A Presentation to the Northfield Chapter
of Citizens Climate Lobby

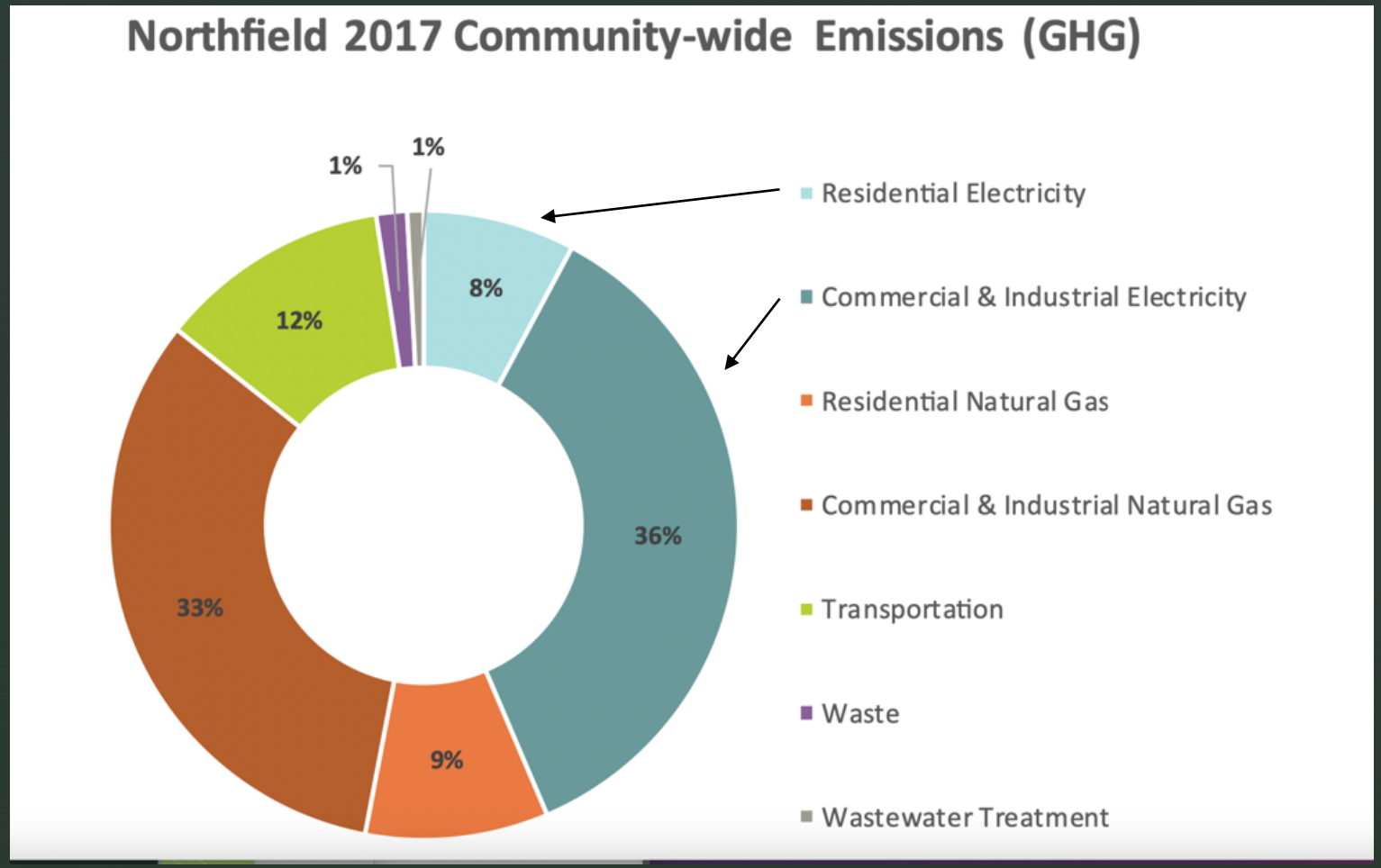
September 10, 2022

Getting Northfield onto the GeoGrid

“The City of Northfield is committed to …being a 100% carbon-free community by 2040.”

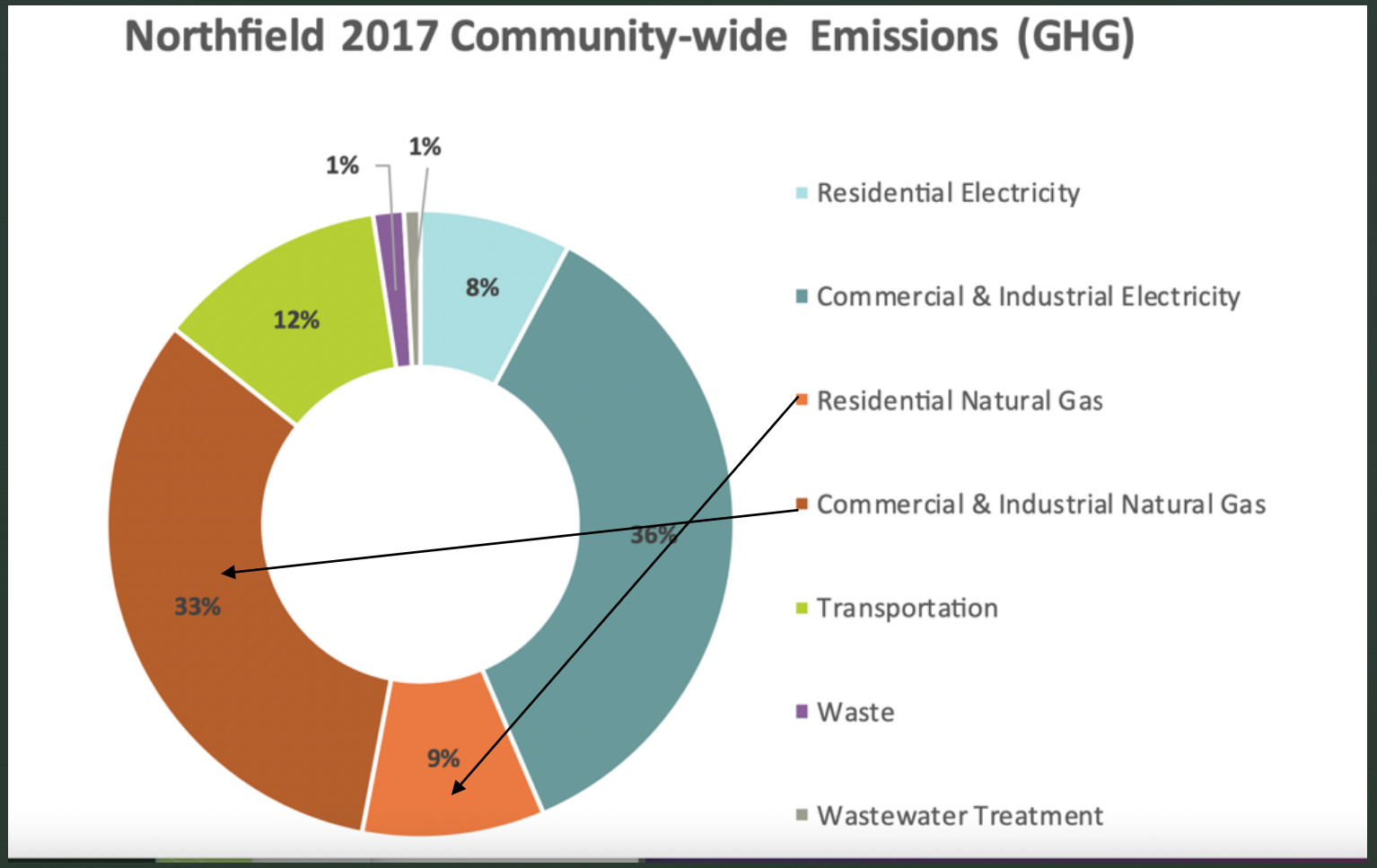
City of Northfield Climate Action Plan
Adopted November 5, 2019

Xcel to completely eliminate emissions from electricity generation by 2050. *(Blue regions)*



Source: City of Northfield Climate Action Plan

But here's the problem: 9% + 33% = **42%**



Source: City of Northfield Climate Action Plan

So how do we deal with 42% of our GHG emissions?

The GeoGrid

Eversource, *New England's* ***largest gas utility,*** *broke ground this summer on the first of six* ***GeoGrid pilot projects,*** *and produced this video…*

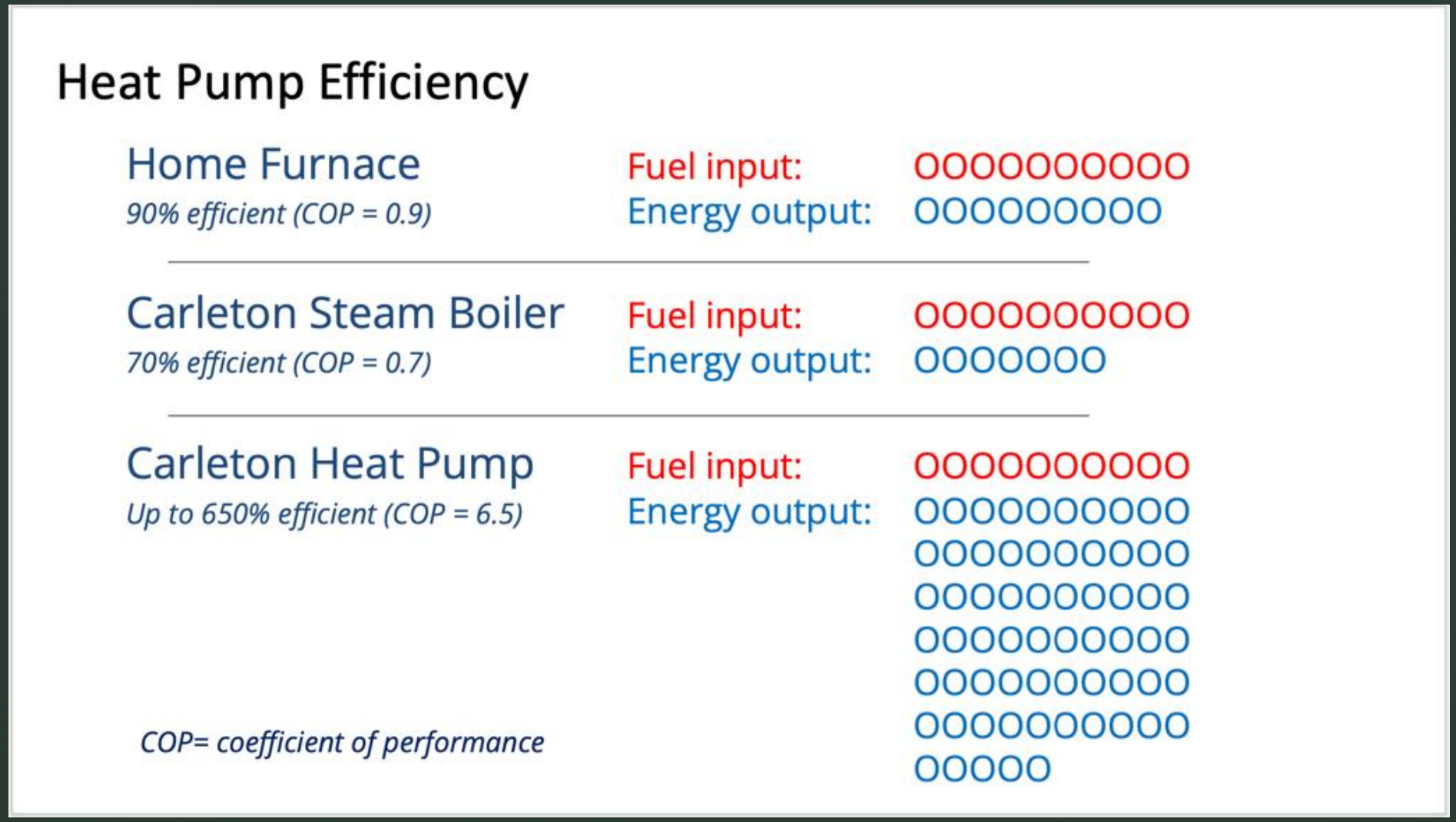
https://www.eversource.com/content/ema-c/business/save-money-energy/clean-energy-options/geothermal-pilot-program

A GeoGrid is an innovative combination of three mature technologies:

- ***Ground Source Heat Pump (GSHP) technology;***
- ***Utility Scale Pipeline and Metering technology;***
- ***Networked Energy Management technology.***

Heat pumps are remarkably effective for heating and cooling buildings.

- *Use the **same technology as a refrigerator**:*
  *(which **is** actually a heat pump).*
- *Are **reversible:** provide **both heating and cooling**.*
- *Use **only electricity:** no (scope 1) GHG emissions;*
- *Are **very cost competitive** to operate;*
- *Have **high (positive) coefficients of performance…***



Graphic courtesy of Martha Larson and Carleton College

Heat pumps …(continued)

- ***NOT** limited by constant 55 degree ground temperature.*
- ***NOT** affected by ambient air temperature (GSHP);*
- ***NOT** susceptible to frosting;*
- ***NO** combustion products or emissions;*
- ***NO** toxic chemicals in ground loops (water + food quality propylene glycol as antifreeze).*

The most common GSHP configurations….

Vertical ground loop configuration:

Horizontal ground loop configuration:

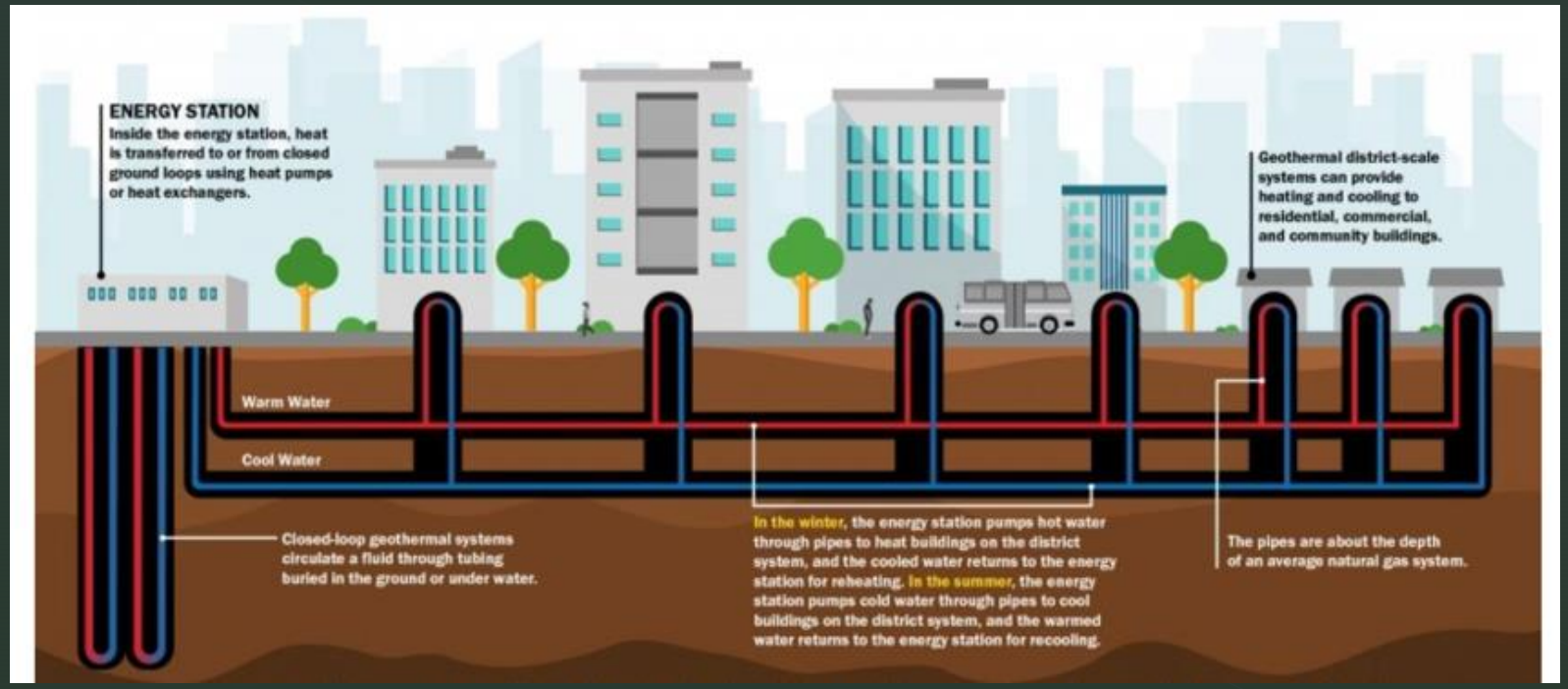
Excavation at the Kraewood development site, Northfield, MN… a good opportunity for horizontal ground loops.

The majority of GSHP in the U.S. are installed to serve a single building,…

…but excavating and drilling are a high proportion of installation costs…

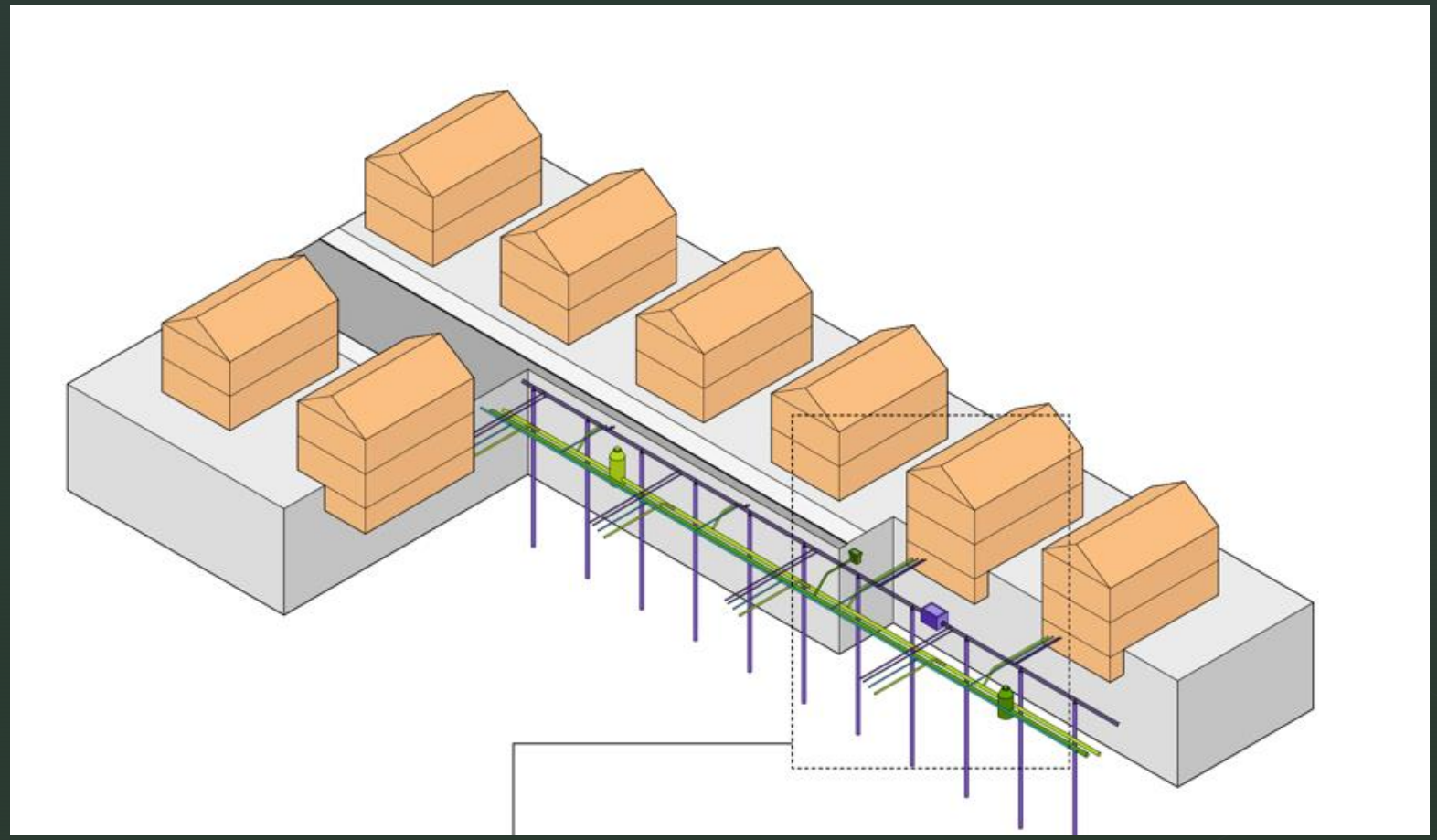
Drilling the ground loops on West side of my house at 907 2nd Street West, Northfield. Took 3 days!

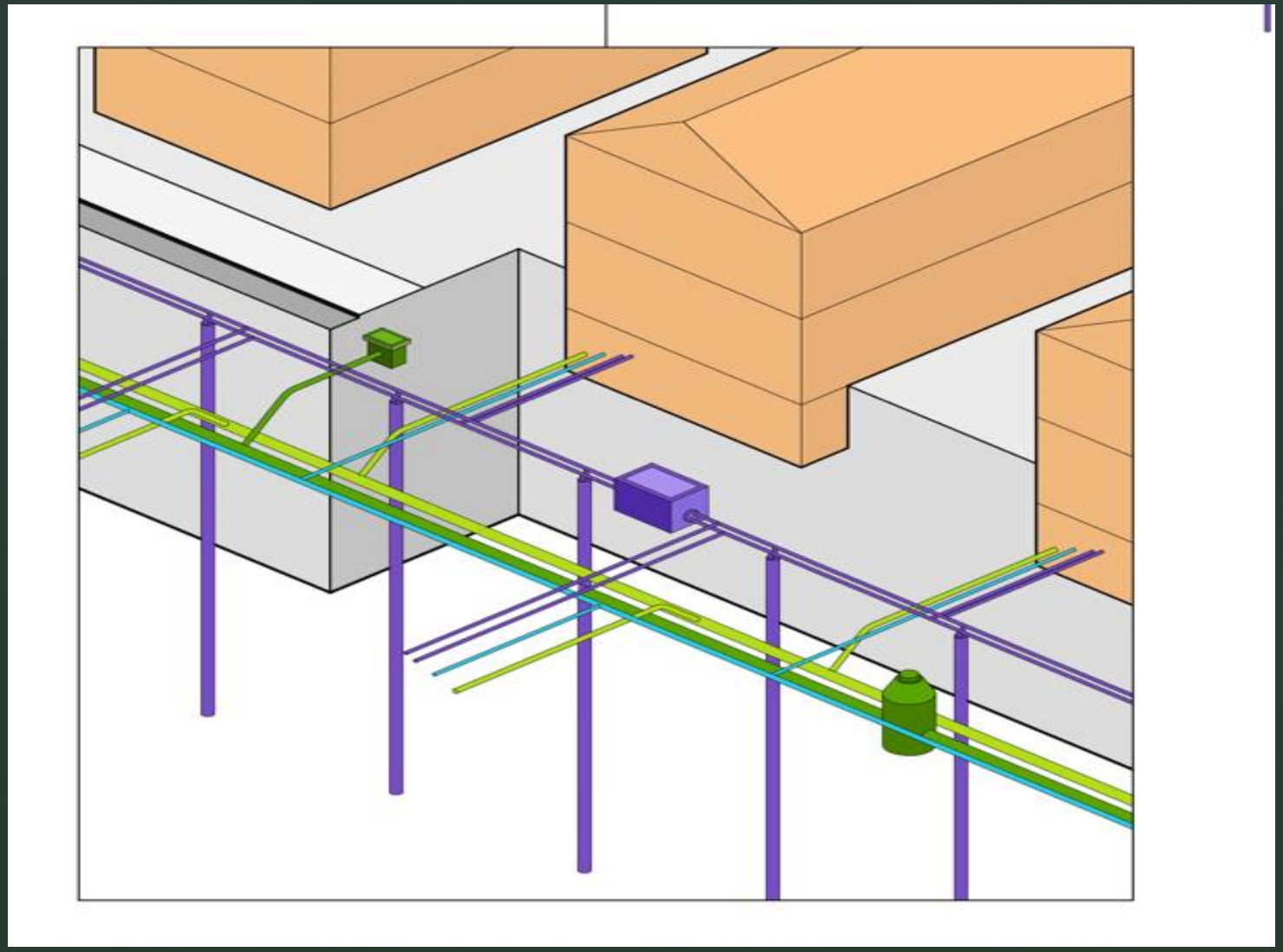
It makes more sense for buildings to share costly ground loop infrastructure…



A Geo Micro District

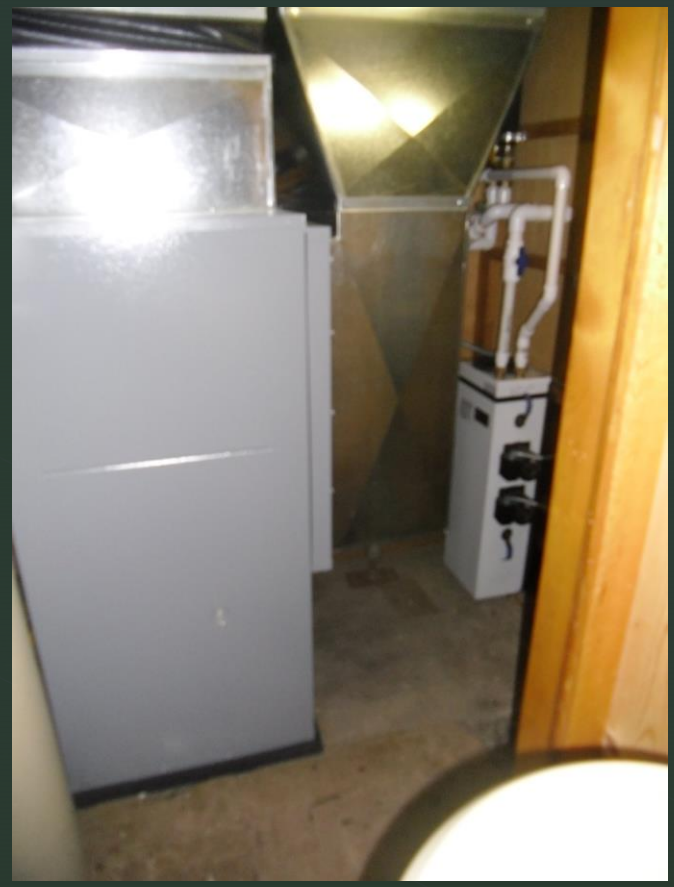
Ground loops and pumps could be located in the existing utility Right-Of-Way…





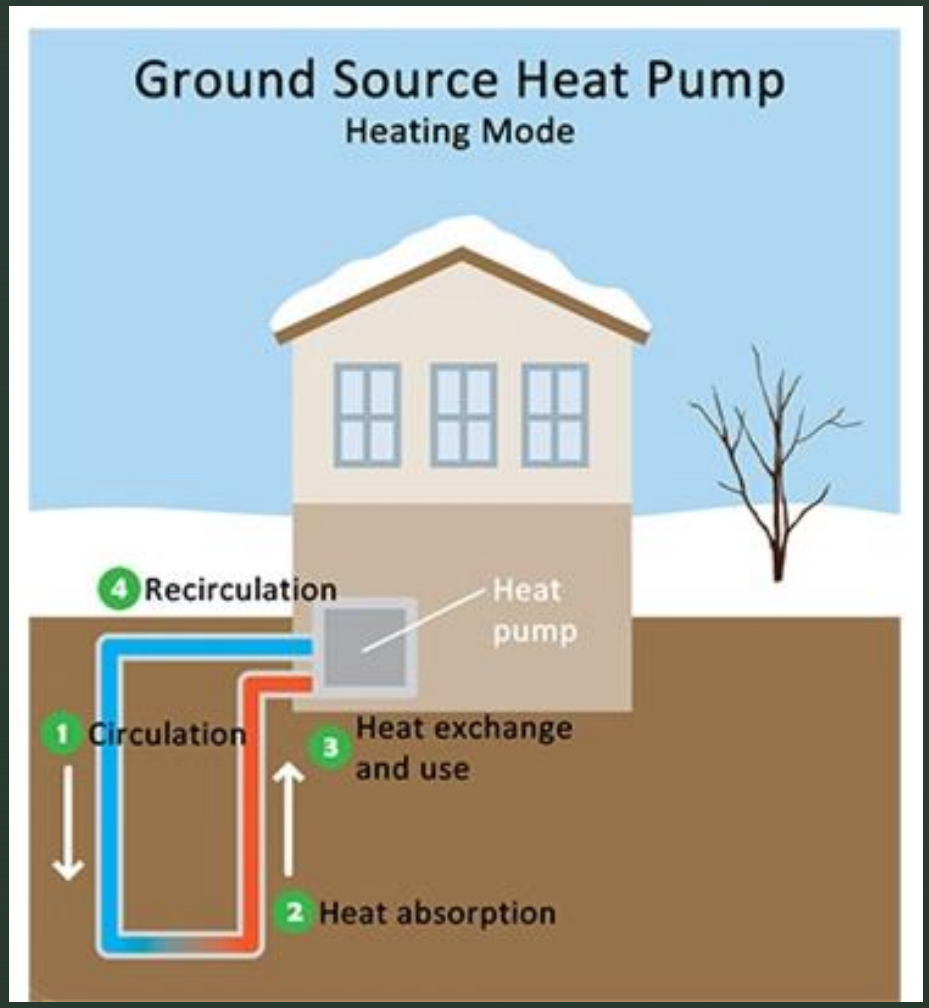
PURPLE: ground loop; including vertical boreholes.
GREEN: Existing gas and water utility pipelines.

… and heat pumps would be located within the individual buildings.

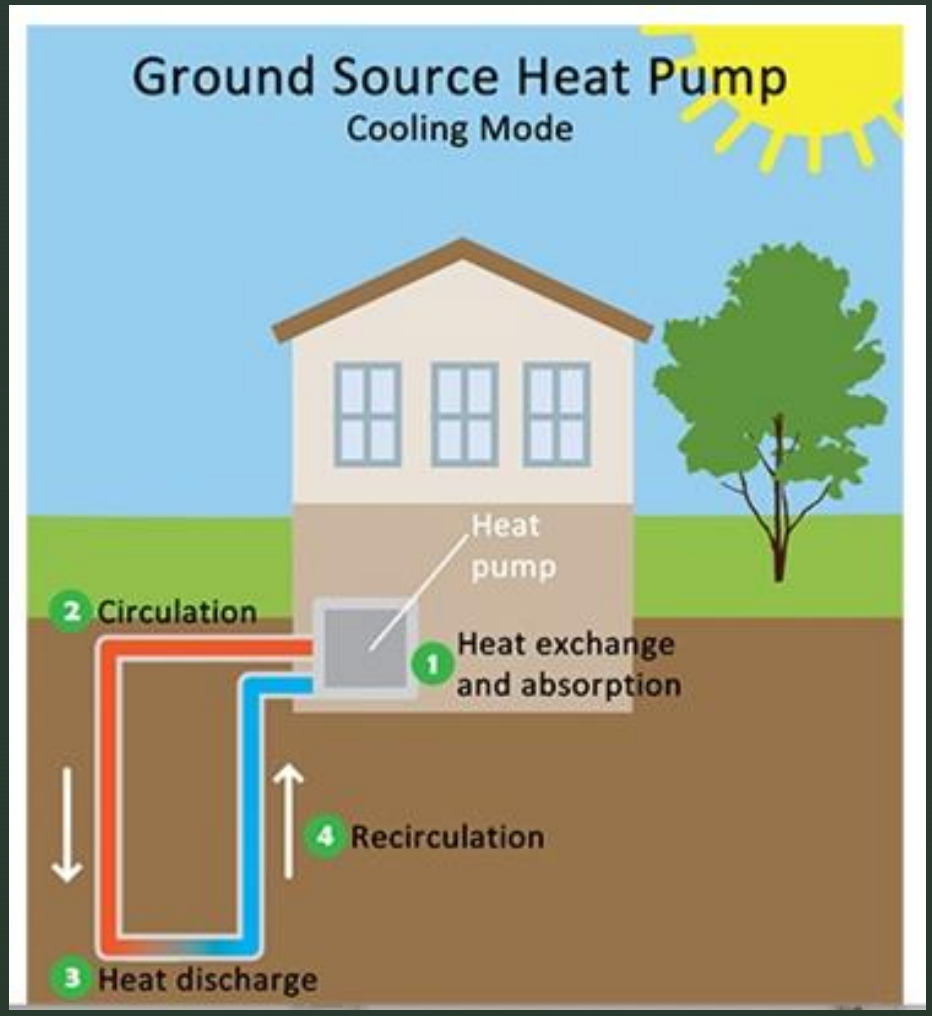


Front and back of my heat pump; circulating pumps on far right would be part of public infrastructure in a GeoGrid.

In Winter, ***heat is extracted from ground*** *and deposited in building. So building warms and* ***ground cools…***



In Summer, ***heat*** *from building* ***is deposited in ground.***
Building cools and ***ground warms.***



However, seasonal heating and cooling loads are rarely identical.

*E.g. In Minnesota **residential** heating demand is generally **greater** than cooling demand,…*

…more heat is extracted** from ground in winter **than is returned** in summer**.

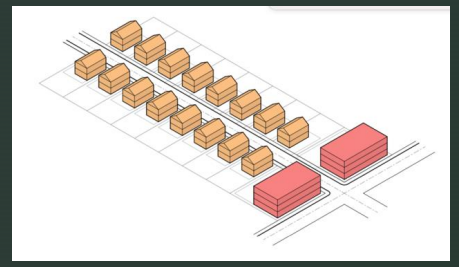
***To avoid freezing the ground**, ("thermal degradation") GSHP individual systems are typically **undersized** w.r.t. heating loads, and **back-up heating** is installed:*

- *Electric resistive heating;*
- *Small gas fired furnace.*

Undersizing *could be done in a GeoGrid as well, but would* ***require the same relatively costly back-up heating****…*

$$$$$$

A better approach, *available in a networked GeoGrid is to* ***trade 'waste' heat*** *by* ***interconnecting buildings*** *with different thermal needs.*



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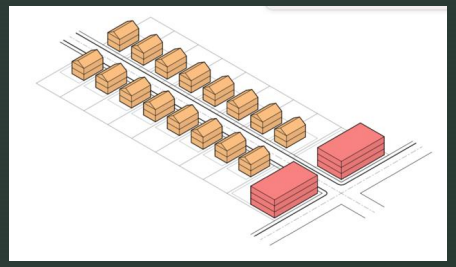

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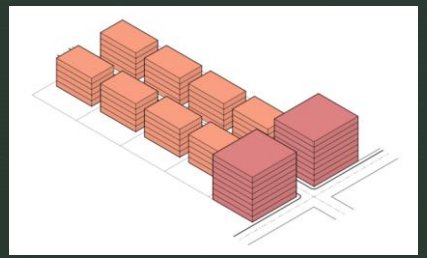

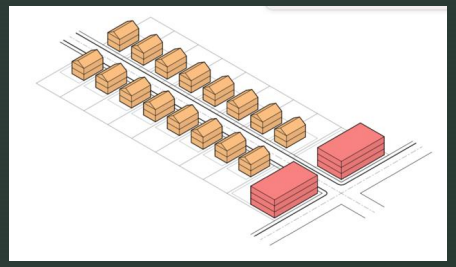

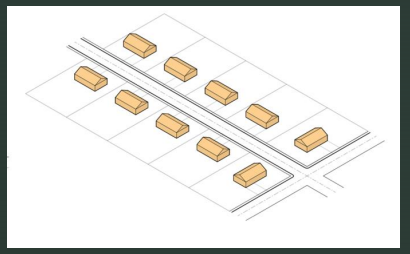

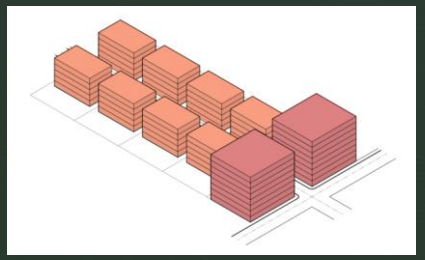

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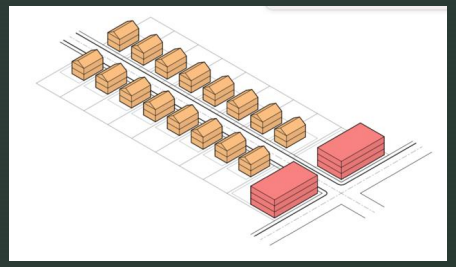

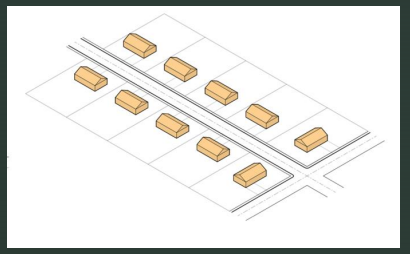

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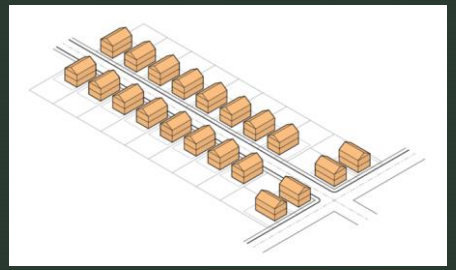
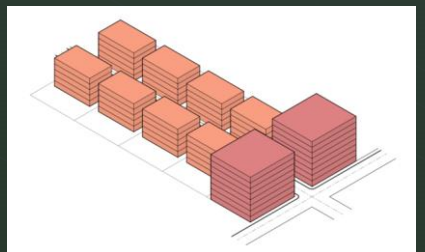
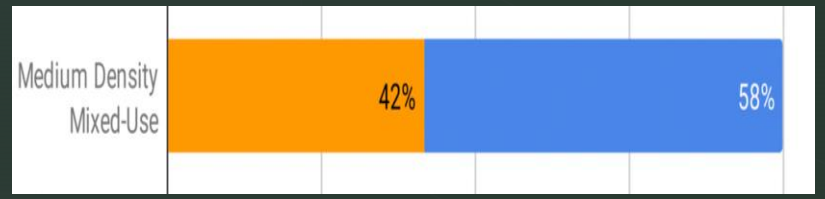
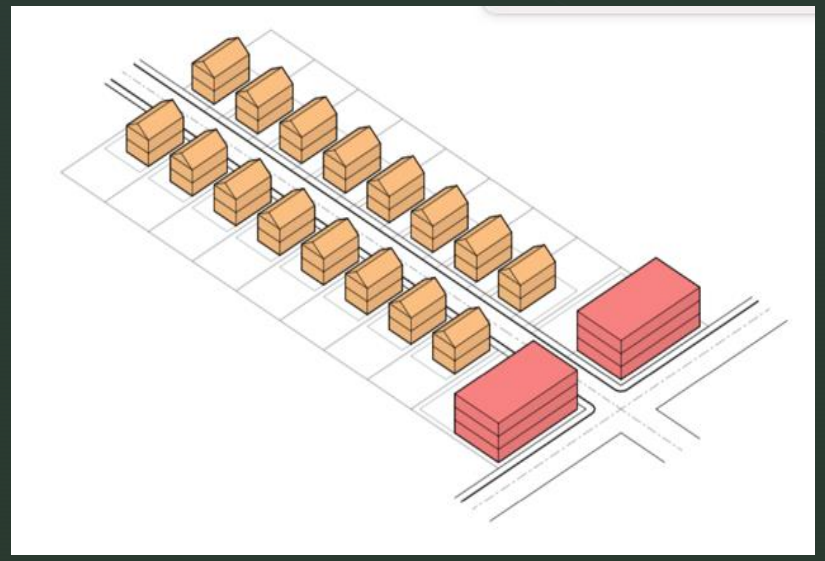




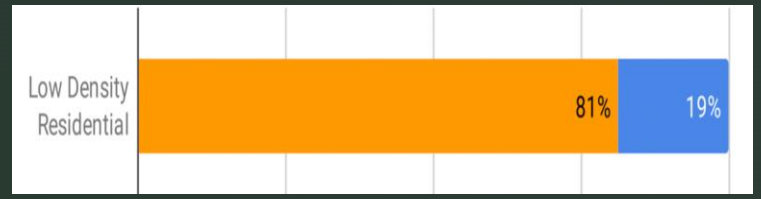
MEDIUM DENSITY-MIXED USE neighborhoods have a LARGER than average COOLING LOAD…

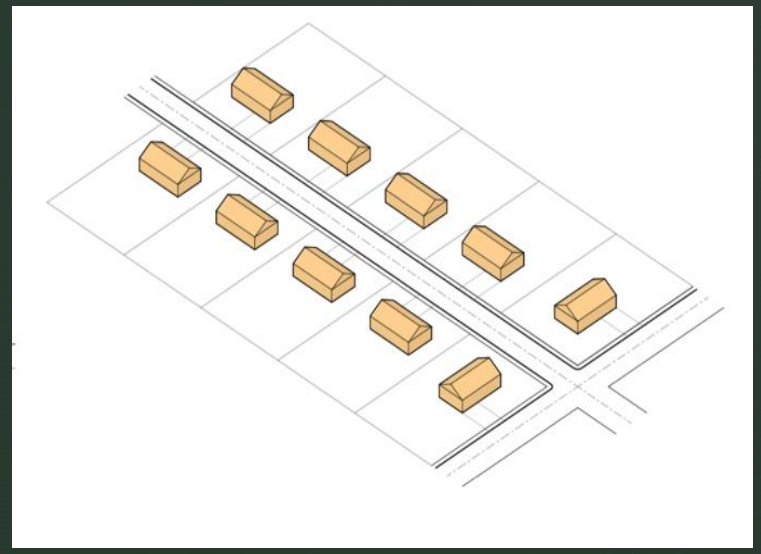




HEAT

LOW DENSITY RESIDENTIAL neighborhoods have a LARGER than average HEATING LOAD…





This Thermal balancing of the network provides a central role for utilities, making them partners rather than adversaries in societies inevitable transition away from fossil fuels.

It's a win-win situation!

Greenhouse Gas Reductions

- *Replacement of boilers and furnaces with GSHP results in significant reductions in GHG emissions;*
- *These reductions will increase as electricity becomes ‘greener”;*
- *This solves the “42%’problem” with our CAP.*

GHG reductions: LOW DENSITY RESIDENTIAL

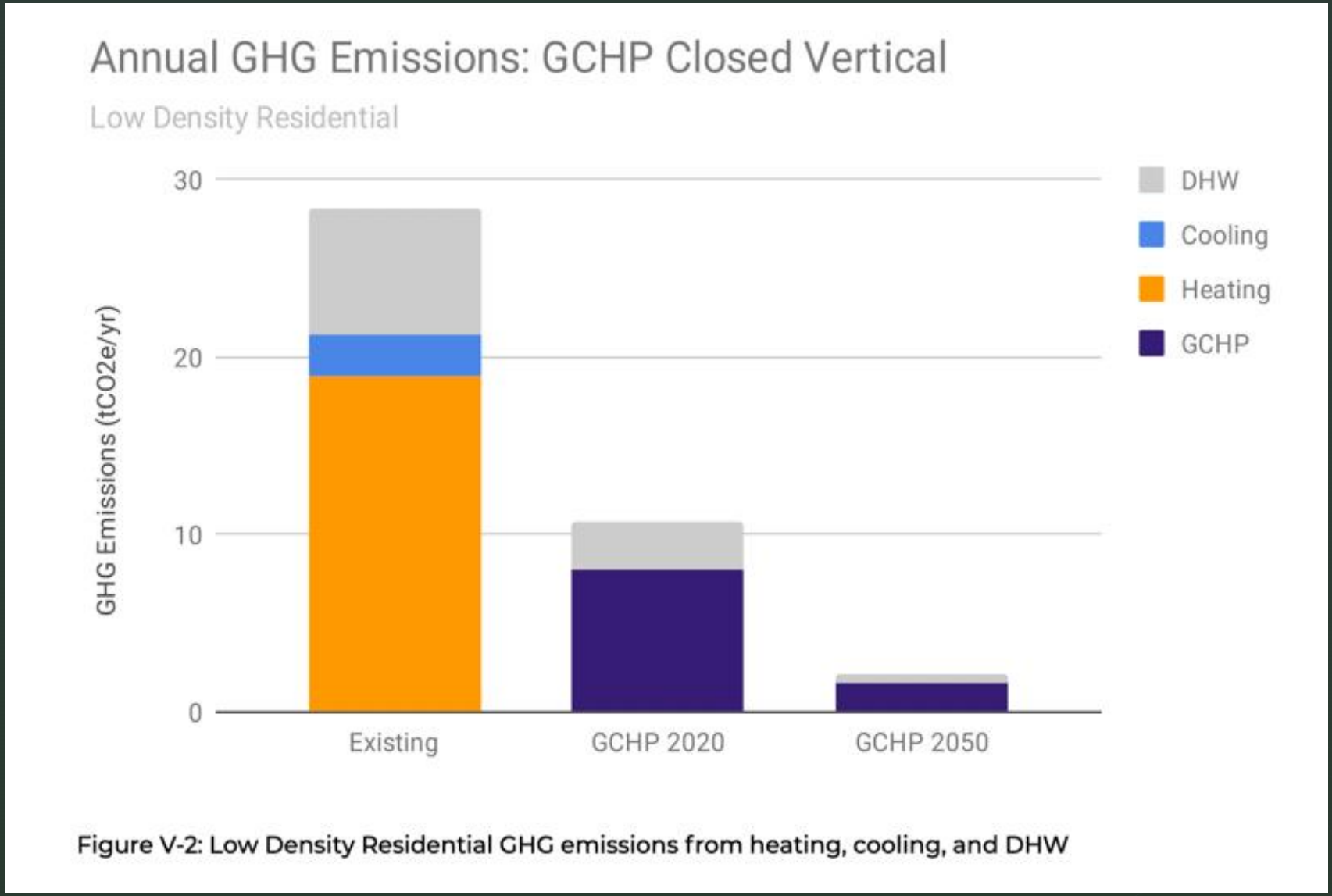


Figure V-2: Low Density Residential GHG emissions from heating, cooling, and DHW

Courtesy B-H feasibility Study commissioned by HEET

GHG reductions: MEDIUM DENSITY - MIXED USE

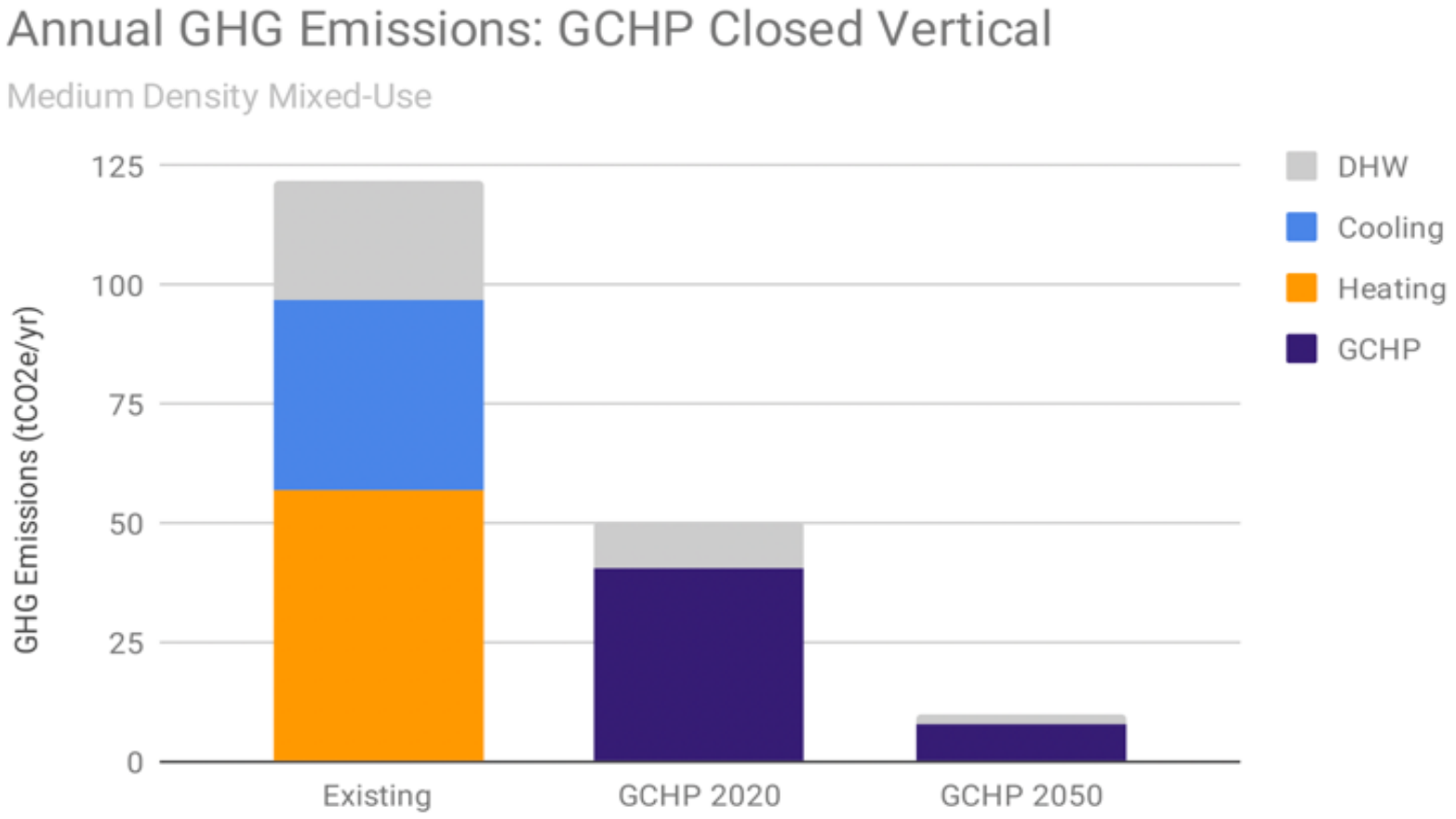


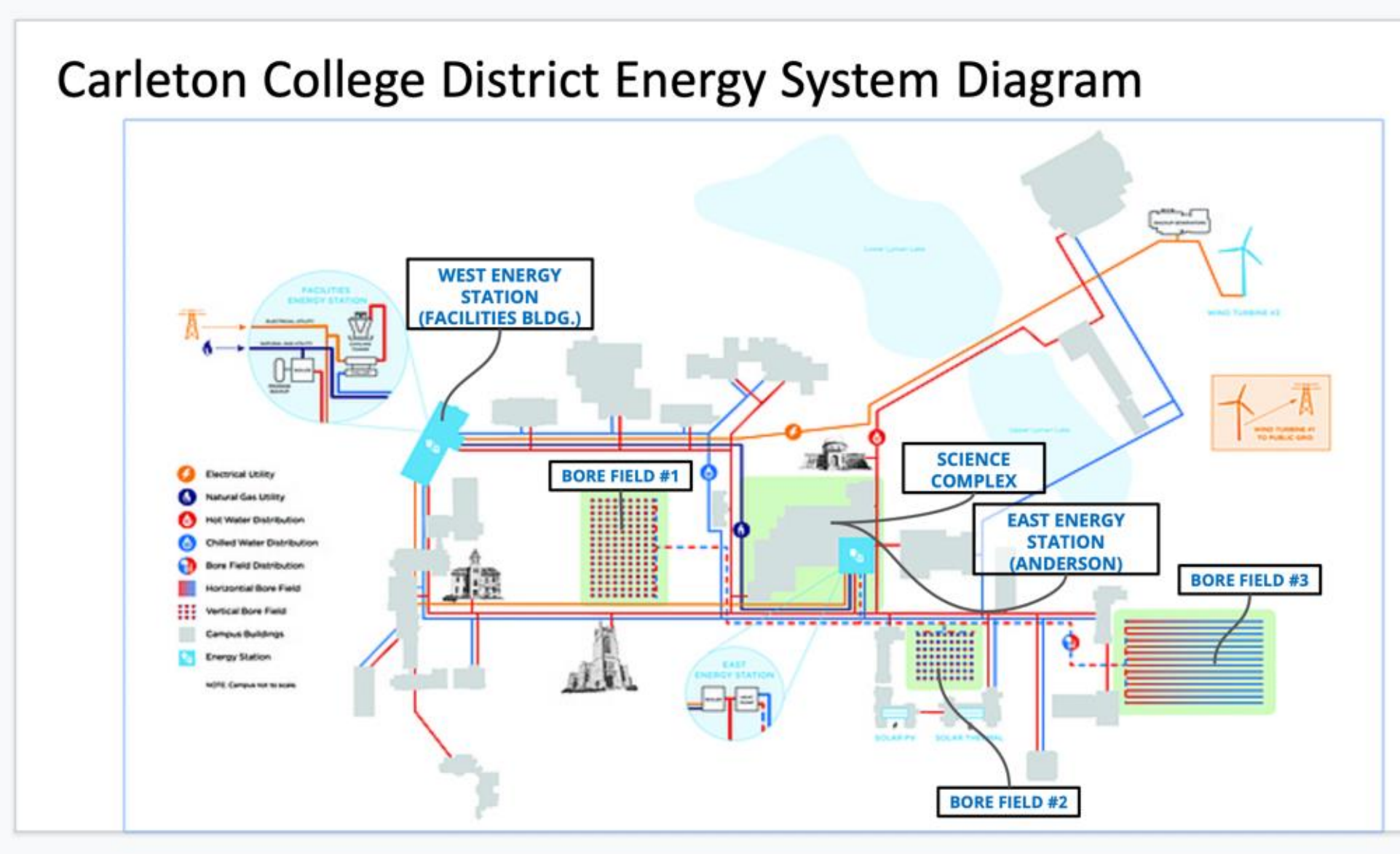
Figure V-3: Medium Density Mixed-Use GHG emissions from heating, cooling, and DHW

Courtesy B-H feasibility Study commissioned by HEET

ExistingGeoGrids

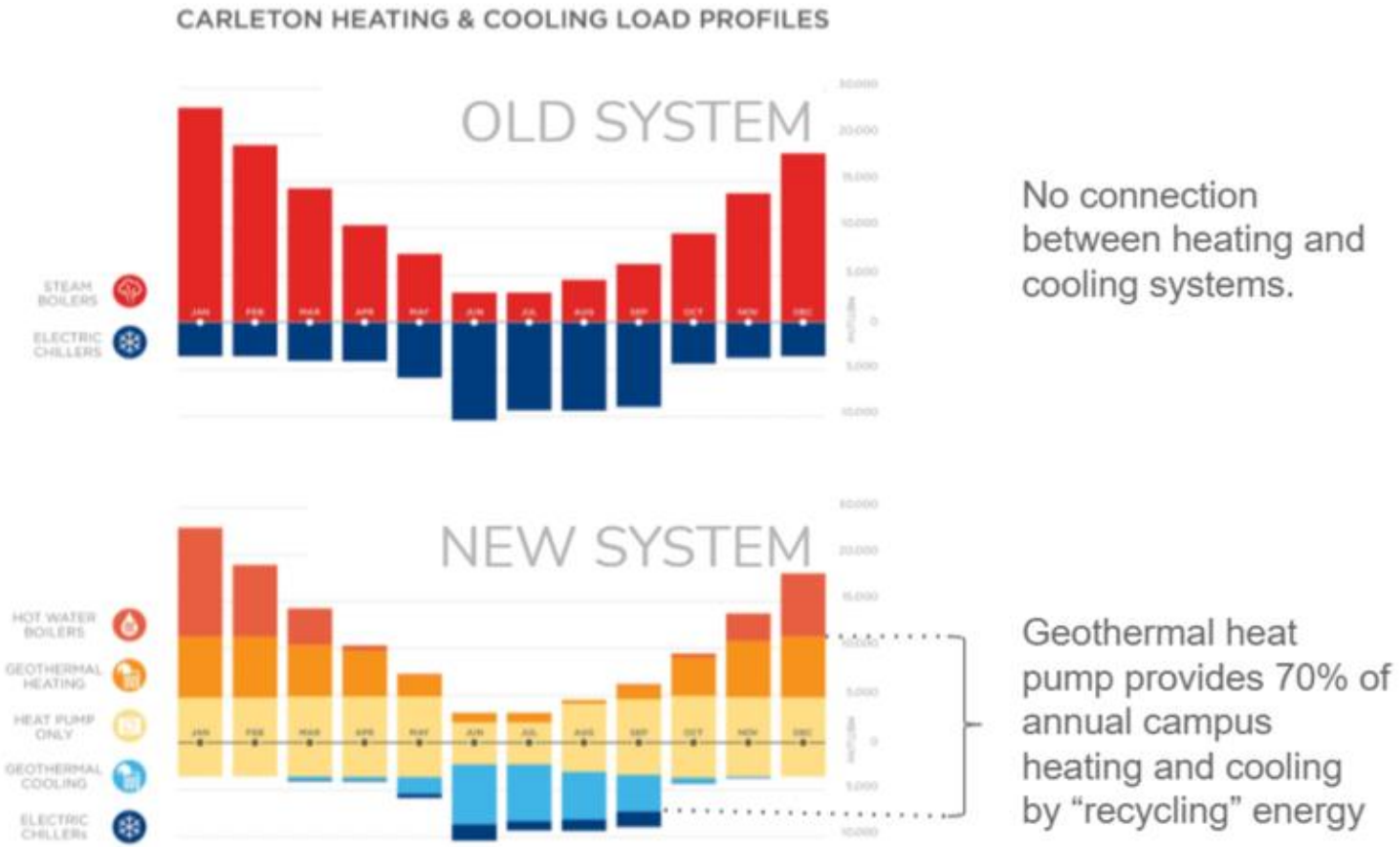
Carleton College, Northfield, MN

Science Complex, Carleton College



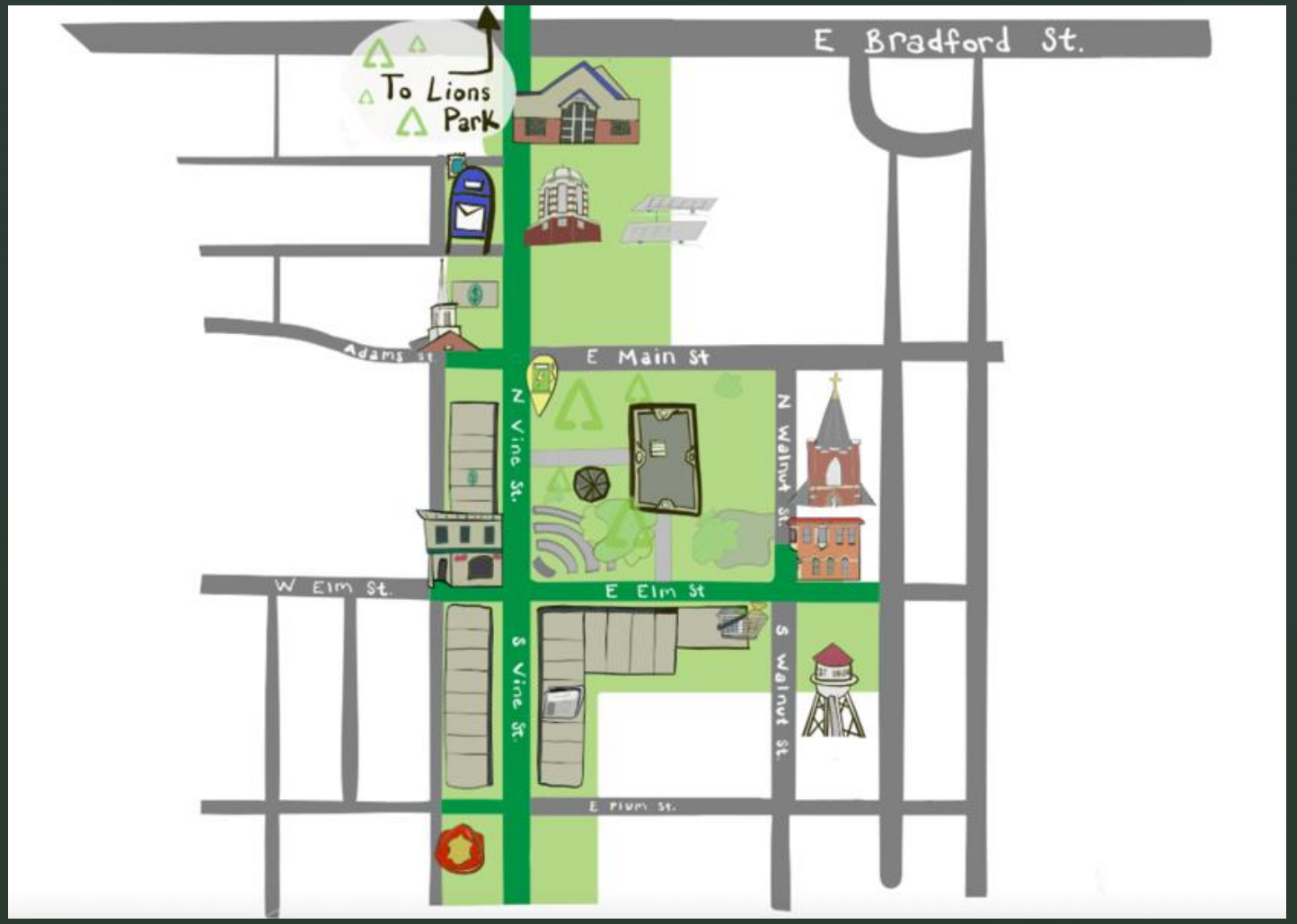
Slide courtesy of Martha Larson and Carleton College.

Heating and Cooling Systems Can Now Trade Heat



Slide courtesy of Martha Larson and Carleton College.

In 2013, the town of West Union, Iowa completed construction of a district geothermal system.



West Union, Iowa (cont.)…

- *Serves **60 downtown buildings** (330,000 square feet);*
- *264 ton capacity, ($32,925 per ton of capacity);*
- ***8.7M$ total installation costs;***
- ***2.3M$ cost of public system** (boreholes, pumps)**, entirely paid for** with a **HUD** Community Development Block Grant, **EPA** Climate Showcase, and **DOE** funding. (The rest was building conversion costs.)*

*There are currently **tens of millions of dollars available to municipalities** willing to start designing and developing community geothermal districts.*

[Community Geothermal Heating and Cooling Design and Deployment | Department of Energy]

Many of my slides and info are courtesy of….

*Buro-Happold Technical Feasibility Study Commisioned by HEET**

***Home Energy Efficiency Team, Cambridge, MA**

Also, many thanks to:

- ***Bruce Anderson,*** *Northfield EQC*
- ***Martha Larson,*** Director of Sustainability, RMF Engineering (Formerly Manager of Campus Energy & Sustainability at Carleton College)
- ***Janet Petri,*** *Northfield EQC*
- ***Audrey Schulman,*** *Co-founder and Co-executive director of HEET (Home Energy Efficiency Team)*
- ***Buro-Happold Engineering***

Questions?

- *How does a heat pump work…*
- *Installation Costs…*
- *Operating Costs…*
- *Building Conversion Costs…*