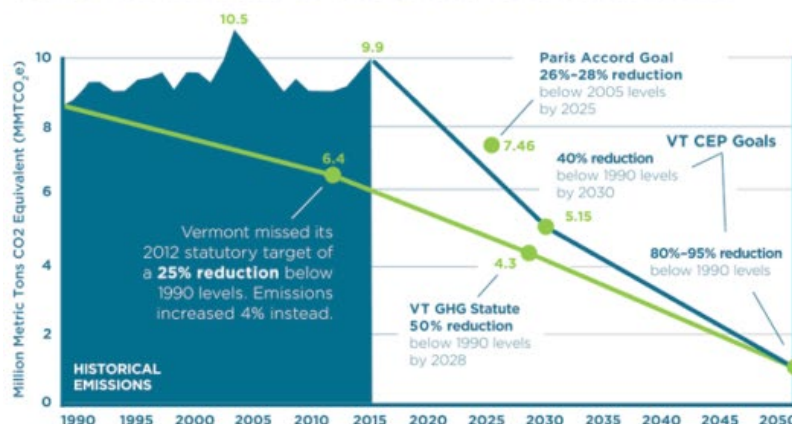


City of Burlington Benefits

- Demonstrated approach in several schools and university buildings in our city
- Strong and powerful tool in our chest of HVAC technologies to achieve NZE
- Lowest green house gas emissions of any heat pump option
- Shared and community systems could provide equitable solutions for BTV residents
- Strategy that could mitigate growth of energy consumption
- Lower peak demand increases can help keep electric rates stable for all

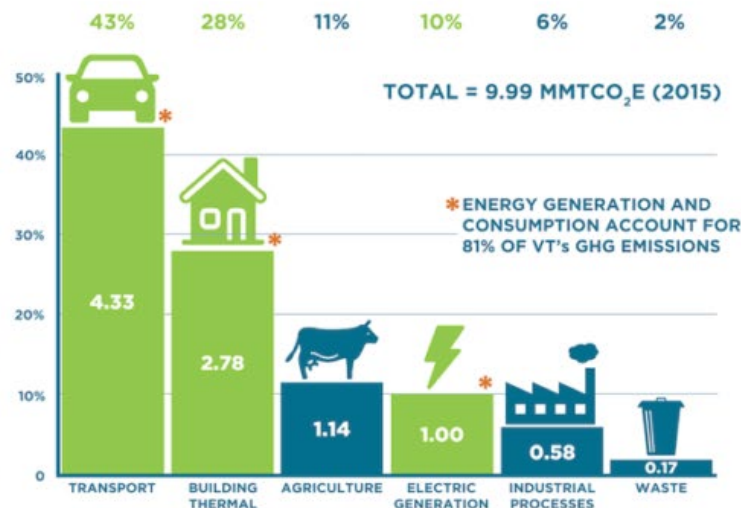
Vermont's greenhouse gas emissions have been increasing despite significant reduction commitments

What will it take to meet our commitments?



Transportation & thermal energy are the largest contributors to Vermont's greenhouse gas emissions

Vermont's GHG emissions by sector



Source: 2018 Greenhouse Gas Emissions Inventory Brief (1990-2015), VT Agency of Natural Resources.



- Reduce total energy consumption per capita by 15% by 2025, and by more than one third by 2050.
- Meet 25% of the remaining energy need from renewable sources by 2025, 40% by 2035, and 90% by 2050.
- Three end-use sector goals for 2025: 10% renewable transportation, 30% renewable buildings, and 67% renewable electric power.

State of Vermont Benefits

- Thermal energy uses in buildings are our second greatest source of GHGs
- Targeted and effective strategy to reducing GHG emissions from building sector
- Means to achieving the goals of the state's Comprehensive Energy Plan
- Economic development opportunity for entrepreneurs and small businesses
- Offers alternatives to heating industry professionals impacted by electrification
- Workforce and supply chain support can encourage people to move to Vermont



Vermont Urban University Union

- GSHP infrastructure added to new building on campus
 - Also: Envelope + HVAC upgrades, LED lighting
 - Total of 875,000 kWh in electric energy savings
- 381,000 kWh electric savings from heating & cooling
 - Additional 16,000 therm natural gas savings from heating
- Energy use intensity = 49 kBtu/sf/year
 - 47% better than baseline = 92 kBtu/sf/year



[BTV 2030](#)



Vermont Rural K-12 School

- Renovation replaced fuel oil boiler
- \$1,900 annual savings
- Energy use intensity = 28.5 kBtu/sf/year
 - 44% better than prior EUI = 51 kBtu/sf/year
 - 70% better than baseline = 48.5 kBtu/sf/year



[Huntington Energy Committee](#)



New Rebate Programs

- Small systems (residential systems and commercial systems with 10 or less tons of cooling capacity) are eligible for rebates of up to \$1,500 per ton of cooling capacity.
 - Single family homes can receive up to \$15,000.
 - Multi-family projects qualify for the large system rebate tier.
- Large systems (commercial and multi-family systems with more than 10 tons of cooling capacity) are eligible for rebates of up to \$1,200 per ton of cooling capacity.
 - A single building can receive up to \$100,000.
- Community systems (systems serving multiple residential, commercial, or both types of buildings) are eligible for rebates of up to \$1,000 per ton of cooling capacity.
- A site with multiple buildings can receive multiple incentives.



Let's Keep in Touch!

- Gretchen Schimelpfenig, PE,
Commercial Energy Services Engineer
- gschimelpfenig@burlingtonelectric.com
- @BuildGreenUS & @BurlingtonElec
- Send me your questions about how
geothermal heat pumps might benefit
your home or business!



www.burlingtonelectric.com/gshp
www.burlingtonelectric.com/gshp-loops

DANDELION



Welcome to the future of comfort.



Demand is catastrophically high

We closed Q3 with >\$25MM in run rate bookings.

GROWTH

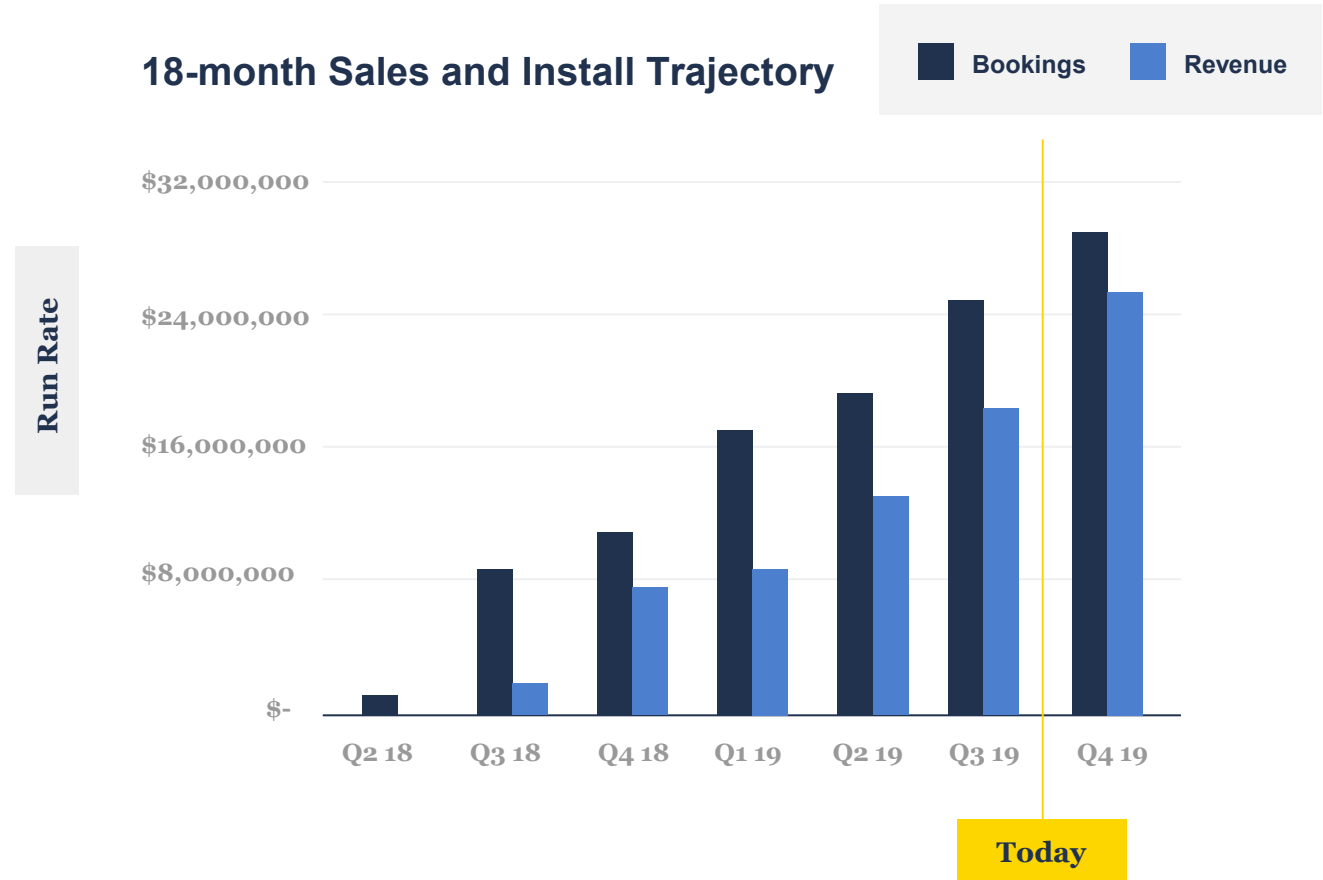
>4x y/y revenue growth

>5x y/y sales growth

INITIAL MARKET

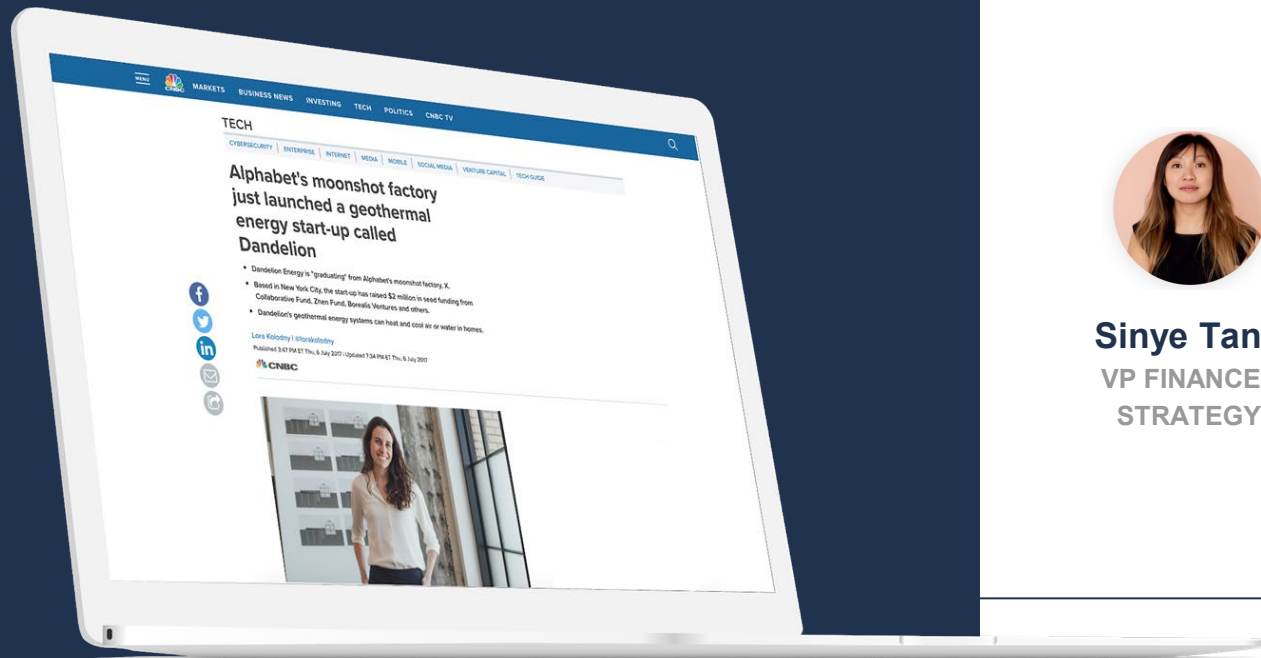
These results achieved with only two warehouses in upstate NY.

18-month Sales and Install Trajectory



ORIGIN STORY

Spun out of Google X in 2017



Kathy Hannun

CEO



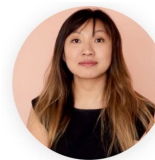
James Quazi

CTO



Dan Yates

EXECUTIVE CHAIRMAN



Sinye Tang

VP FINANCE /
STRATEGY



**Levi
Blankenship**

DIR SALES



Ryan Carda

DIR ENGINEERING



Ilyas Frenkel

DIR MARKETING

DANDELION



Initial market: sufficiently huge

Northeast Heating Oil

REGION	OIL & PROPANE HOUSEHOLDS	ANNUAL SPEND ON FUEL
New England (MA, CT, ME, NH, VT, RI)	2.59 M	\$6.5 Bn
New York	2.46 M	\$6.1 Bn
Pennsylvania	1.18 M	\$2.9 Bn
New Jersey	0.55 M	\$1.4 Bn
Mid-Atlantic (MD, DE)	0.49 M	\$1.2 Bn
7.28 M		\$18.1 Bn

Our customers LOVE geothermal



Price

"We paid nothing upfront and paid less our first year than we paid each year for oil."

SCOTT S, BALLSTON SPA, NY



Convenience

"It is a pleasure to no longer worry about the oil company coming on time or missed deliveries."

SUSAN M, RHINEBECK, NY



Health

"We are very glad we don't need to worry about carbon monoxide poisoning anymore."

MATT V, FEURA BUSH, NY



Comfort

"The system is much quieter. We no longer need to turn up the TV in the living room when the furnace comes on."

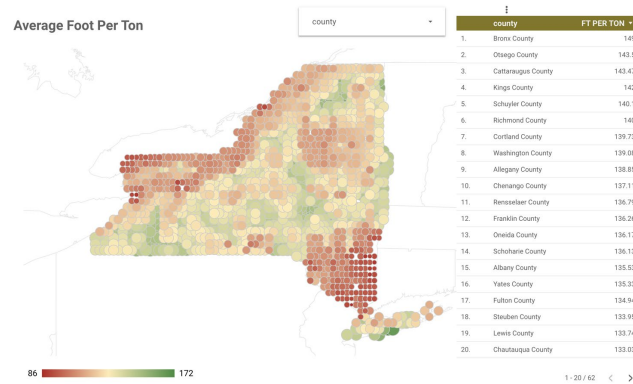
SEAN D, POUGHKEEPSIE, NY

DANDELION



A revolutionary system to install ground loops

SUBTERRANEAN MAPPING



SONIC DRILL RIG



MUD CYCLONE



- We are building up a knowledge of the subterranean, depth to bedrock etc
- Allows us to drill with the right method for the job
- We install the right amount of the loop

- Sonic technology liquifies loose earth for 10x faster drilling
- Enables reuse of expensive steel casing

Patent #7270182

- Keeping the site clean is a huge deal in residential
- Enables recirculation of water for drilling

Electric utilities love geothermal so much they're paying for it

They know geothermal regularly doubles electric bills.
So they've started to offer incentives themselves. In NY alone:



\$264/year payment



\$5,000/home payment
(Dandelion exclusive)
+ \$0.05/kWh discount



Up to \$2000 rebate
(\$400/ton)



\$4,000 - \$10,000
rebate (\$2,000/ton)

It's like AT&T giving away the iPhone to drive up network fees: utilities are AT&T, we're their iPhone.





Thank you!