Decarbonizing Minnesota's Natural Gas End Uses

Meeting 5

April 10th, 2020

Via Zoom

GREAT PLAINS INSTITUTE | Better Energy. Better World.

AGENDA

9:00	Welcome and Introductions
9:15	Presentation and Q&A: The Promise and Potential of EE in Decarbonizing Minnesota's Natural Gas End-Uses
10:00	Discussion on Energy Efficiency
10:45	BREAK
11:00	Overview of District Energy Systems in Minnesota
11:05	Presentation and Q&A: The Promise and Potential of Geothermal Technology in Decarbonizing Minnesota's Natural Gas End-Uses Discussion
11:35	Discussion on Geothermal Technologies
12:00	LUNCH
1:00	Presentation and Q&A: District Energy Systems in Minnesota
1:30	Discussion on Geothermal Technologies
2:30	ADJOURN

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Presentation and Q&A: The Promise and Potential of EE in Decarbonizing Minnesota's Natural Gas End-Uses

Carl Nelson and Jon Blaufuss, Center for Energy and Environment

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Decarbonizing Minnesota's Natural Gas End Uses (Meeting #5)

Insights from the 2020-2029 Minnesota Energy Efficiency Potential Study

Date: Friday, April 10, 2020 (9:15 AM – 10:45 AM)

Minnesota Energy Efficiency Potential Study: 2020–2029

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Today's Agenda

Background on Potential Study (Carl)

Methodology (Carl)

Results (Jon)

Program & Policy Recommendations (Jon)

Q & A

Background

Long history of "CIP" (Conservation Improvement Programs)

1980:
PUC directed to initiate a pilot to demonstrate the "feasibility" of investments in EE.

1983: Utilities with revenues greater than $50 million were required to operate at least 1 conservation program. Required "significant" investment.

1989: All Public utilities were required to operate conservation improvement programs. Oversight transferred from PUC, low-income requirements added.

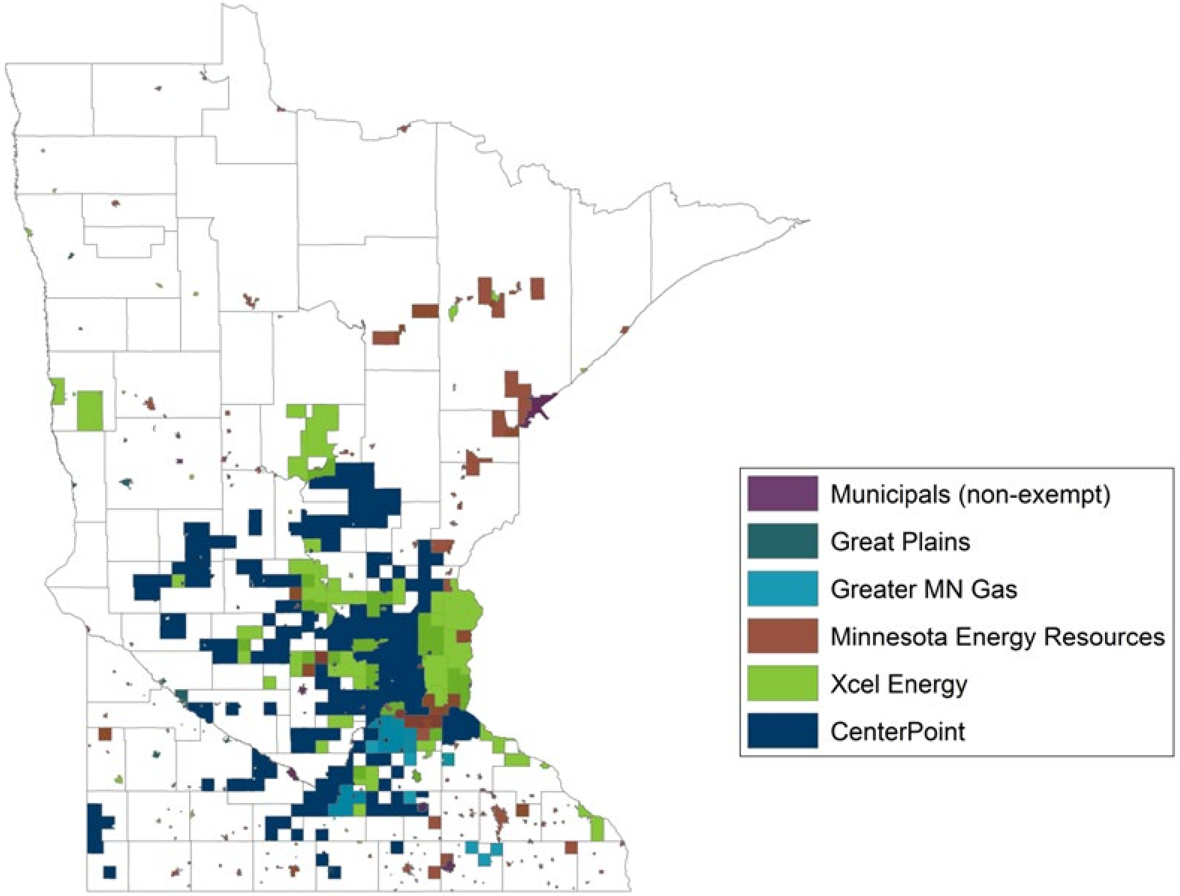
1991:
A specific level of spending was required (1.5% electric, 0.5% gas) & munis and coops were included.

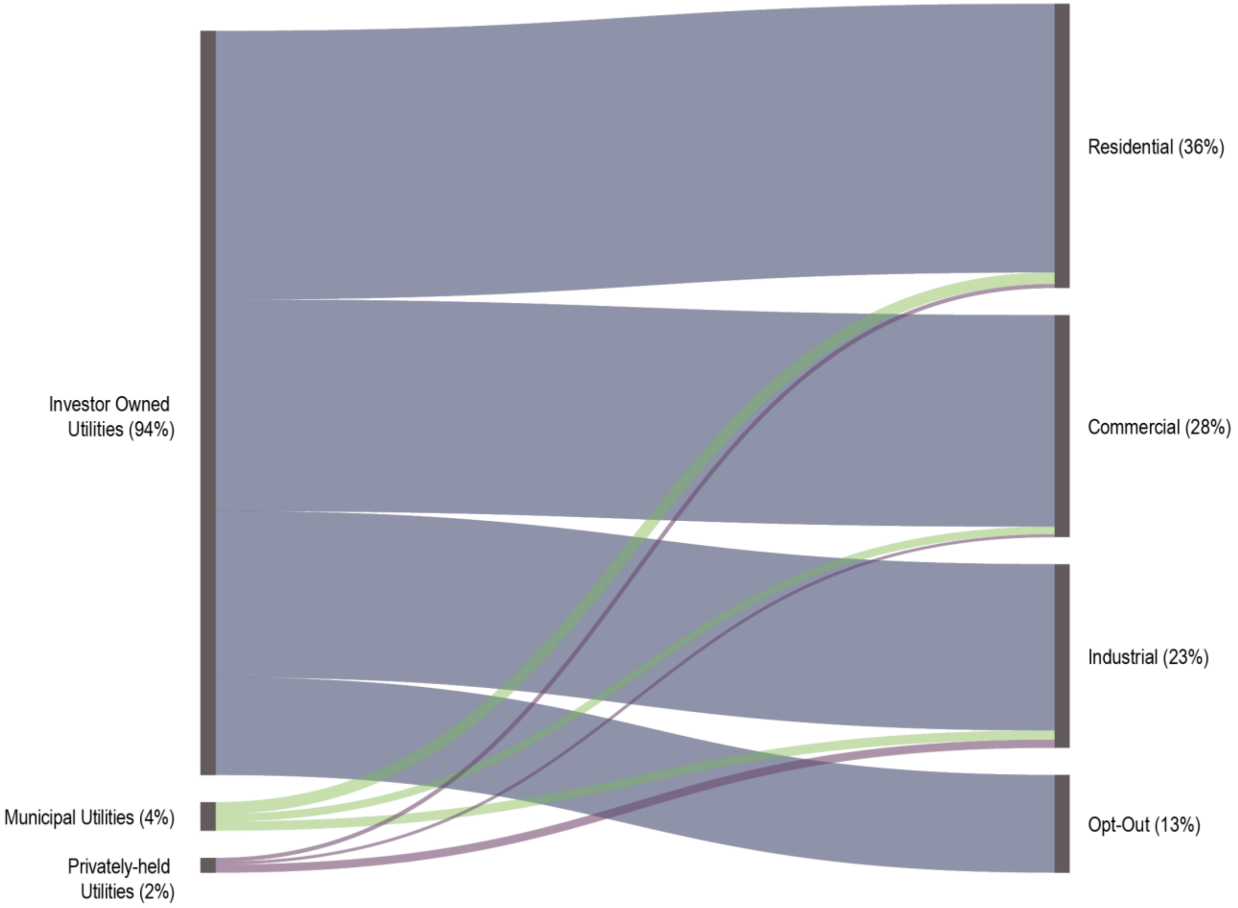
2007:
Next Generation Energy Act Passes.

2010:
1.5% Savings Goal for Utilities takes Effect

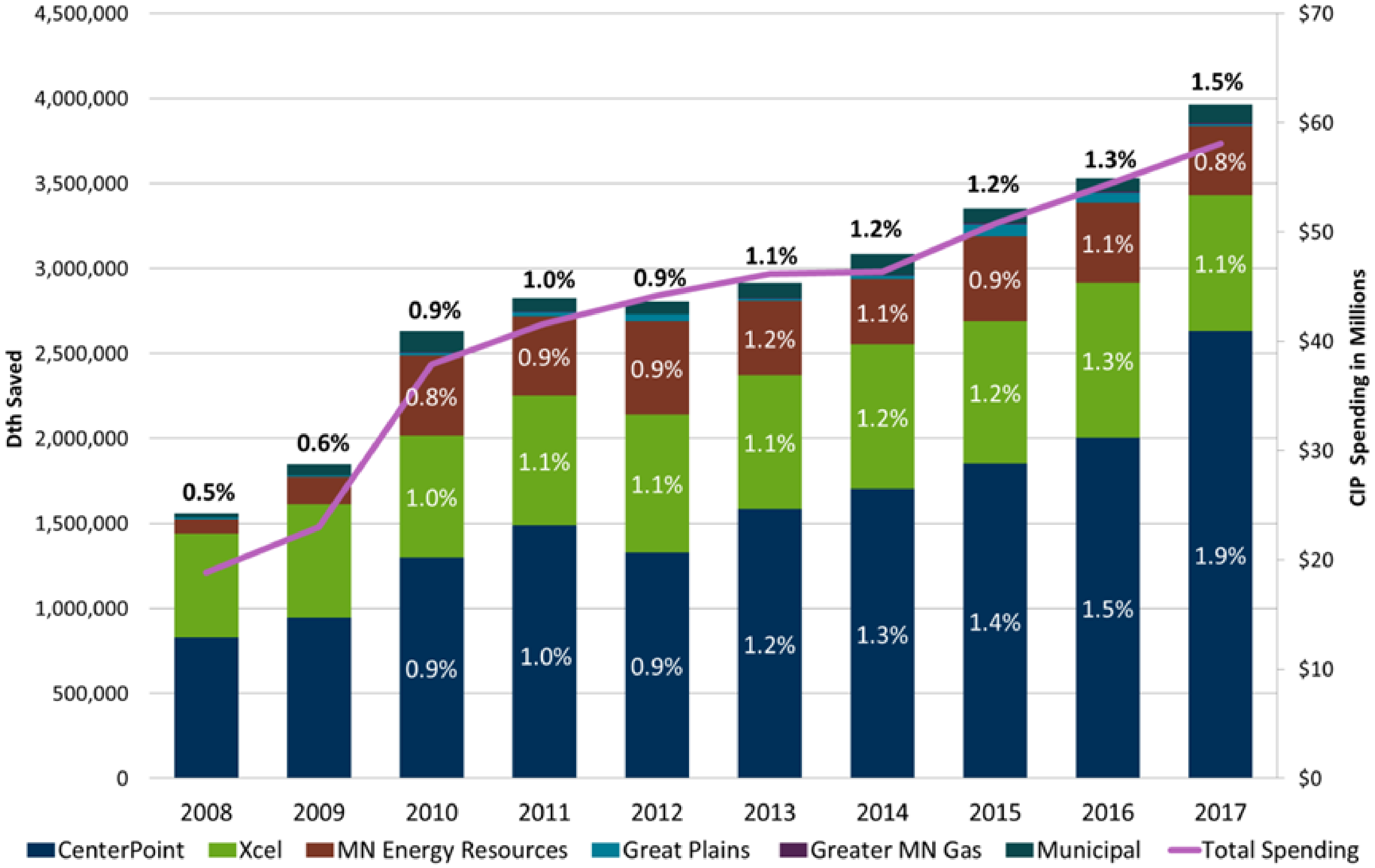
2017:
Munis and Coops meeting a specific threshold exempted from CIP.

Utility Mix in MN – Natural Gas





MN EE Achievements – Natural Gas



Cost of Efficiency in MN

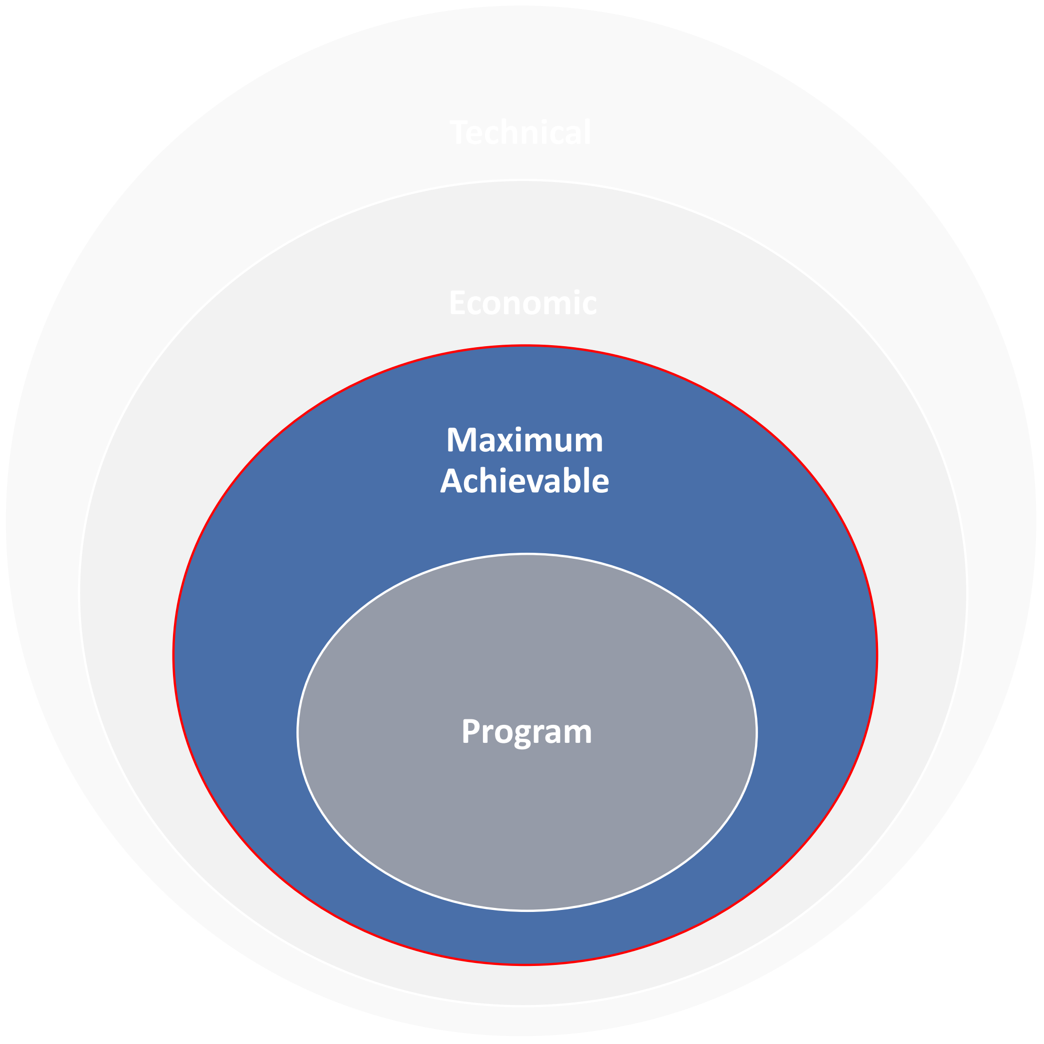
State	ACEEE Ranking	Electric spending ($/kWh)	Gas spending ($/therm)
Massachusetts	1	$0.34	$7.39
California	2	$0.35	$6.02
Rhode Island	3	$0.37	$5.89
Vermont	4	$0.39	$3.68
Oregon	5	$0.29	$3.56
Connecticut	6	$0.43	$6.17
Washington	7	$0.21	$3.83
New York	7	$0.27	$5.12
Minnesota	9	$0.19	$1.76
Maryland	10	$0.33	$9.88

Goals of Study

- Estimate statewide electric and natural gas energy efficiency for 2020-2029
- Produce actionable resources
- Engage stakeholders

Methodology

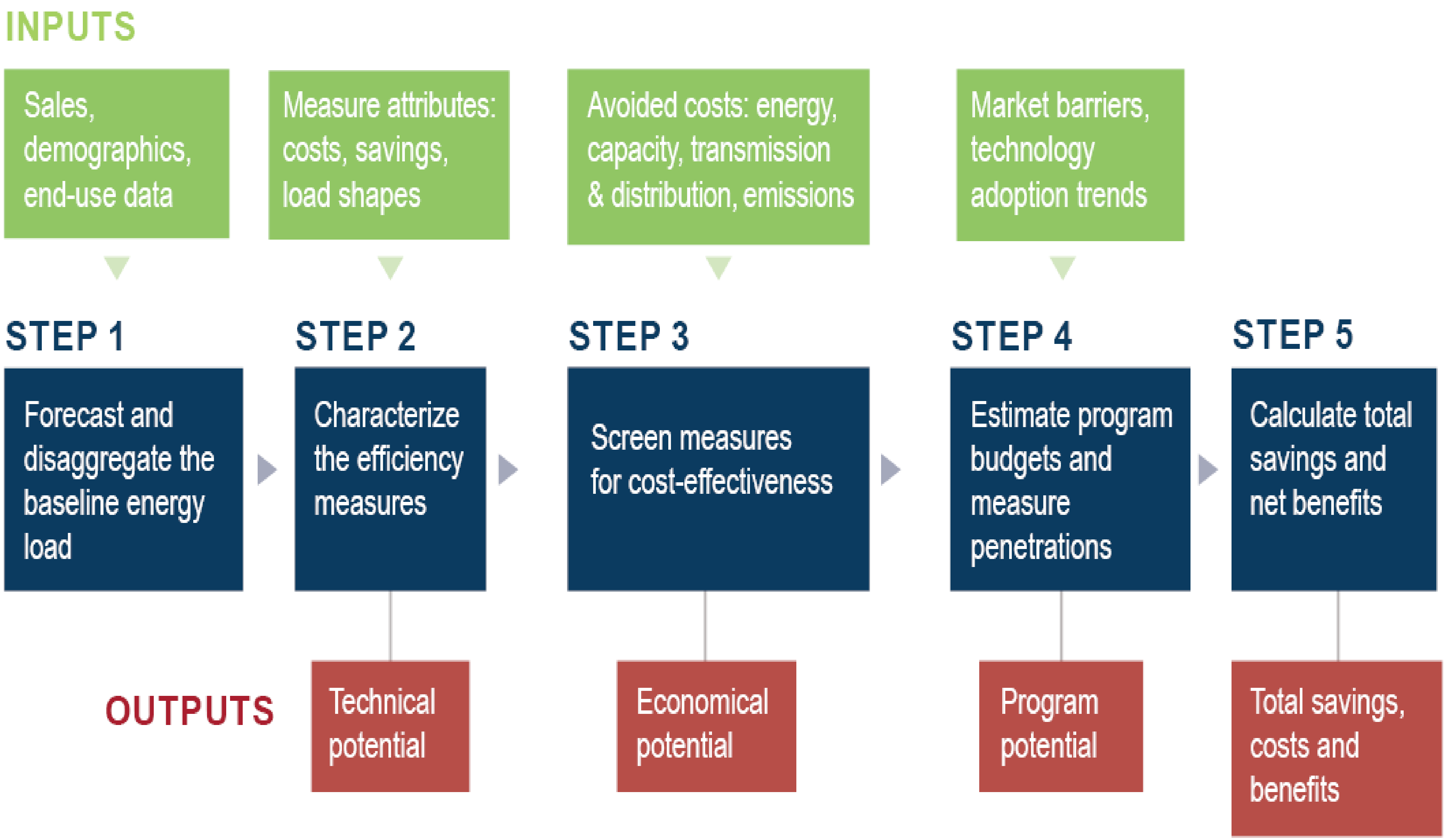
Types of Energy Efficiency Potential



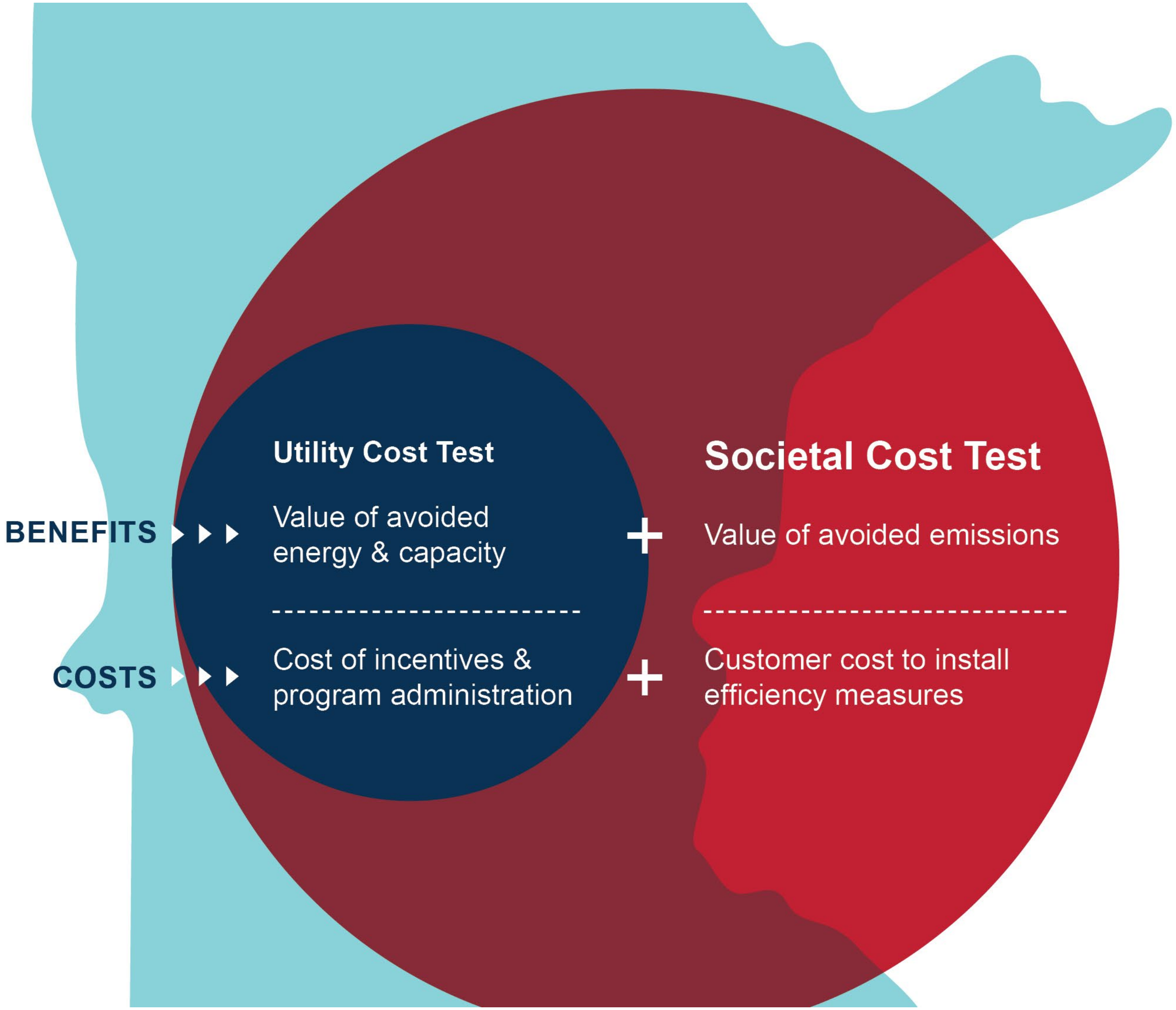
- **Maximum Achievable**: Subset that is achievable considering market barriers, given the aggressive incentives and idealized programs
  - Rebates set at 100%
  - Technology adoption at theoretical maximum

- **Program Potential**: Subset of achievable, given constrained incentives (50%) and program budgets

High Level Methodology Overview

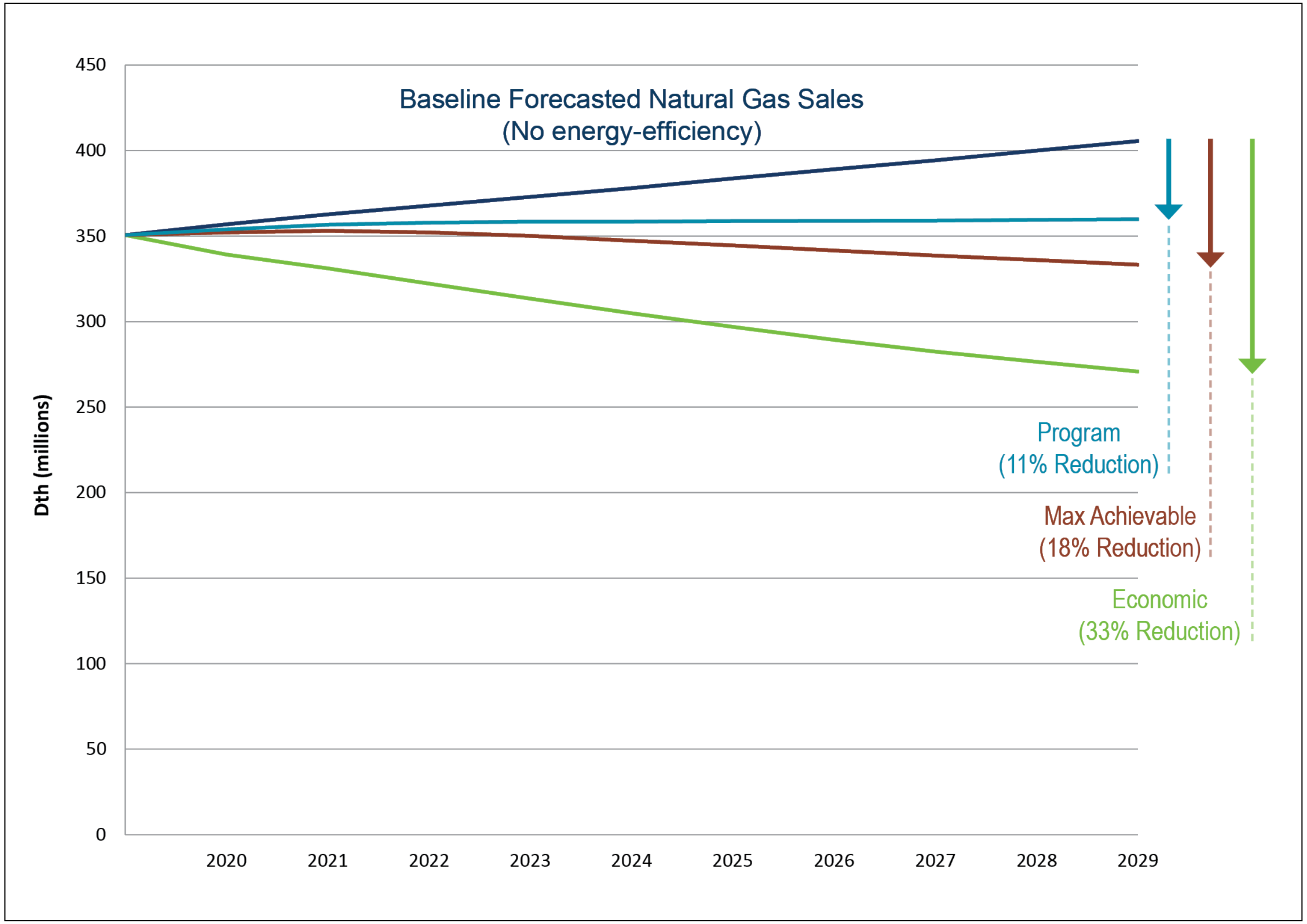


Societal Cost Test Used for Screening

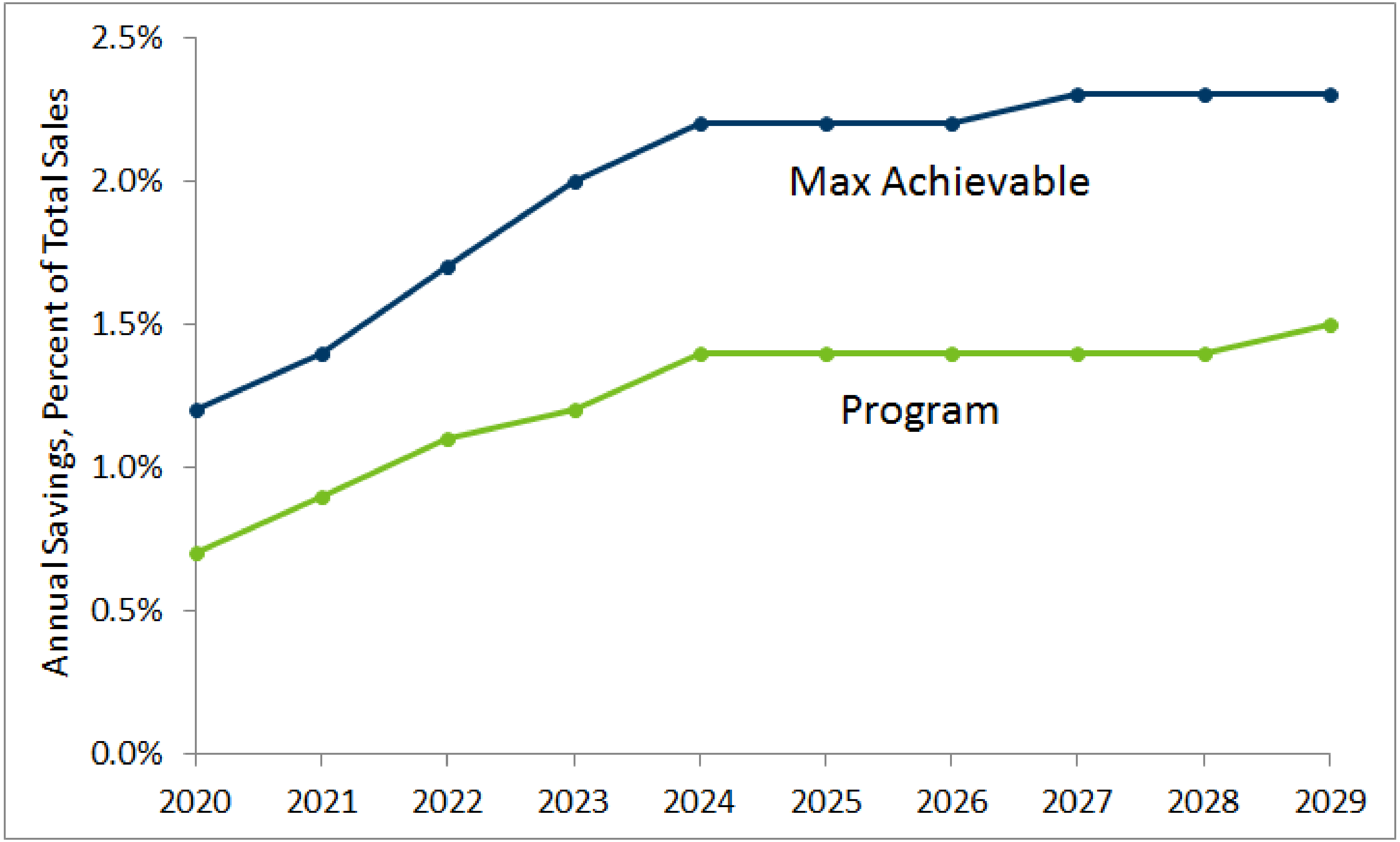


Results

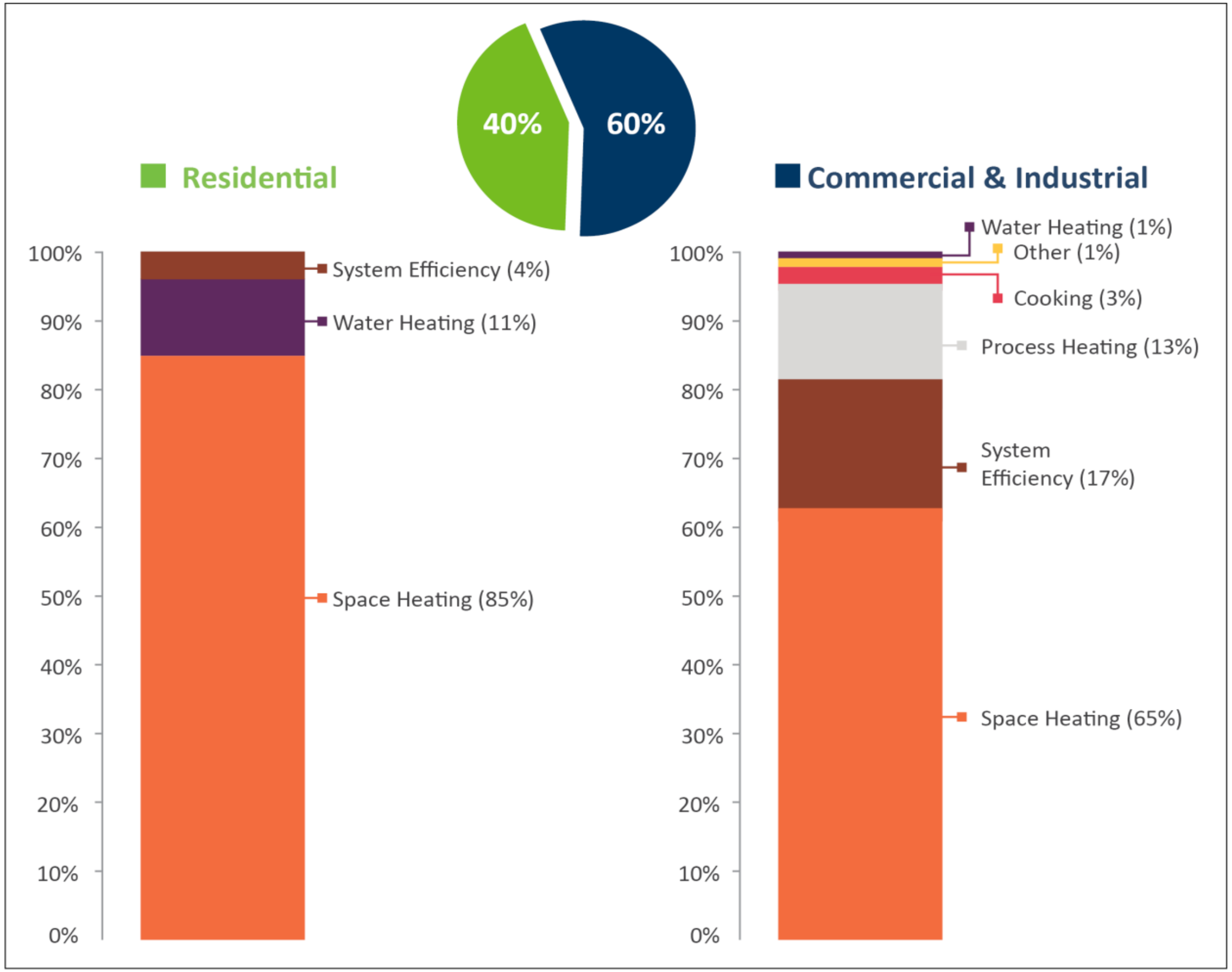
Results – Gas Utilities



Results – Gas Incremental by Year



Results – Gas Potential by End Use



Cumulative annual 2029 savings

Program potential scenario

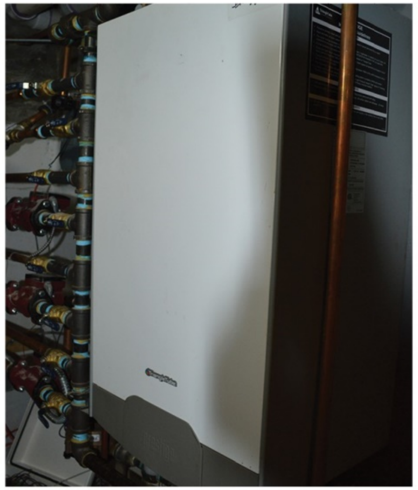
Results – Gas Top Five Residential Measures

Condensing furnace

Tier 1-3 thermostat

Attic insulation & air sealing

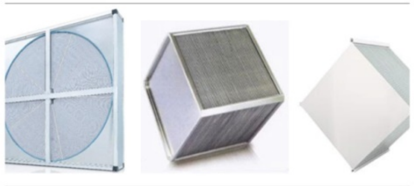
Boiler



Aerosol envelope sealing

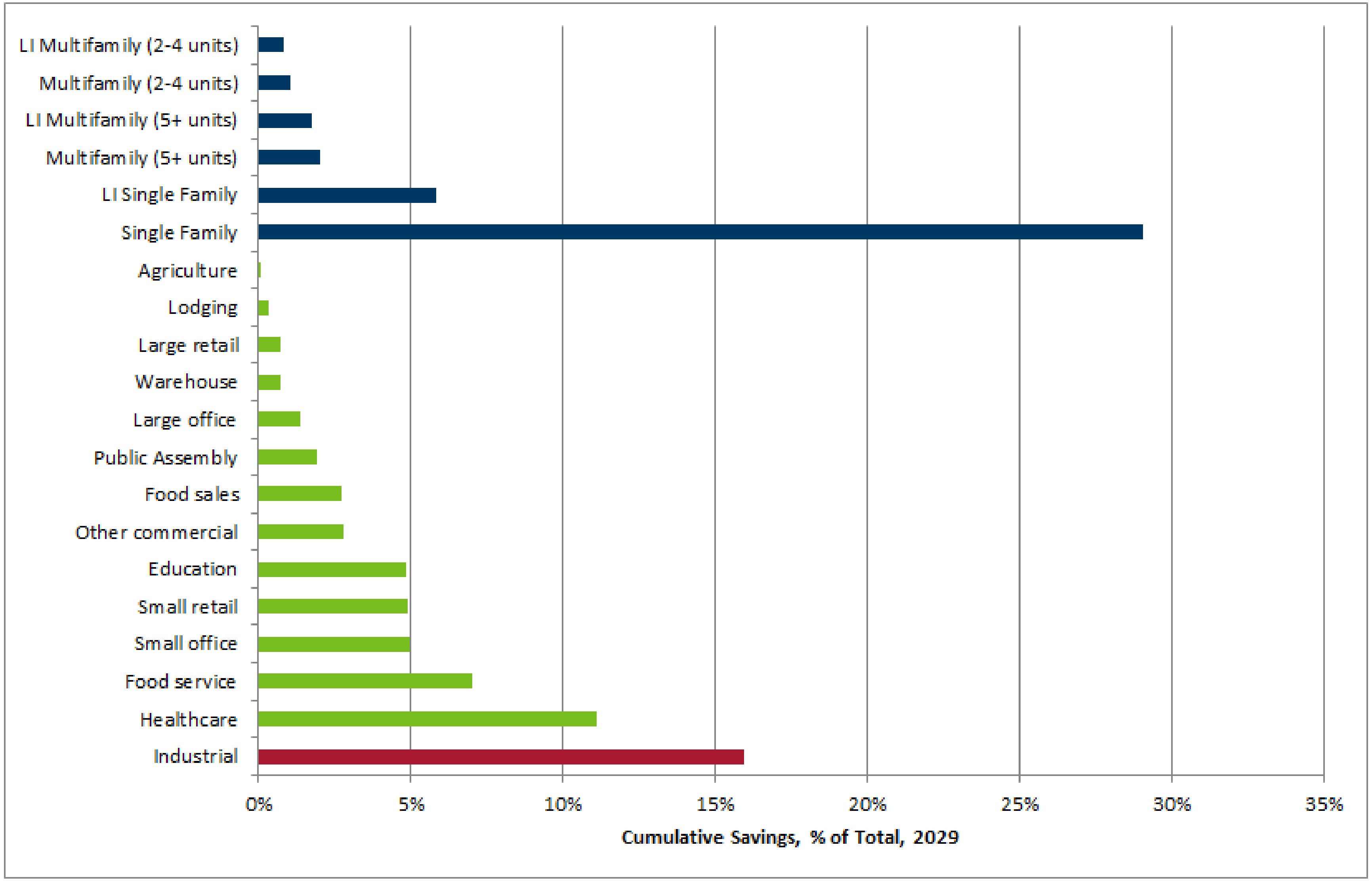
	Condensing furnace	Tier 1-3 thermostat	Attic insulation & air sealing	Boiler	Aerosol envelope sealing
Cumulative 2029 energy savings (Dth, thousands)	5,200	4,600	2,300	1,900	1,100
Percent of total residential energy savings potential	28%	25%	12%	10%	6%

Results – Gas Top Five Commercial Measures



	Energy recovery ventilator	Demand control ventilation	Boilers	Condensing furnaces	Smart thermostat
Cumulative 2029 energy savings (Dth, thousands)	3,600	2,900	2,600	2,500	2,000
Percent of total commercial energy savings potential	16%	13%	12%	11%	9%

Results – Gas Potential by Segment



Program Findings and Recommendations

Current MN Utility Program Findings

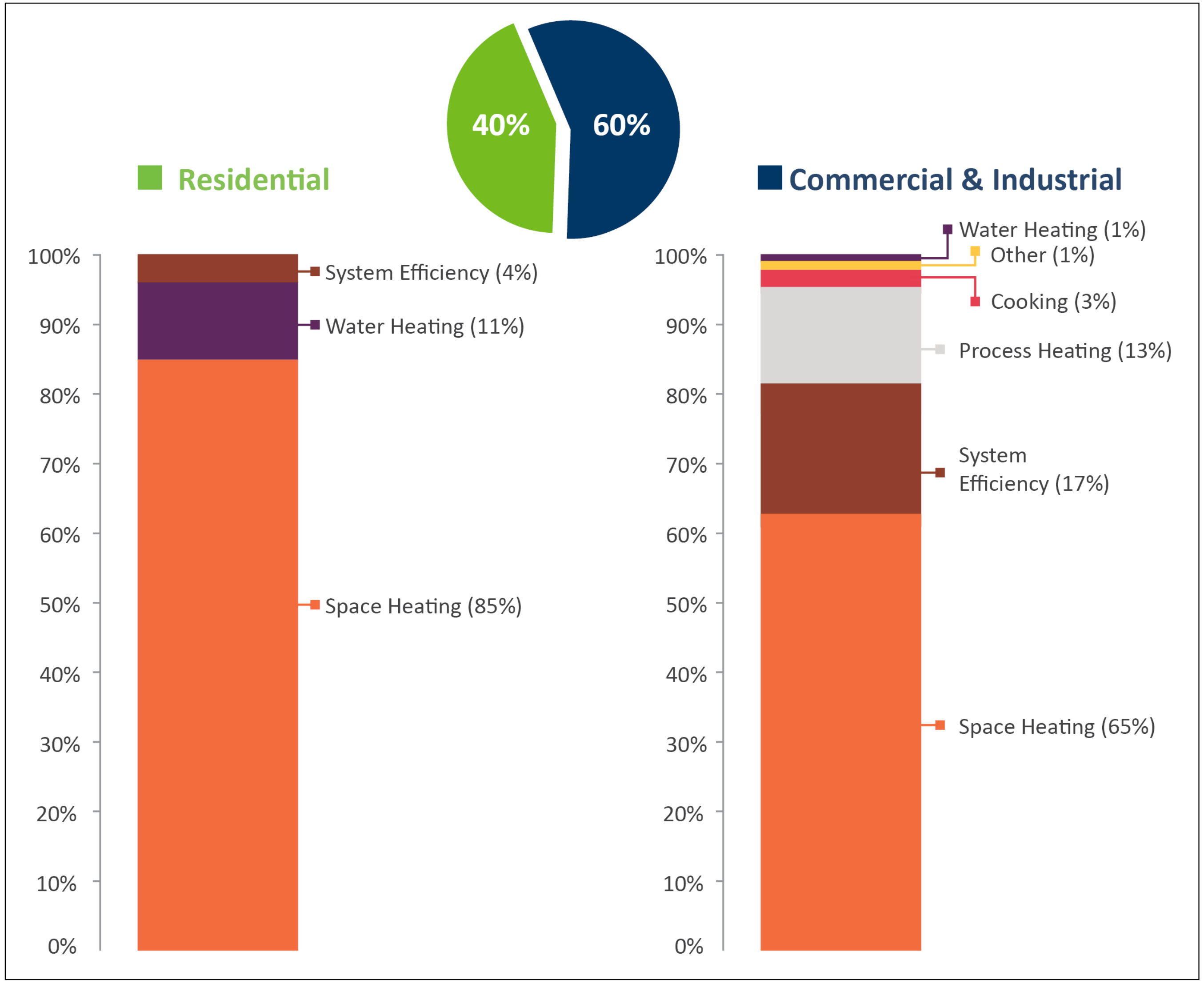
Minnesota has a strong foundation of effective CIP programs

- Minnesota currently has some of the lowest cost and best performing programs in the country
- Utilities in Minnesota – both IOUs and COUs – have been proactive in designing and implementing comprehensive, effective, and innovative program models

Partnerships have helped increase program effectiveness

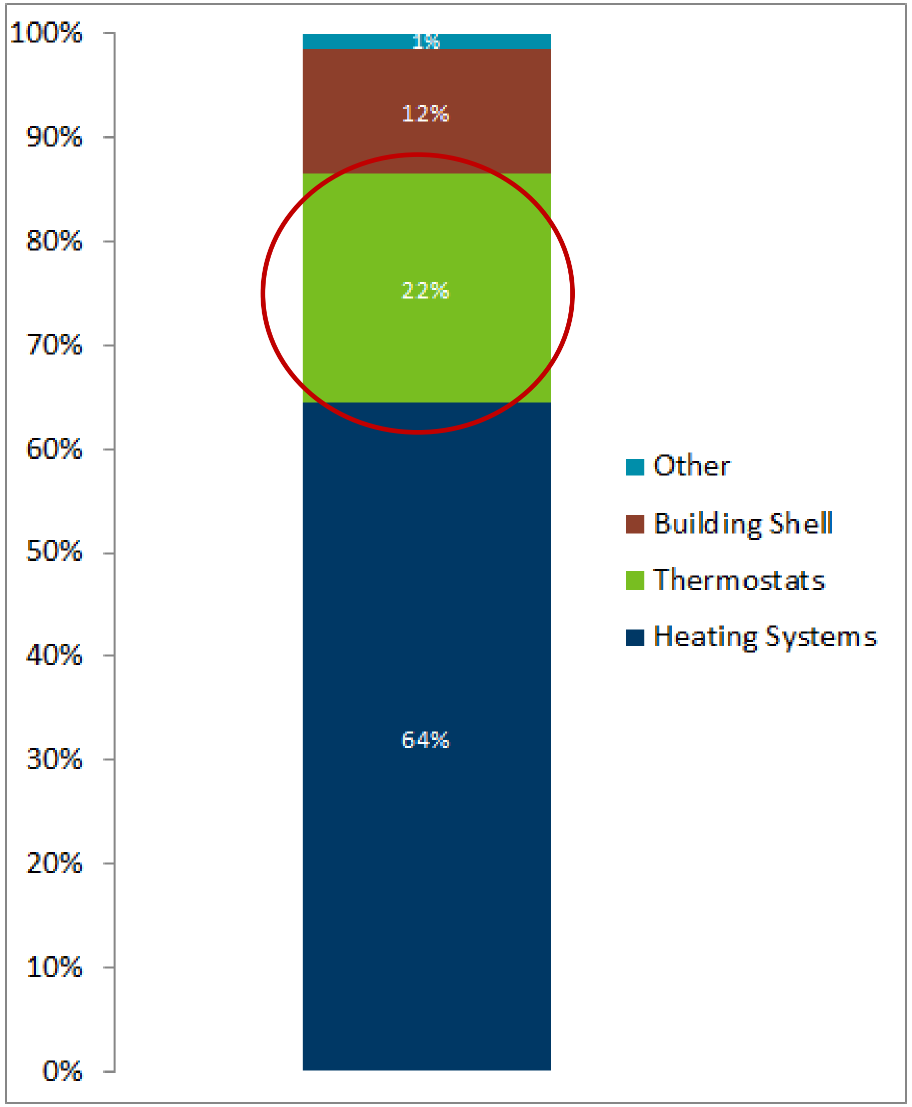
- Deep relationships with trade allies have helped utilities deliver programs
- Smaller utilities face additional challenges in implementing programs, but the most successful COU programs involve cooperation among utilities
- Some utilities have achieved enhanced performance through joint natural gas-electric programs

Sources of Natural Gas Potential



Smart Thermostats Grow in Importance

Measure categories within gas space heating end use



Program Recommendations

Recommendations for Utility Programs:

- Continue to test promising new approaches.
- Offer comprehensive program designs for larger and harder-to-reach customers.
- Develop upstream incentives and associated program support in selected markets.
- Incorporate operational savings into commercial and industrial programs.
- Employ segment-specific strategies to reach customers.
- Deepen trade ally engagement and training efforts.
- Incorporate AMI-enabled capabilities into programmatic strategies.
- Leverage interest by local governments in energy efficiency.

Coordination among Utilities:

- More systematically share best practices and program successes.
- Coordinate more closely on trade ally outreach and training.
- Work further towards coordinated and/or joint implementation of programs.

Workforce Impacts

$6,657,000,000

2020-2029 incremental costs of MN utility-driven energy efficiency investments under program achievable scenario

Jobs supported →

Direct job type	Expected job-years	% of total job-years
HVAC technicians	10,500	21%
Electricians	5,100	10%
Insulation installers	2,200	5%
Mechanical engineers	2,100	4%
Architects	2,000	4%
Plumbers, pipefitters	1,800	4%
Retail salespersons	1,400	3%
Weatherization technicians	1,100	2%
Stationary engineers and boiler operators	700	2%
Other	3,500	7%
Total direct job-years	30,400	62%
Indirect job-years	18,900	38%
TOTAL JOB-YEARS	49,300	100%

Minnesota Energy Efficiency Potential Study Report

Website: www.mncee.org/mnpotentialstudy/home/

CEE's Potential Study Webpage

DOWNLOAD THE REPORT

Full Report

Study Appendices

Study Fact Sheet

WEBINAR ARCHIVE

Study researchers presented on project results and recommendations on December 17, 2018.

Watch the webinar recording

Download the webinar slide deck

FORUM ARCHIVE

Study researchers and stakeholders discussed project results and implications on February 13, 2019.

Watch the full recording

Download the presentation slide deck

Minnesota Energy Efficiency Potential Study Report

Study Appendices

A) Methodology and Data Sources
B) Detailed Model Results
C) Energy Efficiency Measures
D) Behavioral Measures and Approaches
E) Load Management and Demand-Response
F) Low-Income Sector Market Study
G) Rural Utility and Agriculture Sector Market Study
H) Small Commercial Market Sector Study
I) Energy Efficiency Program Benchmarking Report
J) Residential Buildings Primary Data Collection Report
J-2) Residential phone survey data and statistics workbook
K) Commercial Large Buildings Primary Data Collection Report
L) Trade Ally Survey Report
L-2) Trade Ally Survey Interview Scripts
M) Minnesota HVAC Sales Data Report
N) Advisory Committee Membership and Policy Comments
O) Review of Past Minnesota Energy Efficiency Potential Studies
P) Analysis of Workforce Impacts of Modeled Energy Efficiency Programs

Utility Reporting Tools

The utility reporting tool enables results of the potential study to be examined in more granular detail, including by:

- Individual utility (Both electric and natural gas)
- Building segment
- End use
- Measure

Website: https://www.mncee.org/mnpotentialstudy/reporting-tools/

Questions?

Minnesota Energy Efficiency Potential Study: 2020–2029

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Presentation and Q&A: The Promise and Potential of Geothermal Technology in Decarbonizing Minnesota's Natural Gas End-Uses Discussion

Audrey Schulman and Zeyneb Magavi,
Home Energy Efficiency Team

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The GeoMicroDistrict

A Novel Path to Building Electrification

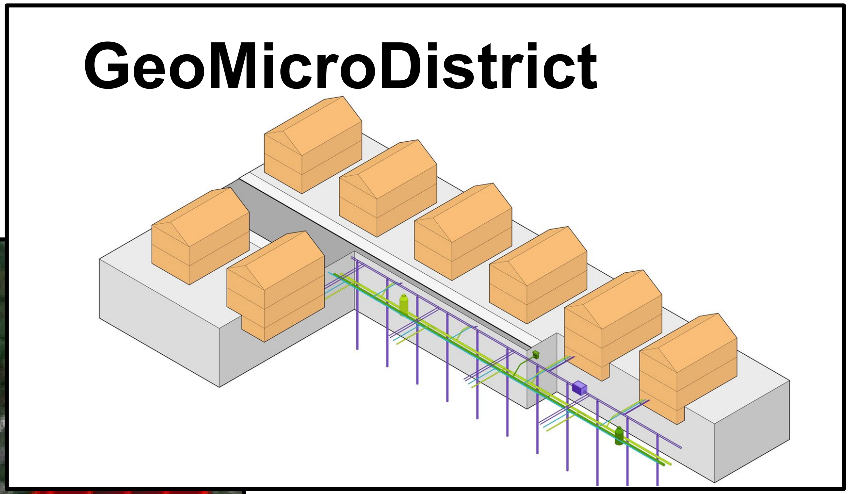
Putnam Foundation

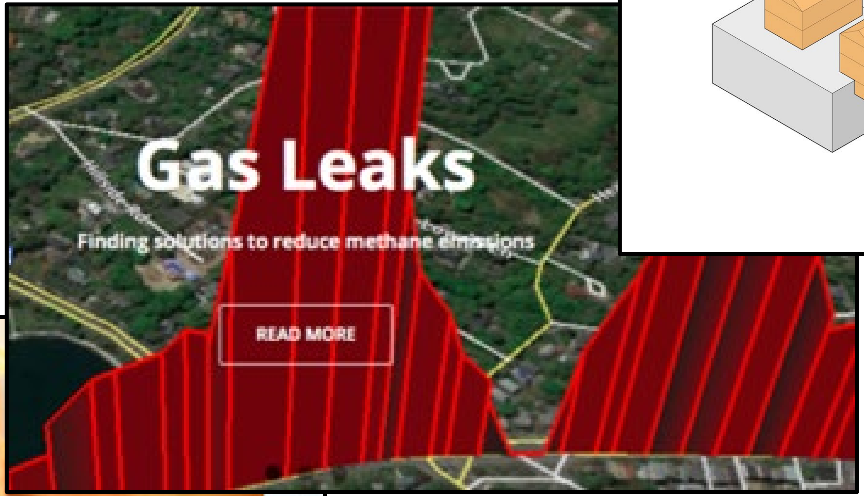
Barr Foundation

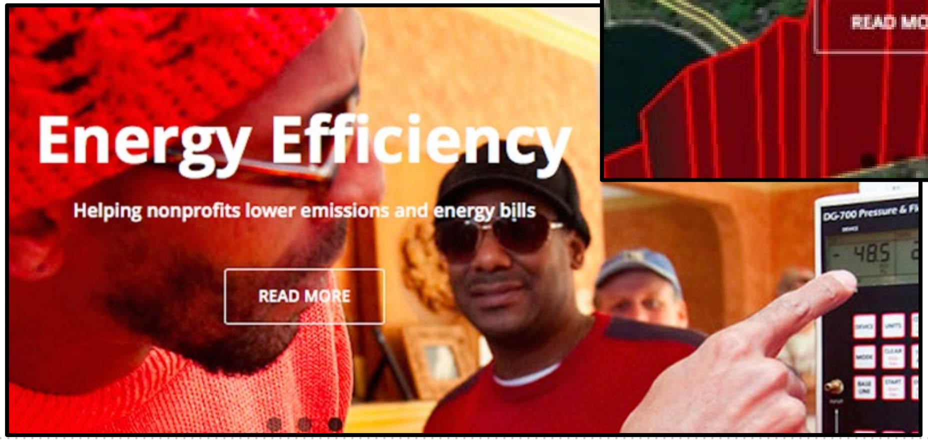
HEET

To cut carbon emissions NOW

by driving systems change.







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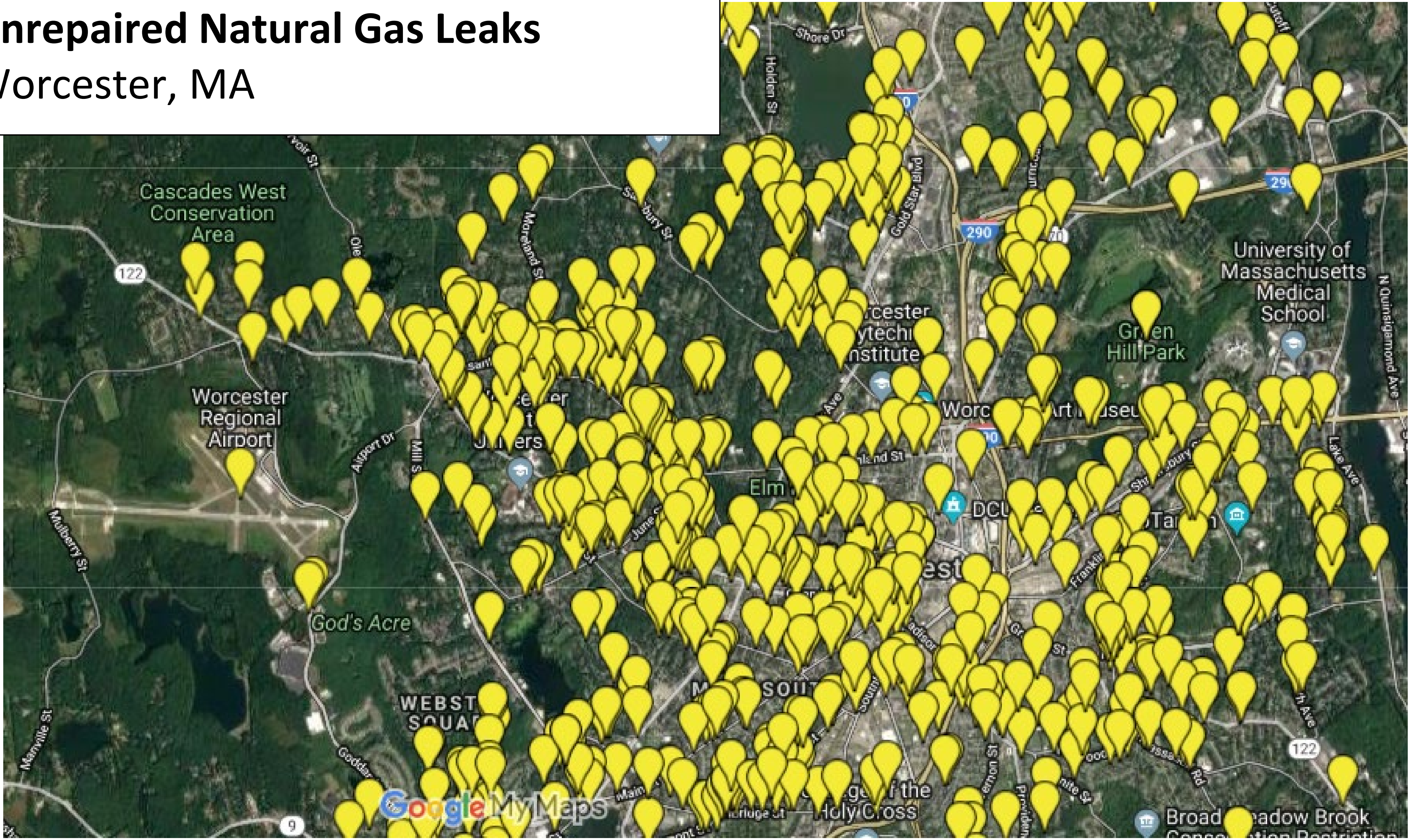
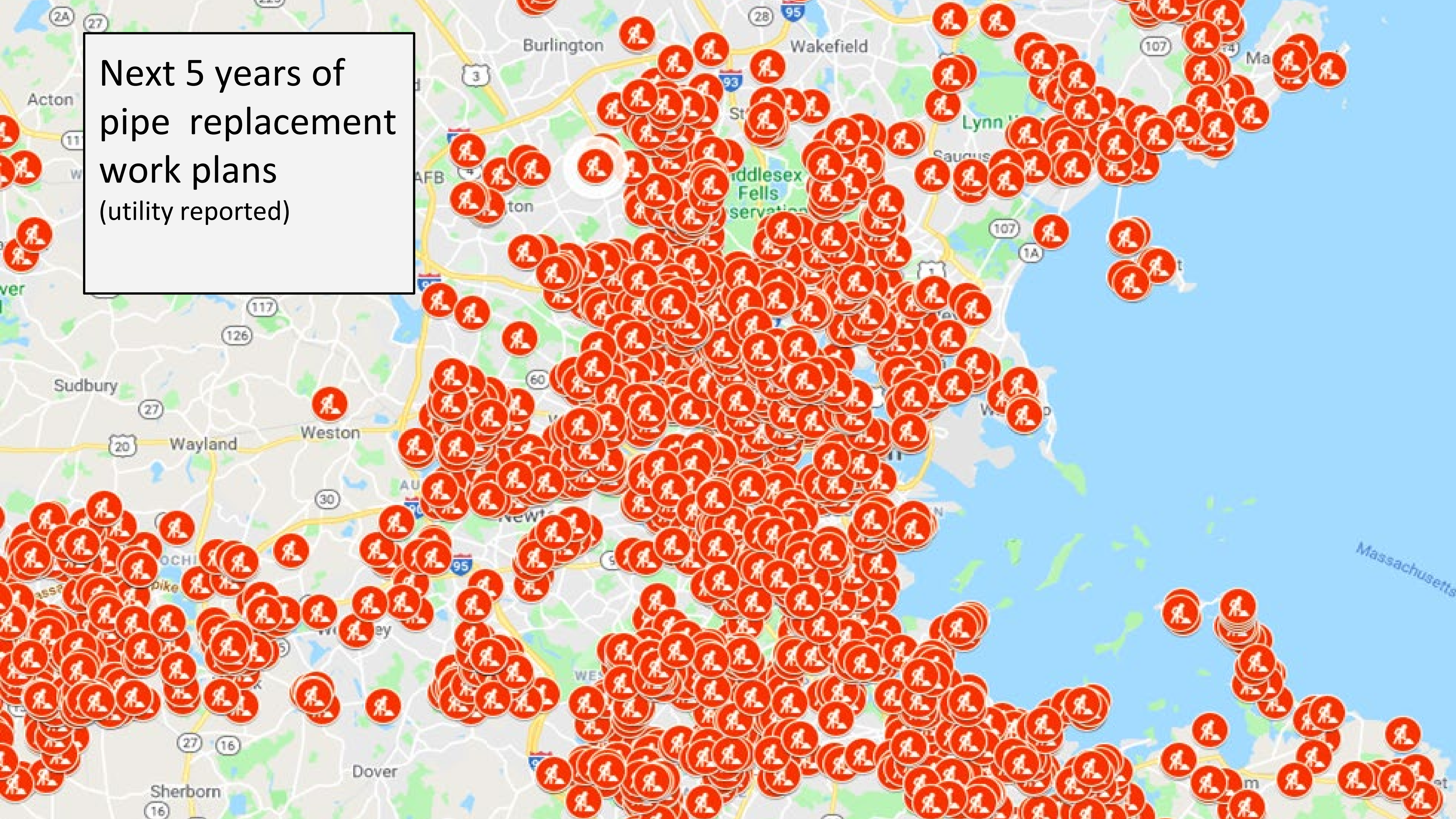
Unrepaired Natural Gas Leaks

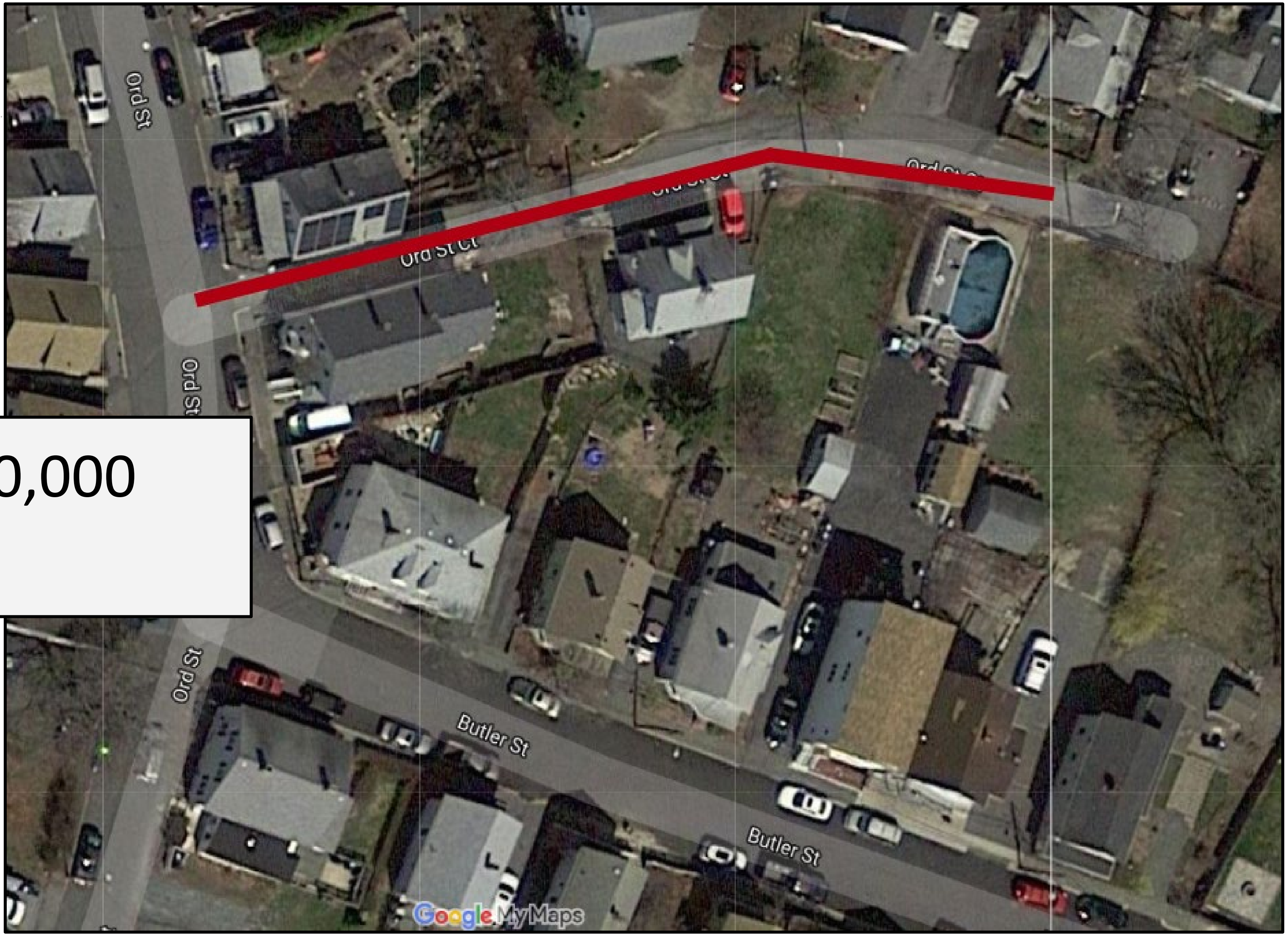
Worcester, MA



Next 5 years of pipe replacement work plans

(utility reported)





Cost: $100,000
4 Homes

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- Don’t work everywhere
- Large burden on electric grid, especially during winter
- Inequity of access
- Requires collapse of gas industry

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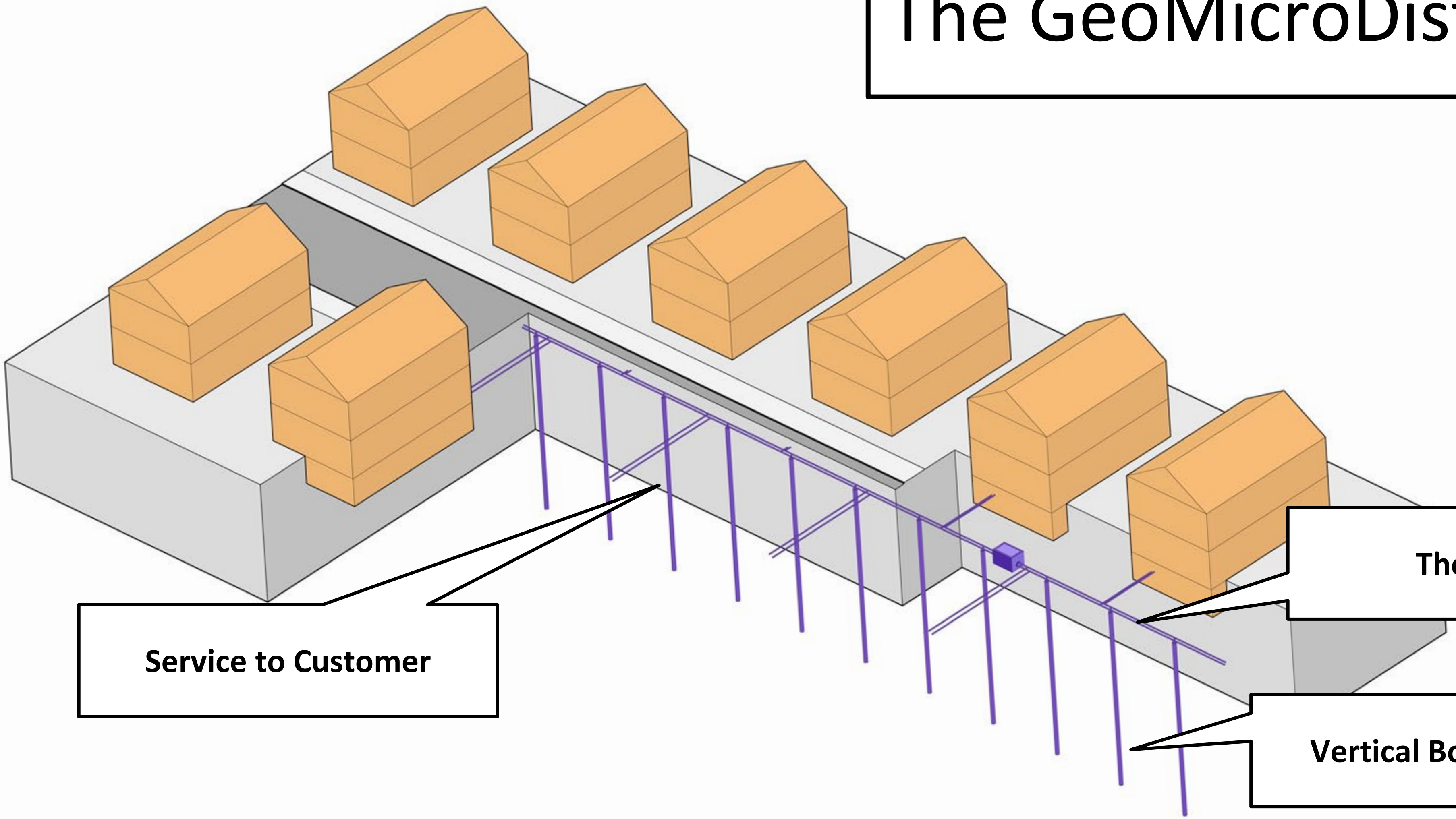
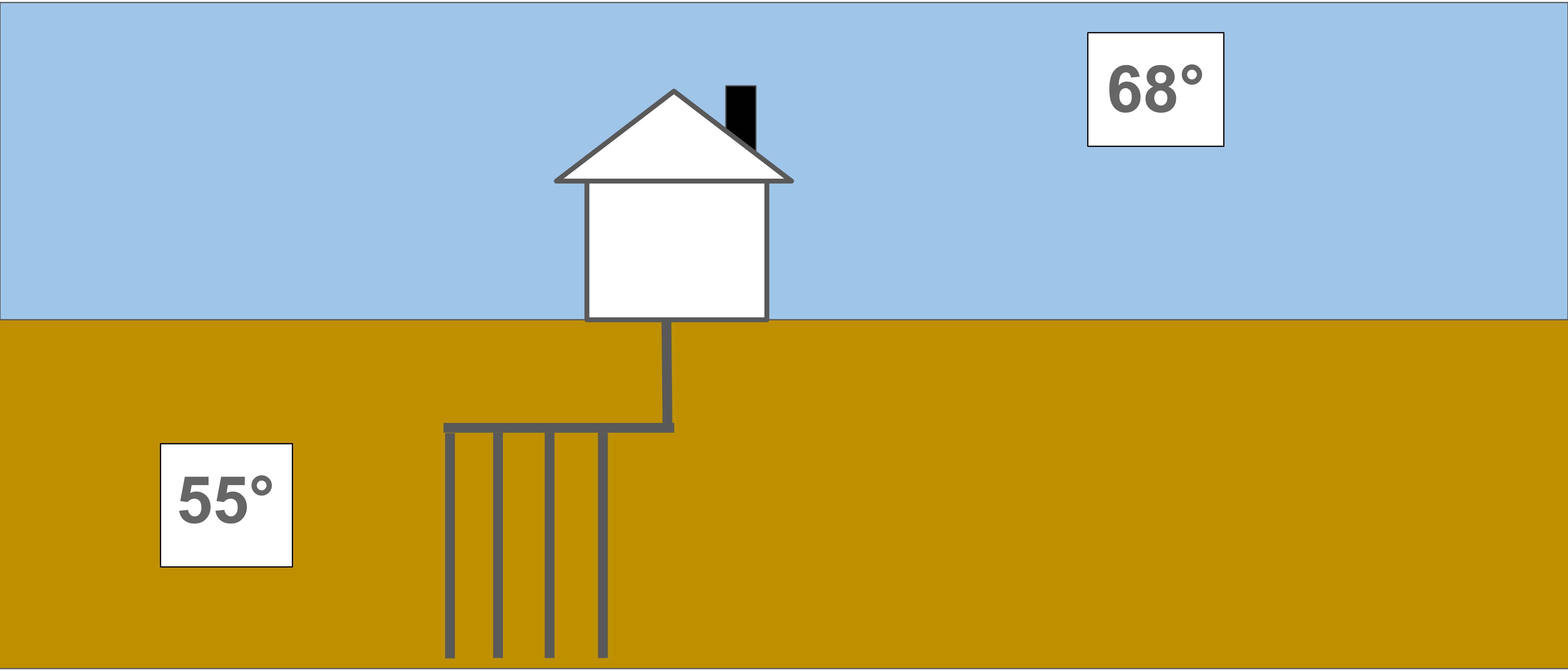
Design Principles

- Safe
- Renewable & Resilient & **Reliable**
- **Low cost** for consumers
- Workers keep their **jobs**
- Minimal legislative & regulatory change
- Equitable & Scalable & Adaptable

The GeoMicroDistrict



Ground Source Heat Pump



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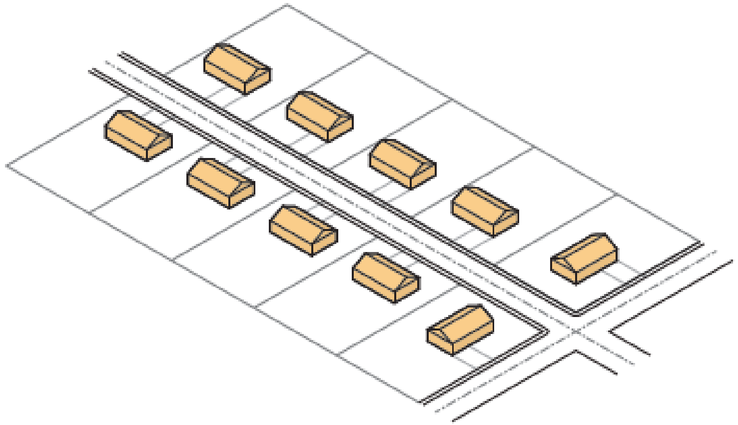
Feasibility Study

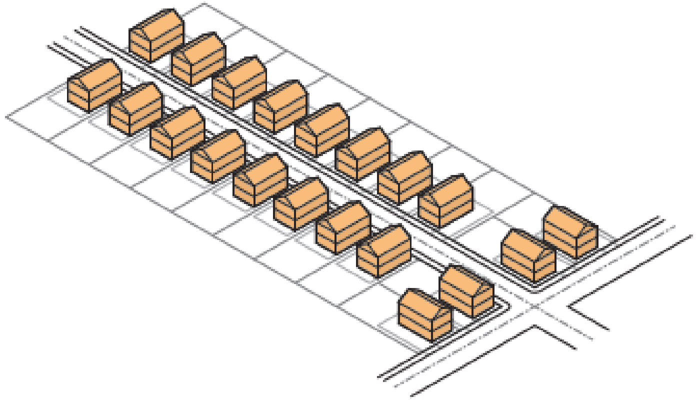
2019

BUROHAPPOLD ENGINEERING

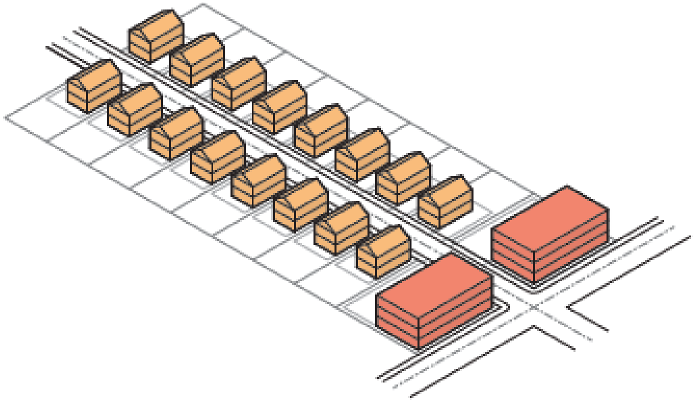
Prototype street segments created



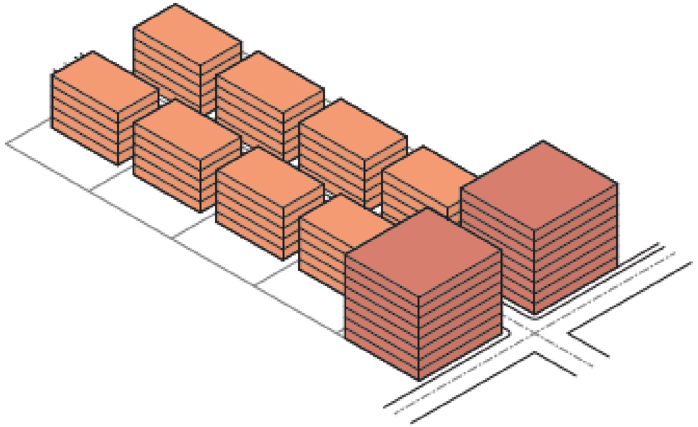
Low density residential



Medium density residential

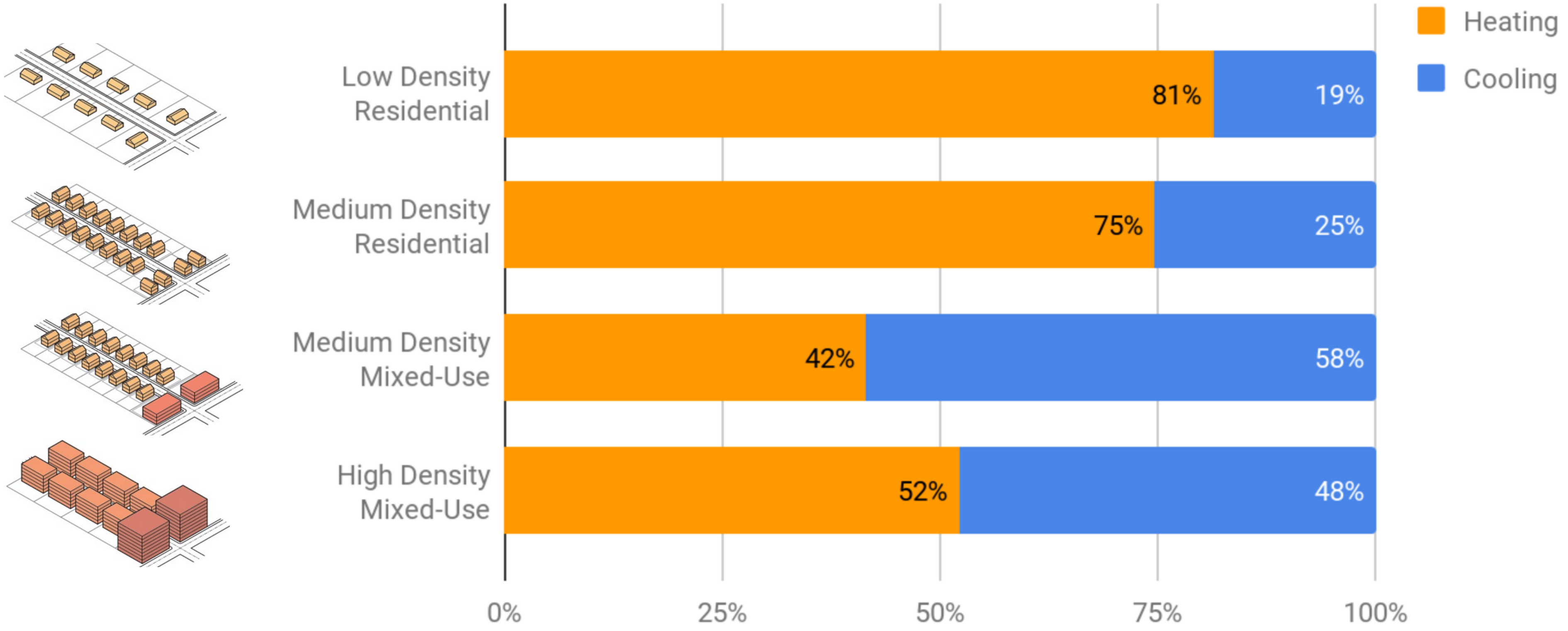


Medium density mixed-use



High density mixed-use

Annual Heating & Cooling Loads



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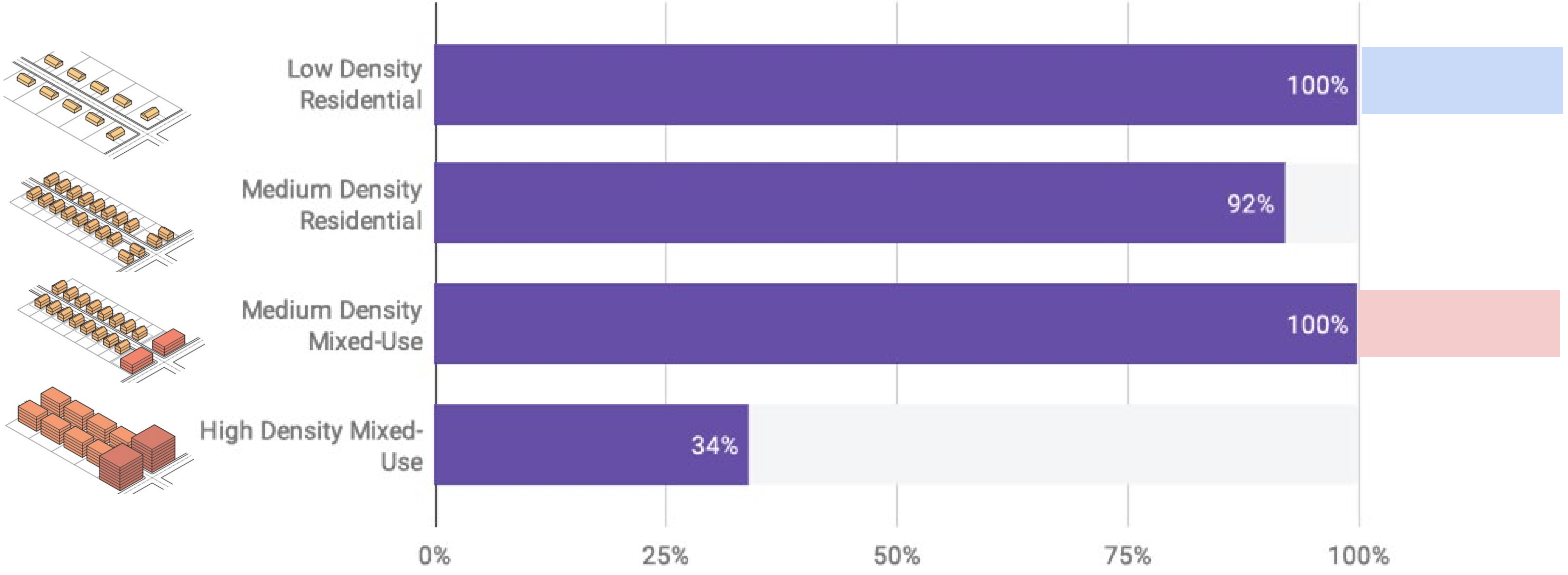
Technical Feasibility per Street Segment

The ability to meet energy demand through boreholes in the street only



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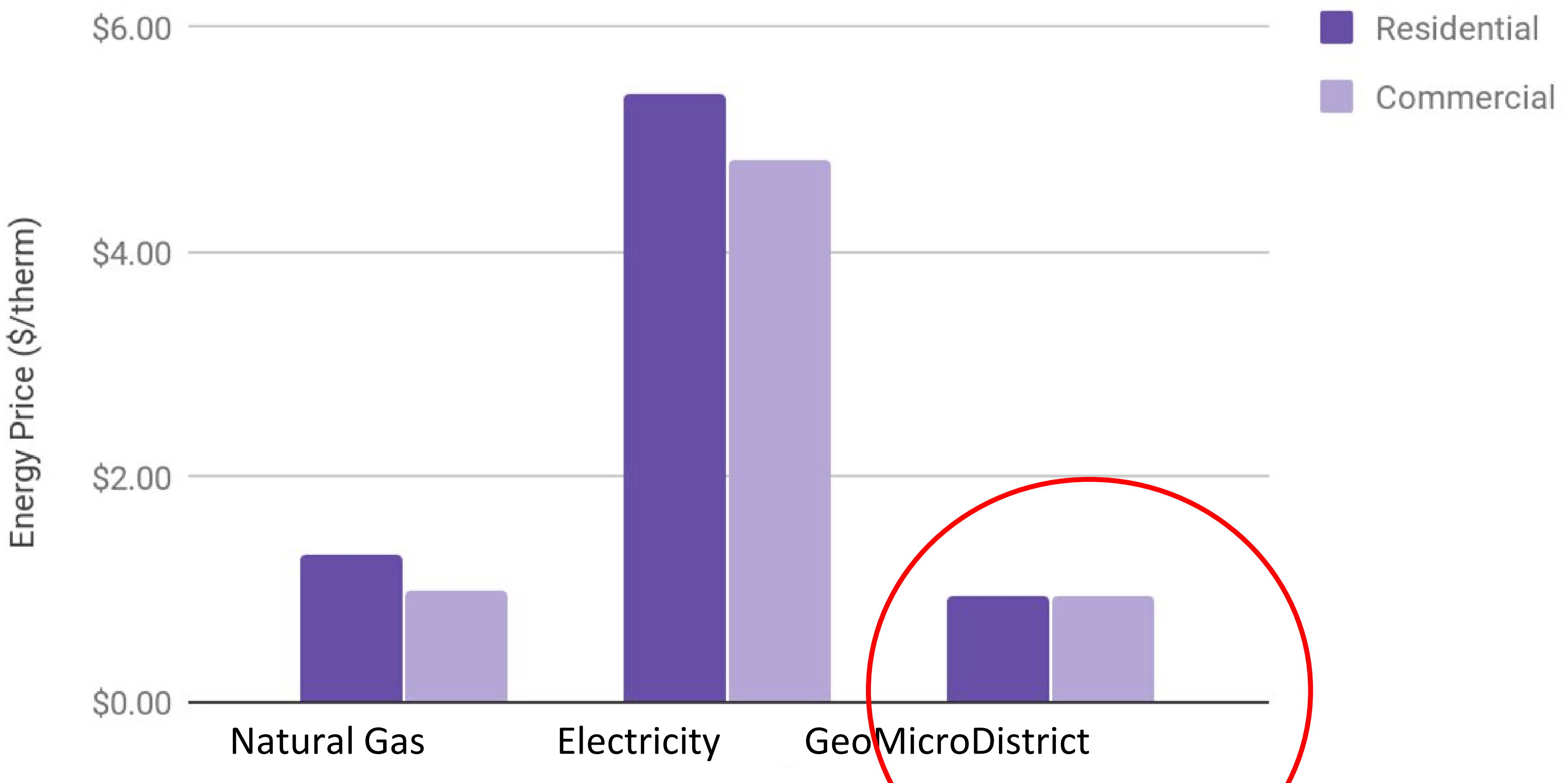
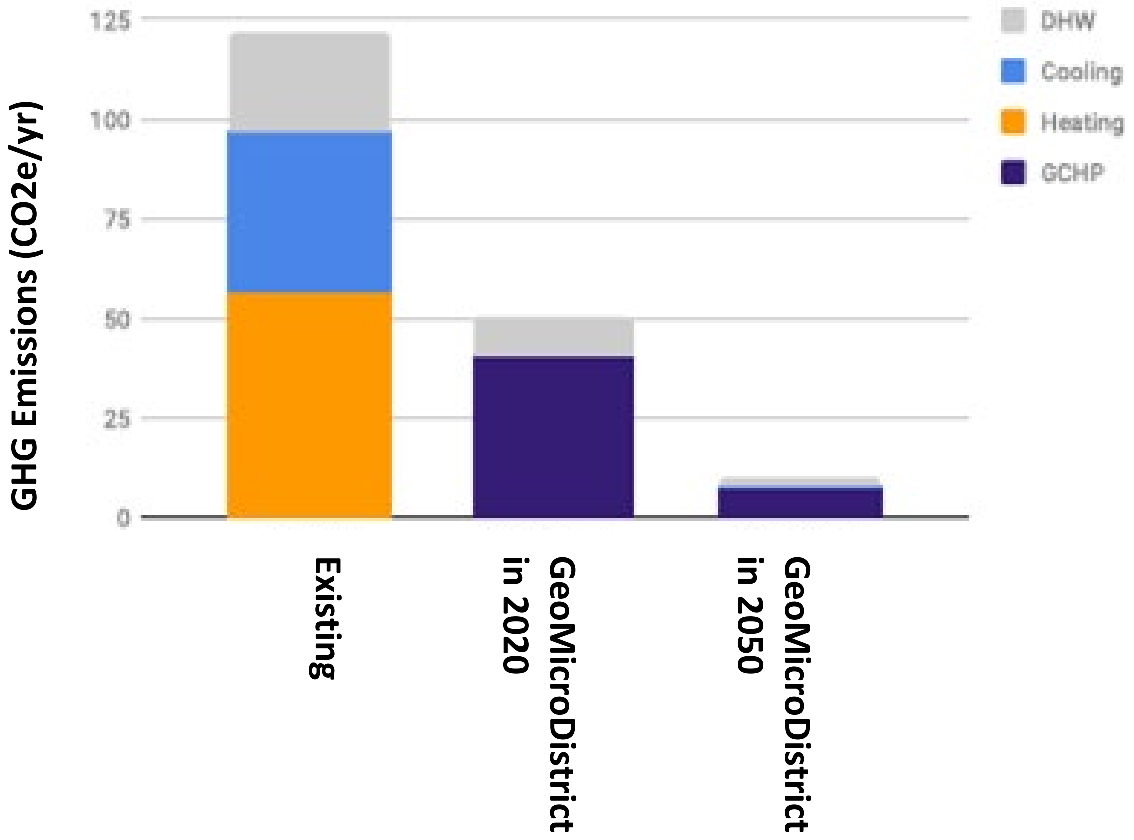
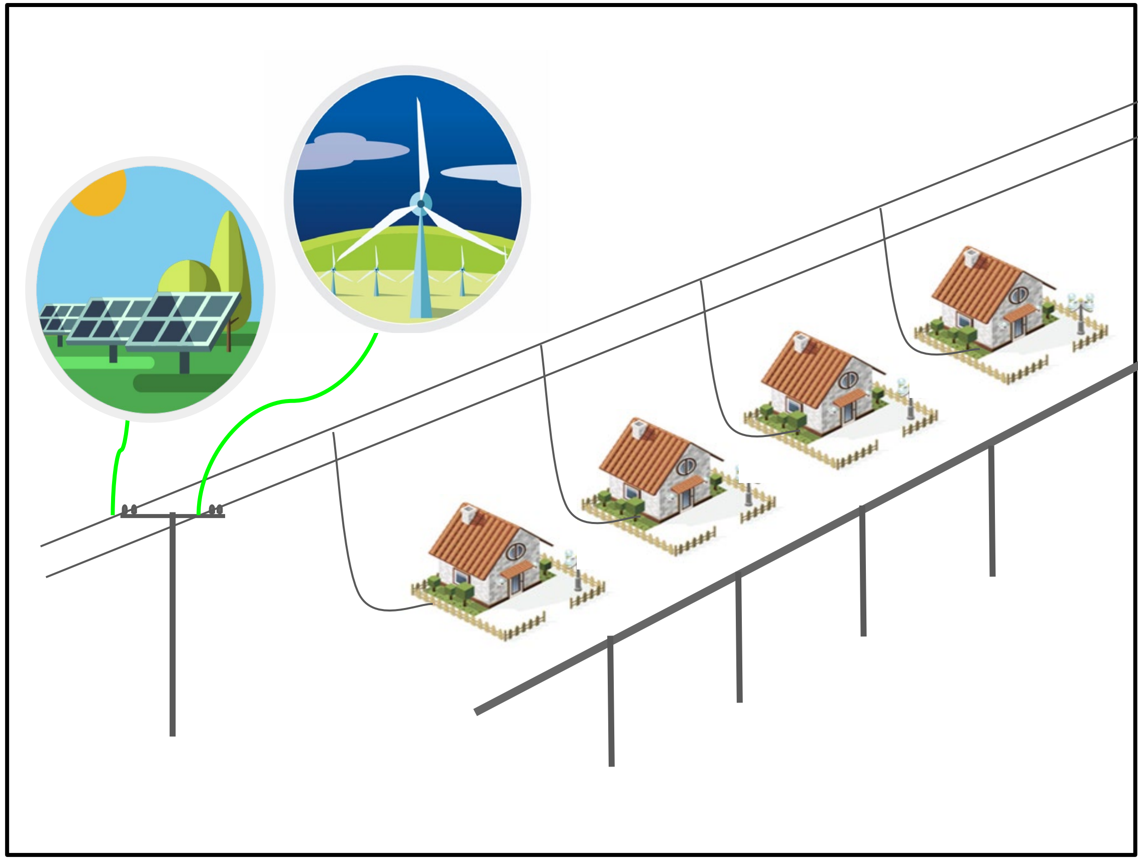
Comparison of Energy Prices



Source: BuroHappold analysis; U.S. EIA

Annual Greenhouse Gas Emissions





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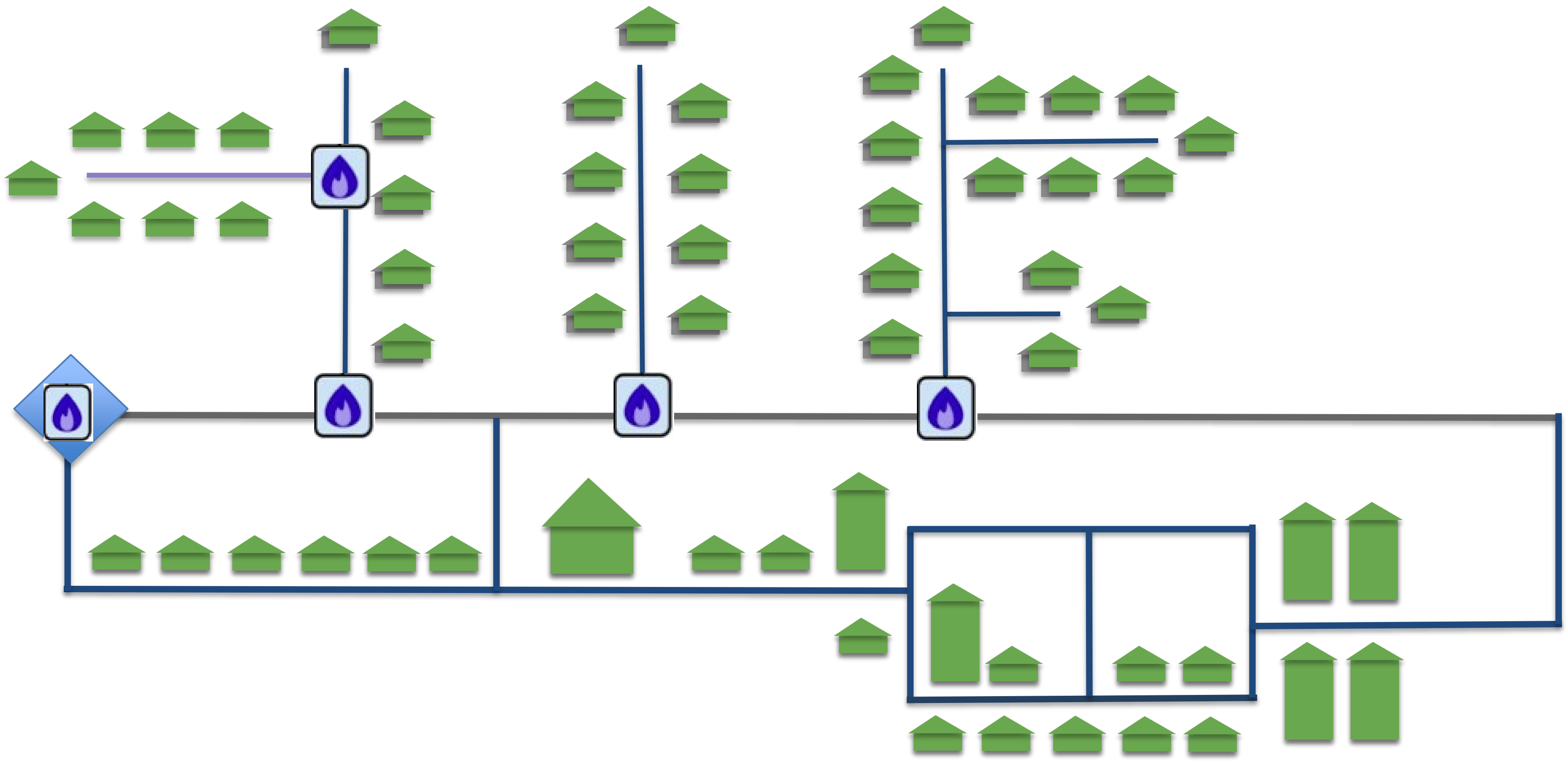
The HEET Grid

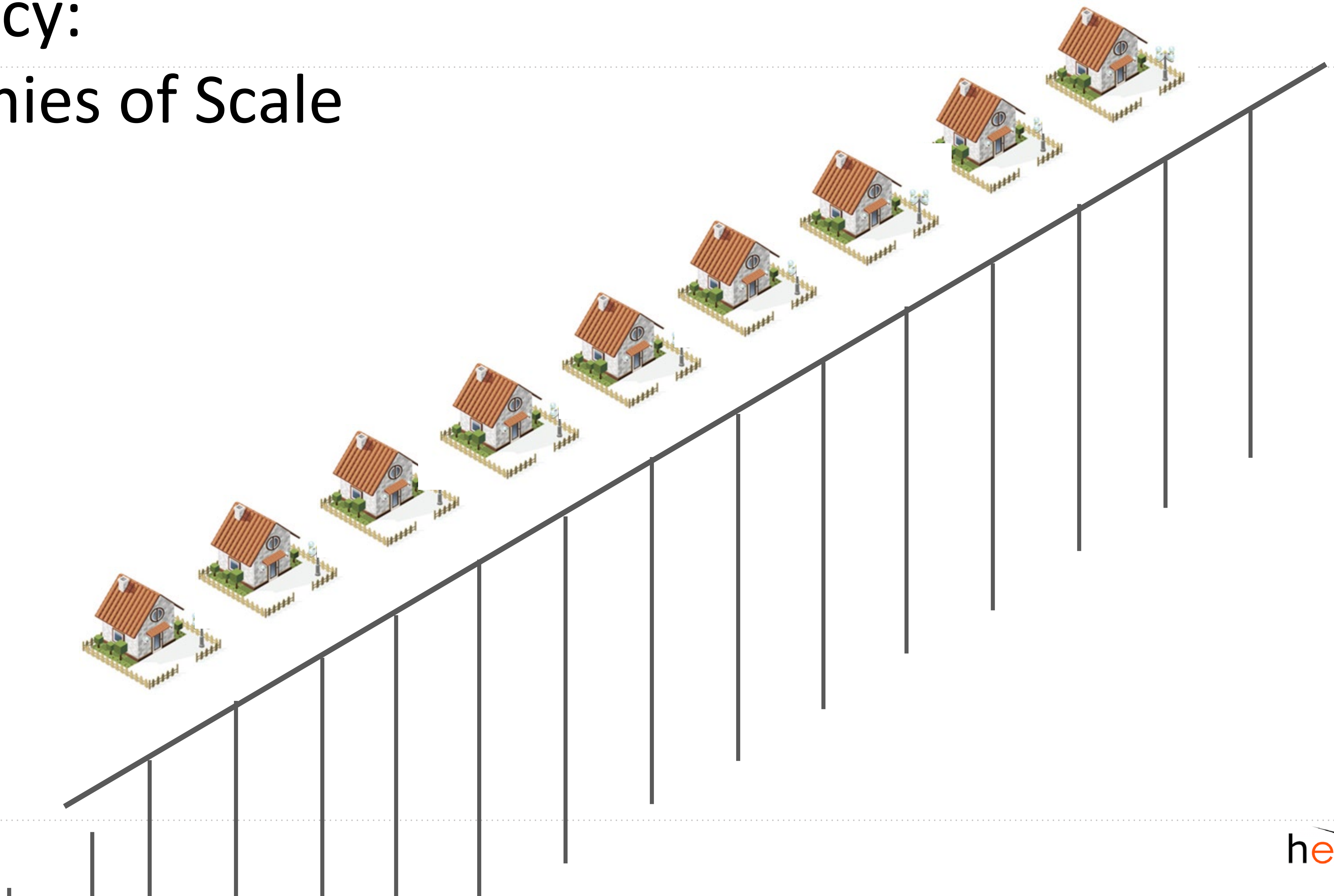


The Towerside Project

Photo: Towersidemsp.org

Just water is in the pipe.

Efficiency:
Economies of Scale



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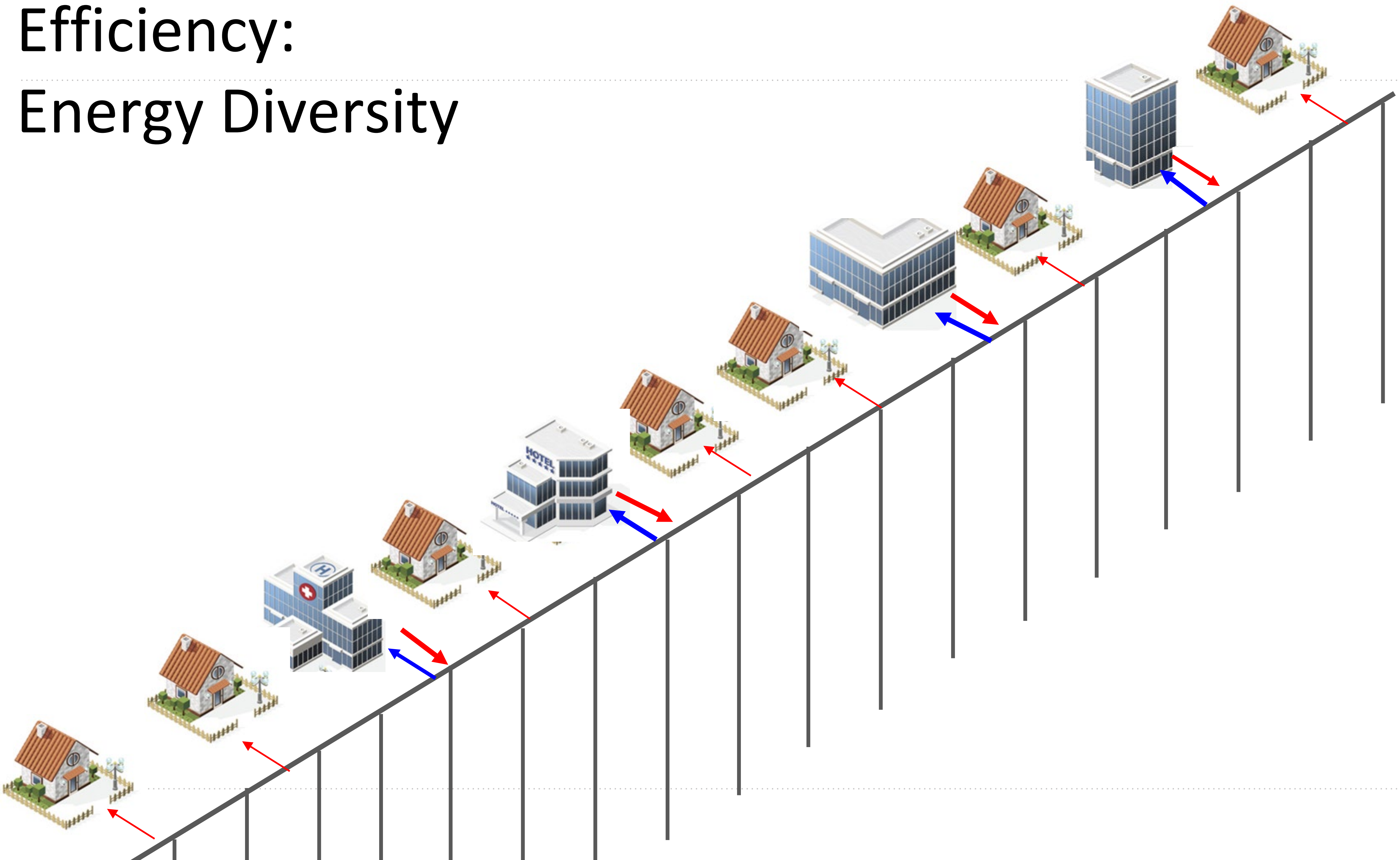
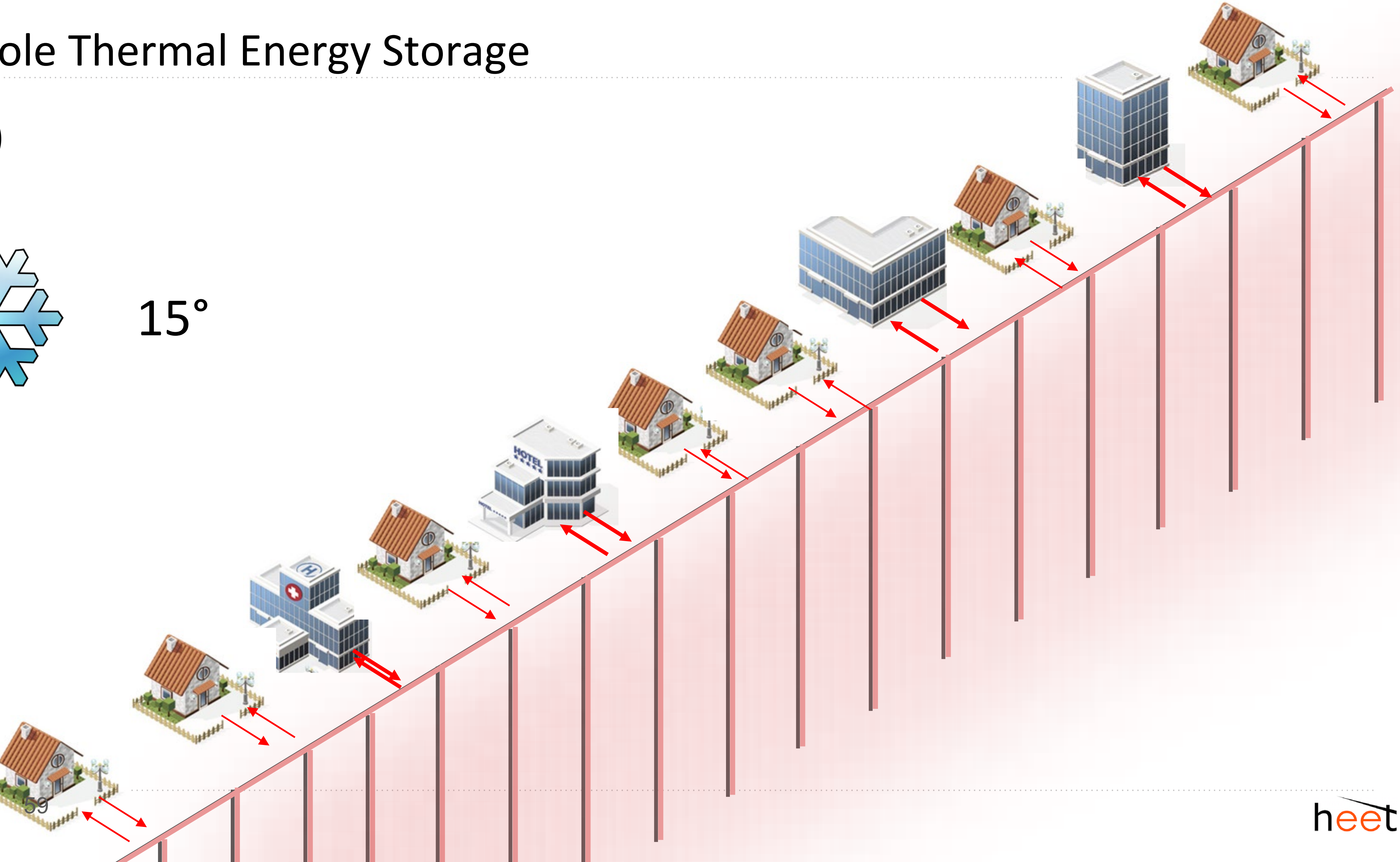
Efficiency:
Energy Diversity



Borehole Thermal Energy Storage

(BTES)



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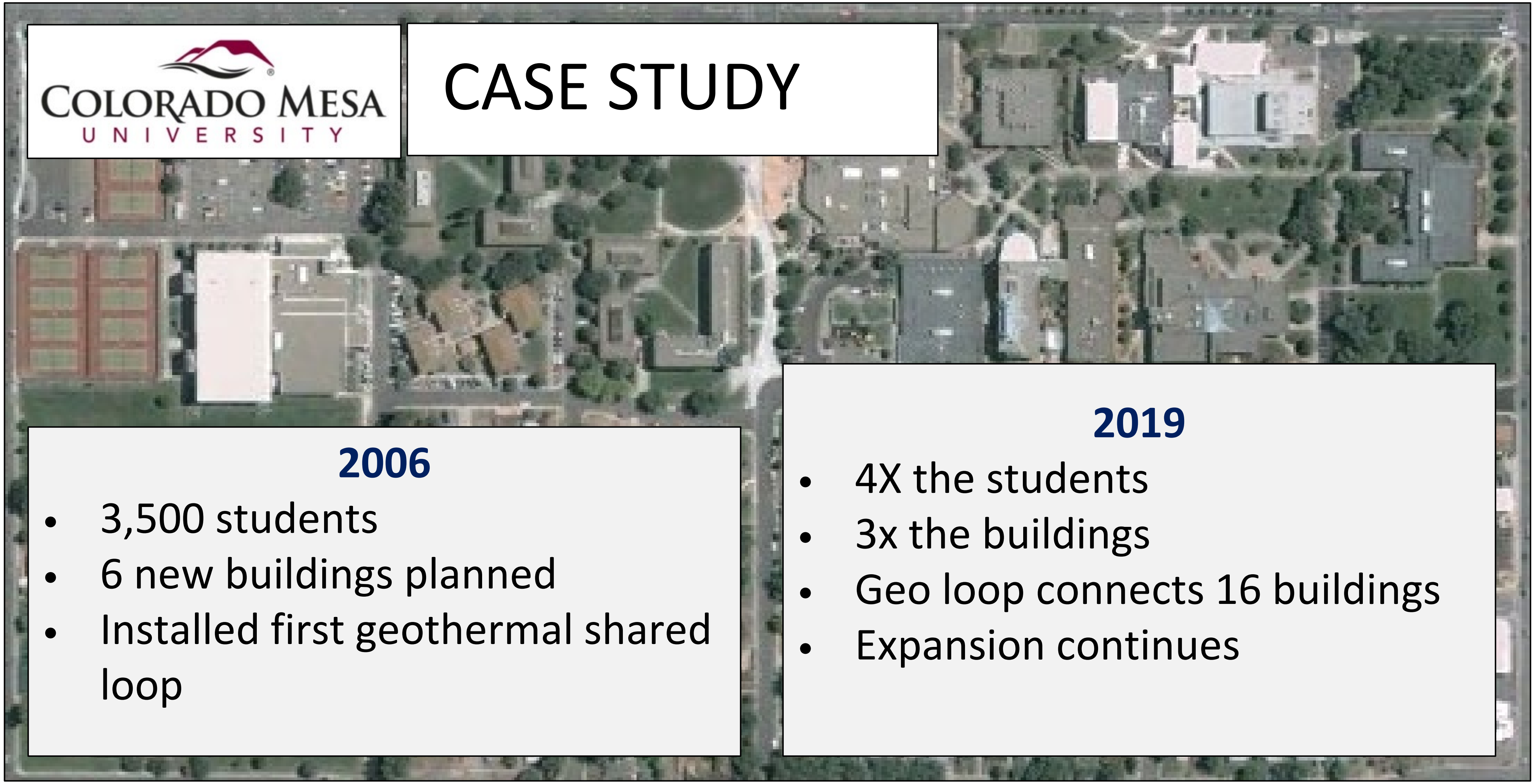

COLORADO MESA UNIVERSITY

CASE STUDY

2006

- 3,500 students
- 6 new buildings planned
- Installed first geothermal shared loop

2019

- 4X the students
- 3x the buildings
- Geo loop connects 16 buildings
- Expansion continues

Courtesy of The GreyEdge Group© & IGSHPA

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Thermal Management: Cooling

Before:

- ~ 3,400 tons
- 14.5mm gallons/yr
- 784 kW

After:

- 750 tons
- 4.5mm gallons/yr
- 185 kW

Courtesy of The GreyEdge Group© & IGSHPA

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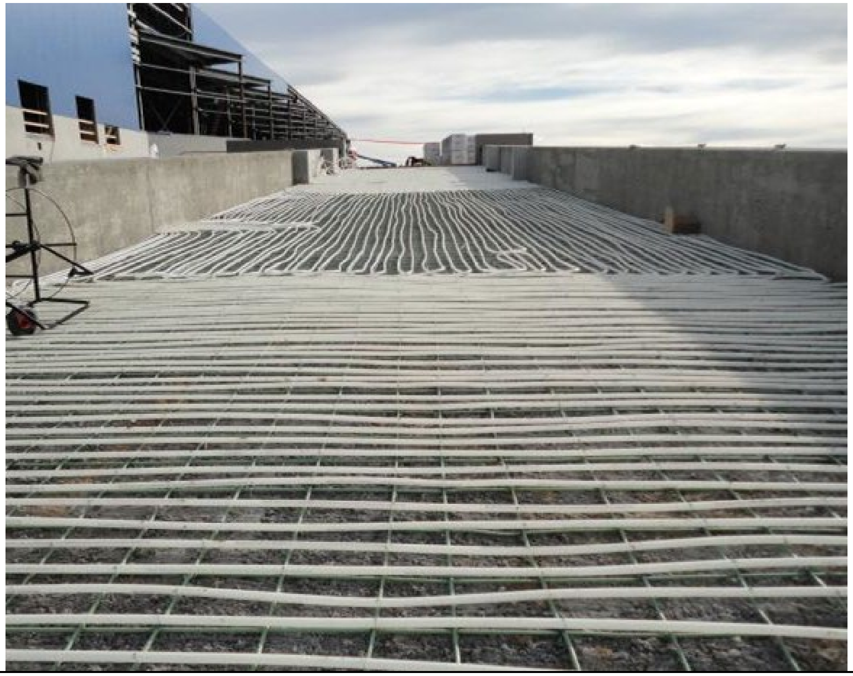
Thermal Management: Bonuses!

Prewarmed Irrigation Water



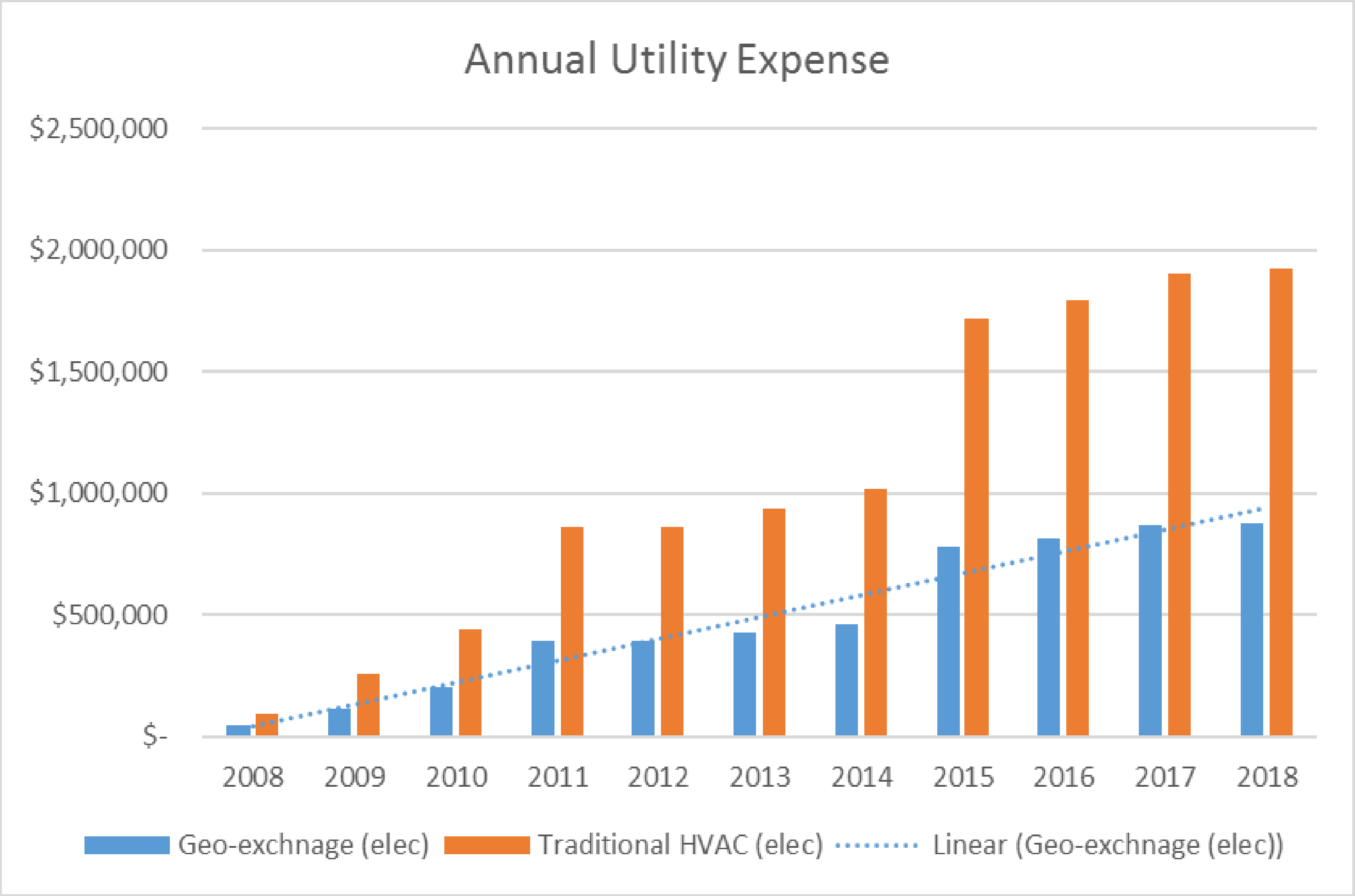
Melted Snow on Sidewalks

Courtesy of The GreyEdge Group© & IGSHPA

Energy & Money Savings

System cost
(post rebates):
$8 Million

Energy savings:
$1 Million/yr



Courtesy of The GreyEdge Group© & IGSHPA

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Eversource Gas President announcing GeoMicroDistrict Pilots in MA.

Research & Evaluation Team

- **MIT** Sloan School , System Dynamics
- **Harvard** T.H.Chan School of Public Health, C-CHANGE Institute
- **BuroHappold** Engineering
- Massachusetts **DEP** (Department of Environmental Protection)
- **Berkeley National Lab**, Earth and Environmental Science
- University of California, **Berkeley**, Civil & Environmental Engineering
- **National Renewable Energy Laboratories**
- Massachusetts **CEC** (Clean Energy Center)
- The Grey Edge Group

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Gas Workers
Academia
Donors & Foundations
Media
Municipalities
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Taste the Future

and *transition* to a clean energy home

- Gas Companies permitted to bill for BTUs
- Permits utility-scale renewable thermal
- Limits gas pipe depreciation past 2050
- Creates Renewable Thermal Credit Market
- Path to 100% Renewable Thermal by 2050

The F.U.T.U.R.E. Act (H.2849/S.1940)

*An Act **F**or a **U**tility **T**ransition to **U**sing **R**enewable **E**nergy*

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What can Minnesota do?

- ➢ Create a path to renewable thermal for gas distribution utilities
- ➢ Move away from investment in new gas infrastructure
- ➢ Redirect investment to thermal resource infrastructure
- ➢ Map your thermal wealth (available sources and sinks)
- ➢ Pilot GeoMicroDistricts in strategic locations to seed expansion

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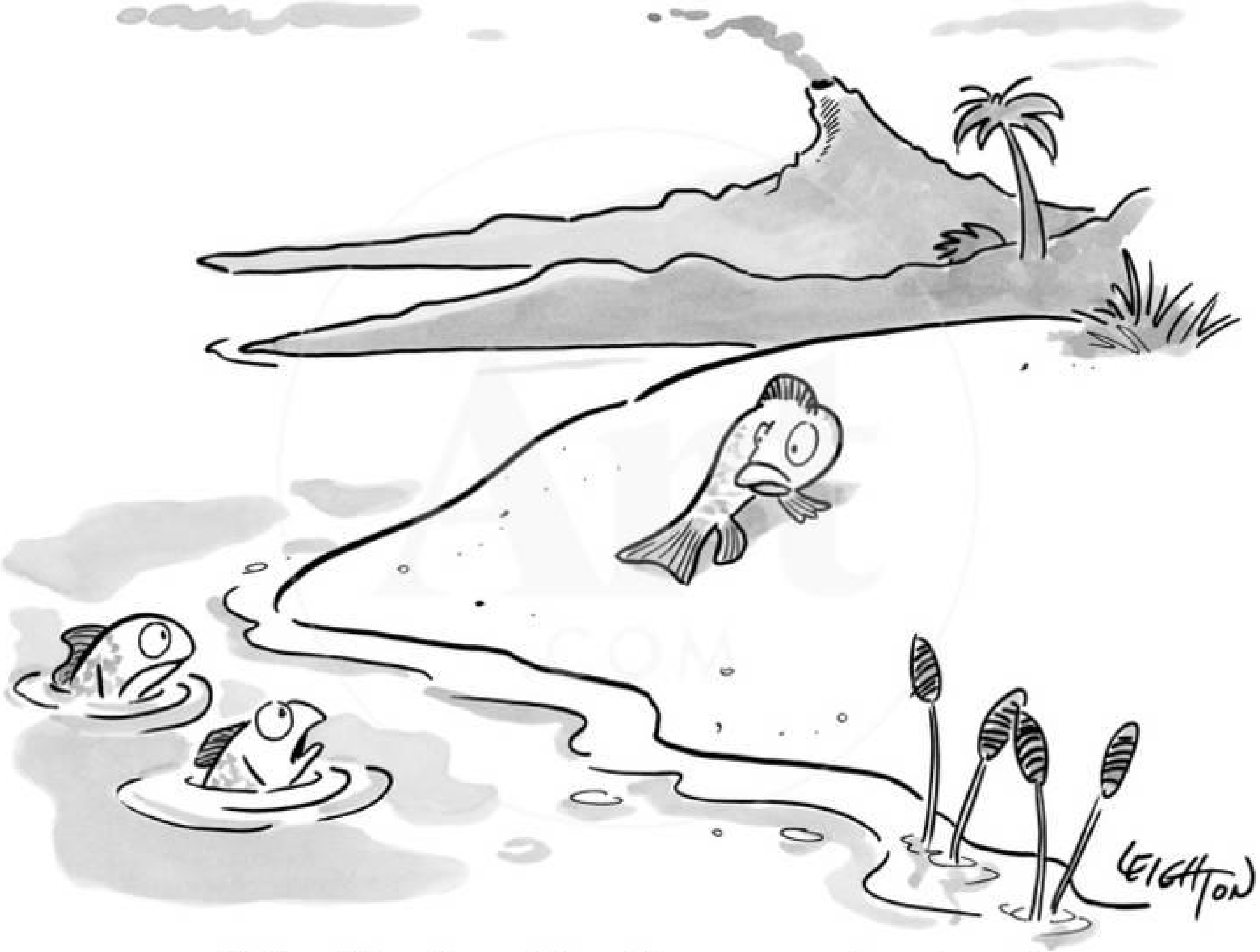
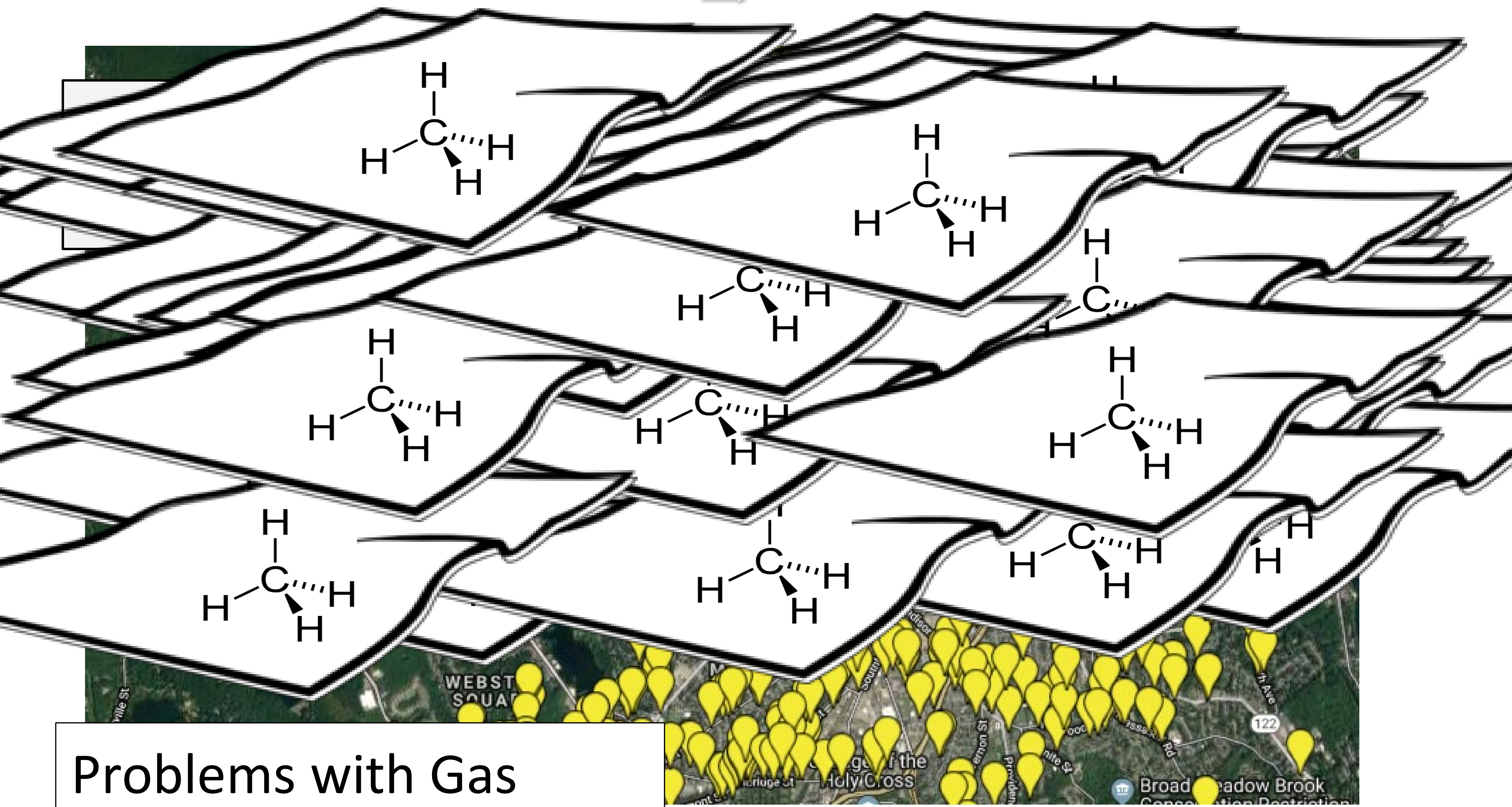


"Go. Evolve. Don't worry about us."



Problems with Gas

Problems with Gas

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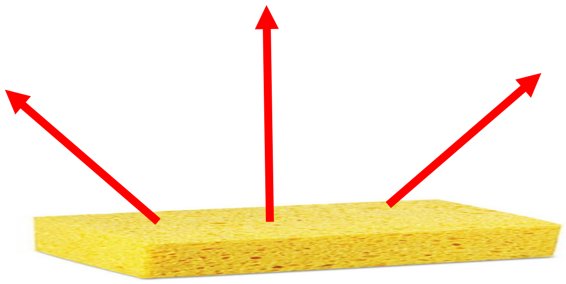
Heat pumps aren't new technology.

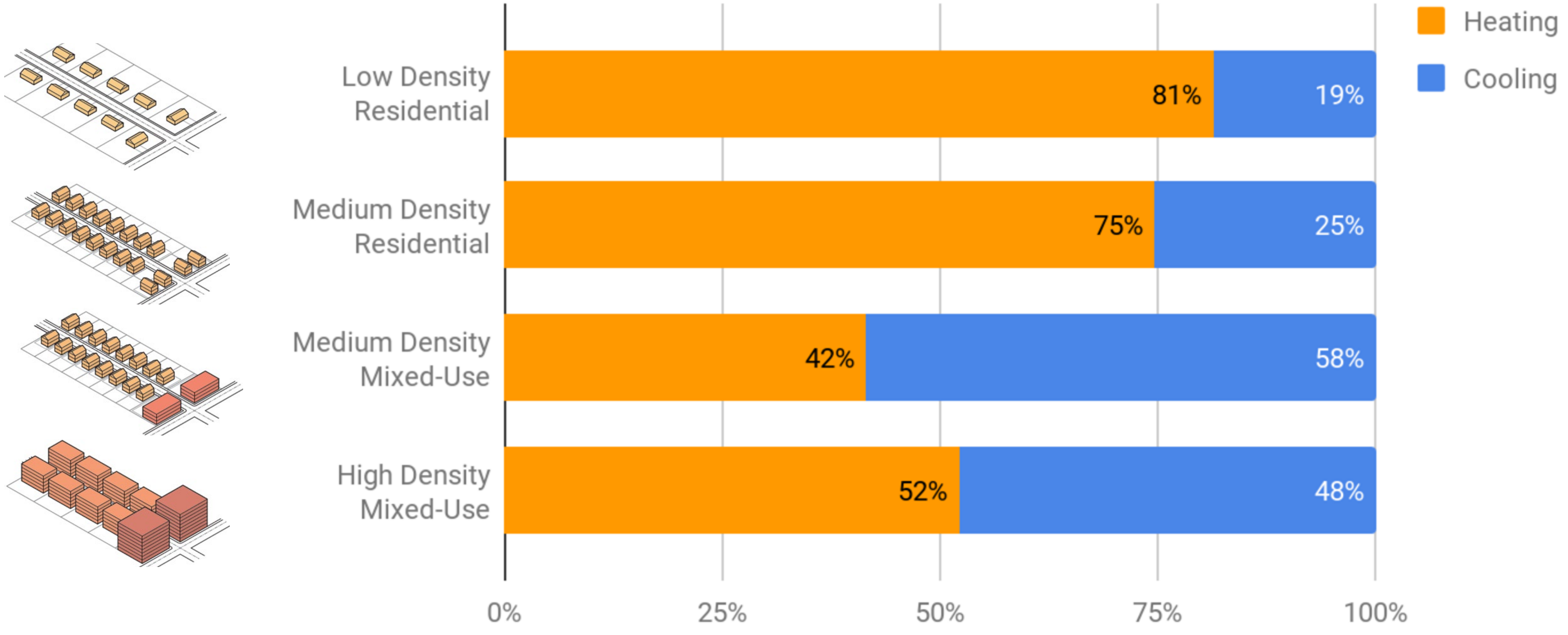
They contain fluid that works like a sponge for heat.

When they expand, they absorb heat.

When compressed they "reject" heat.



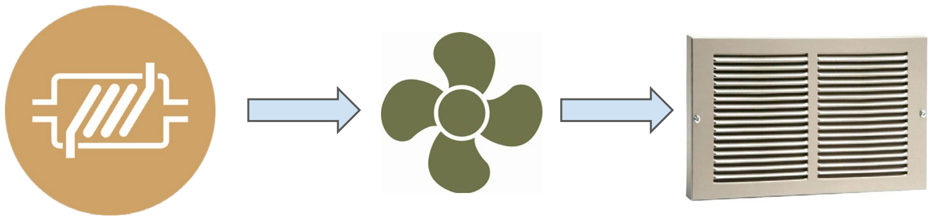
Annual Heating & Cooling Loads



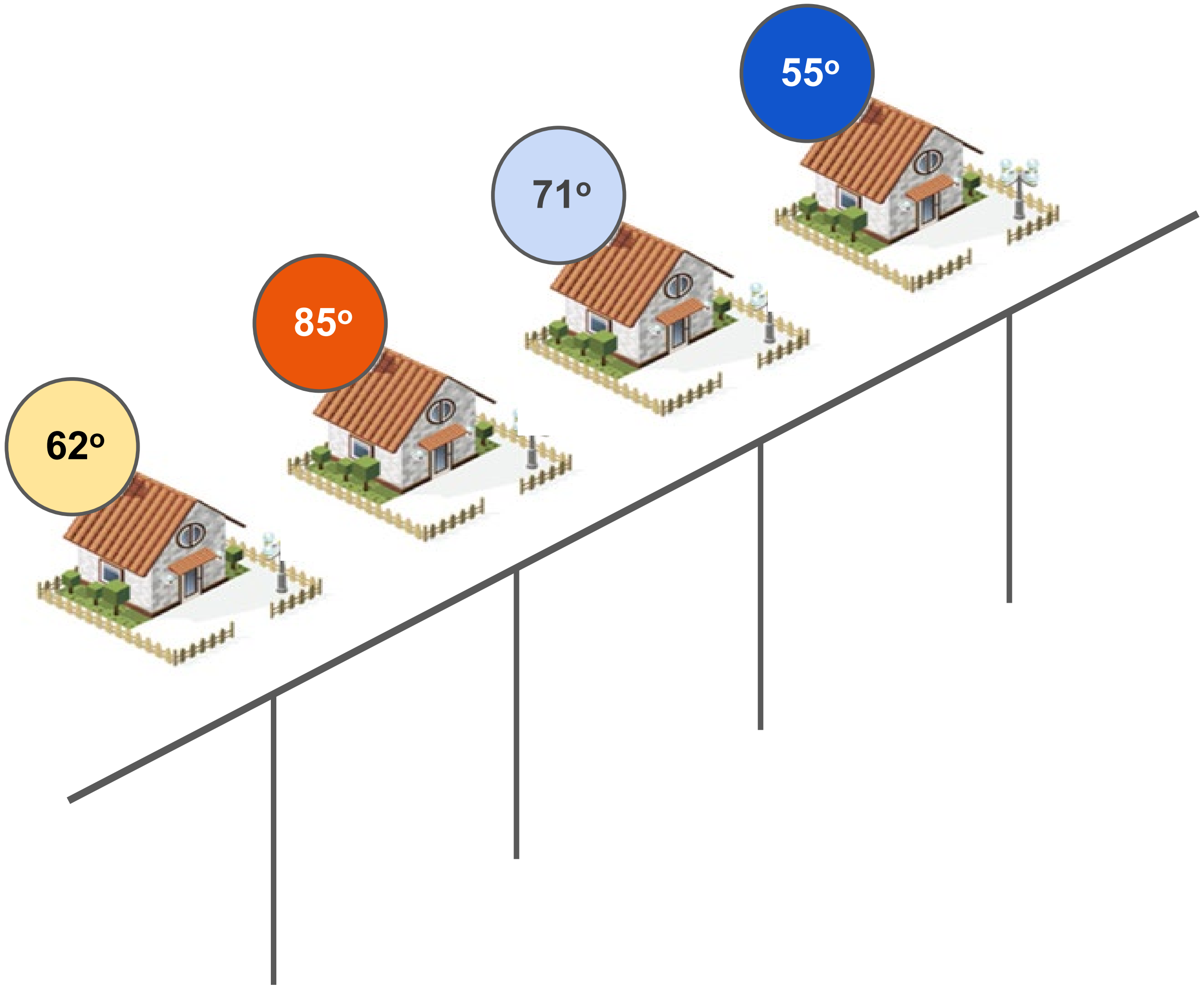
BUROHAPPOLD ENGINEERING heet

Heat Exchange

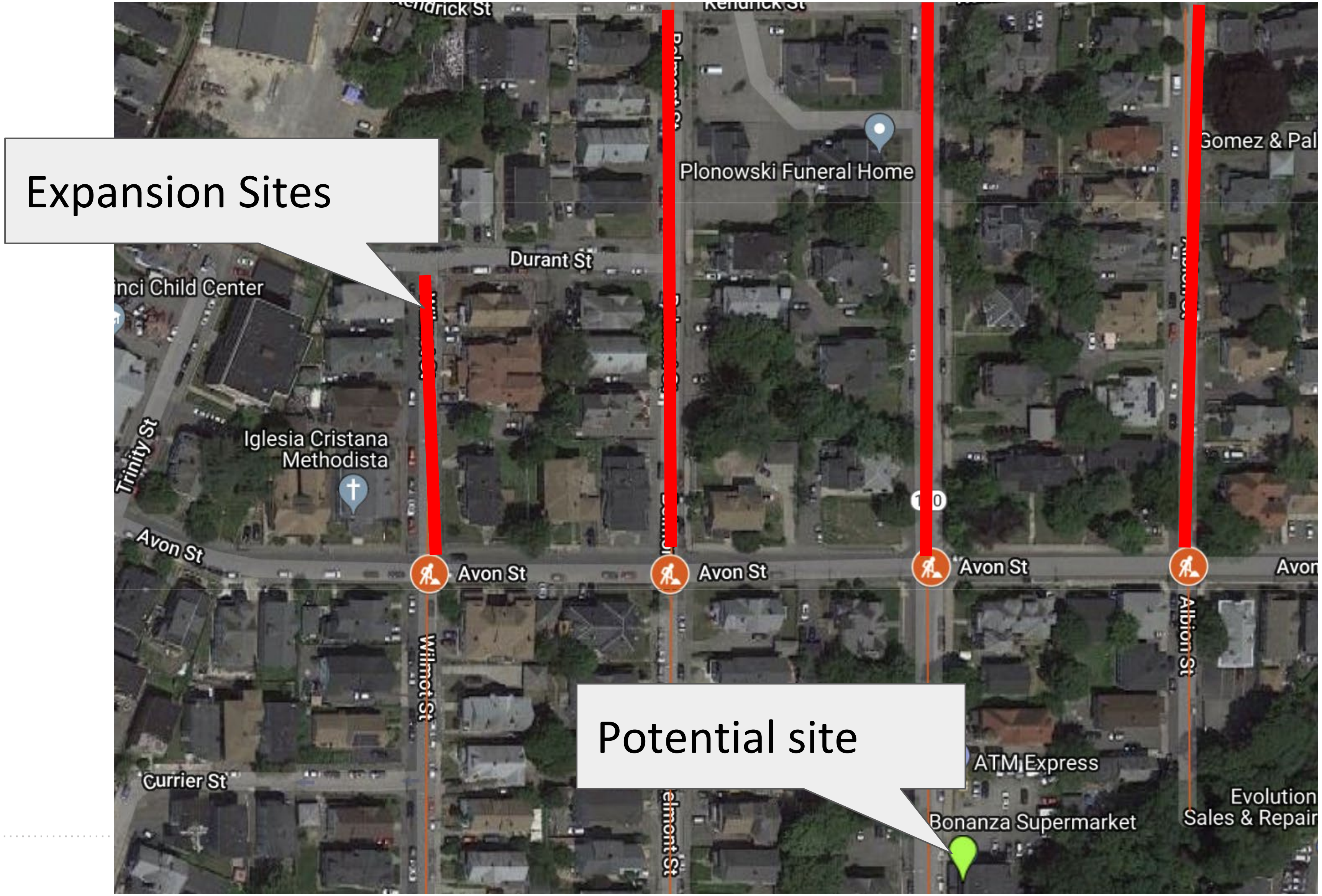
Connects to your existing system



Temperature Control



Site Selection Strategy



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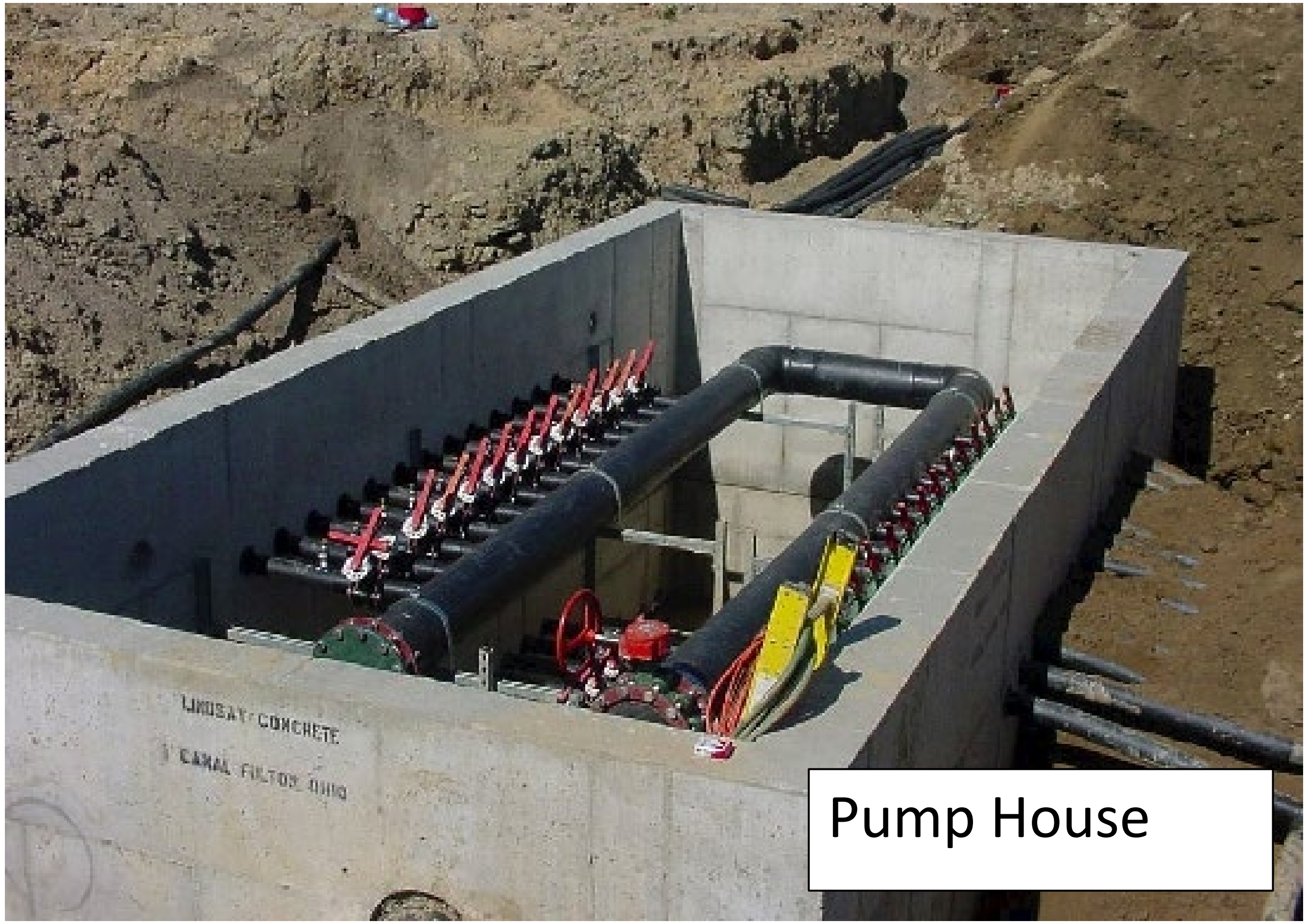
Installation Begins

18” HDPE single pipe carries ambient temperature water around the campus.

Distributed mechanical rooms creates resilience: redundant pumping.

Courtesy of The GreyEdge Group© & IGSHPA



Courtesy of The GreyEdge Group© & IGSHPA

Other Possibilities

2008 Olympic Media Center, Qingdao, China

- 600 refrigeration tons
- Heat pumps
- Energy source: seawater (mechanicals under dock)

Courtesy of The GreyEdge Group© & IGSHPA

Other Possibilities

Lotte Tower, Korea

- Briefly the tallest building in the world
- 123-story mixed-use building
- 1,100 boreholes under building footprint, 600 feet deep
- Waste energy from municipal and waste water
- > 70% of total thermal load

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Courtesy of The GreyEdge Group© & IGSHPA

Other Possibilities:

Drilling Technology for Tight Spaces

Drill rig< 6’ tall

Drills holes 600’ deep

Waste Disposal

Courtesy of The GreyEdge Group© & IGSHPA

‘Taste the Future’ Events

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Create Your Transition Plan Now

My Future Ready Wish List

- ❑ Heat/AC
  - ❑ Cold-temperature Heat Pump. Model: ______________________________
- ❑ Hot Water
  - ❑ Heat Pump Electric Water Heater. Model: __________________________
- ❑ Cooking
  - ❑ Induction Range. Model: ____
- ❑ Dryer
  - ❑ Electric Dryer (Heat Pump). Model: _______________________________
- ❑ Fireplace
  - ❑ Wood or electric insert. Model: __________________________________

Remember the terms "Heat Pump" and "Induction" are your secrets to efficiency.

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AGENDA

9:00	Welcome and Introductions
9:15	Presentation and Q&A: The Promise and Potential of EE in Decarbonizing Minnesota's Natural Gas End-Uses
10:00	Discussion on Energy Efficiency
10:45	BREAK
11:00	Overview of District Energy Systems in Minnesota
11:05	Presentation and Q&A: The Promise and Potential of Geothermal Technology in Decarbonizing Minnesota's Natural Gas End-Uses Discussion
11:35	Discussion on Geothermal Technologies
12:20	**LUNCH**
1:05	Presentation and Q&A: District Energy Systems in Minnesota
1:30	Discussion on Geothermal Technologies
2:30	ADJOURN

cee
Center for Energy and Environment

Presentation and Q&A: District Energy Systems in Minnesota

Nina Axelson, Ever-Green Energy

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Better Energy.
Better World.

District Energy Decarbonization Trends

Emerging Opportunities for Geoexchange and Beneficial Electrification

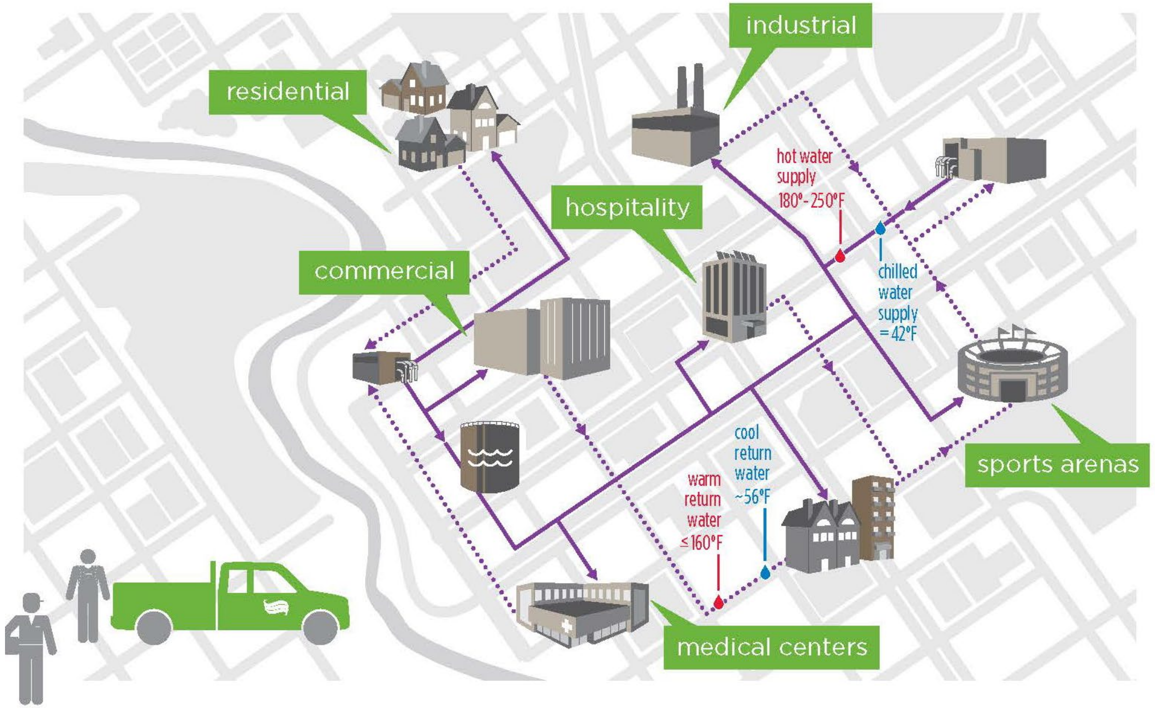
Nina Axelson
VP, Sustainability and Outreach
nina.axelson@ever-greenenergy.com

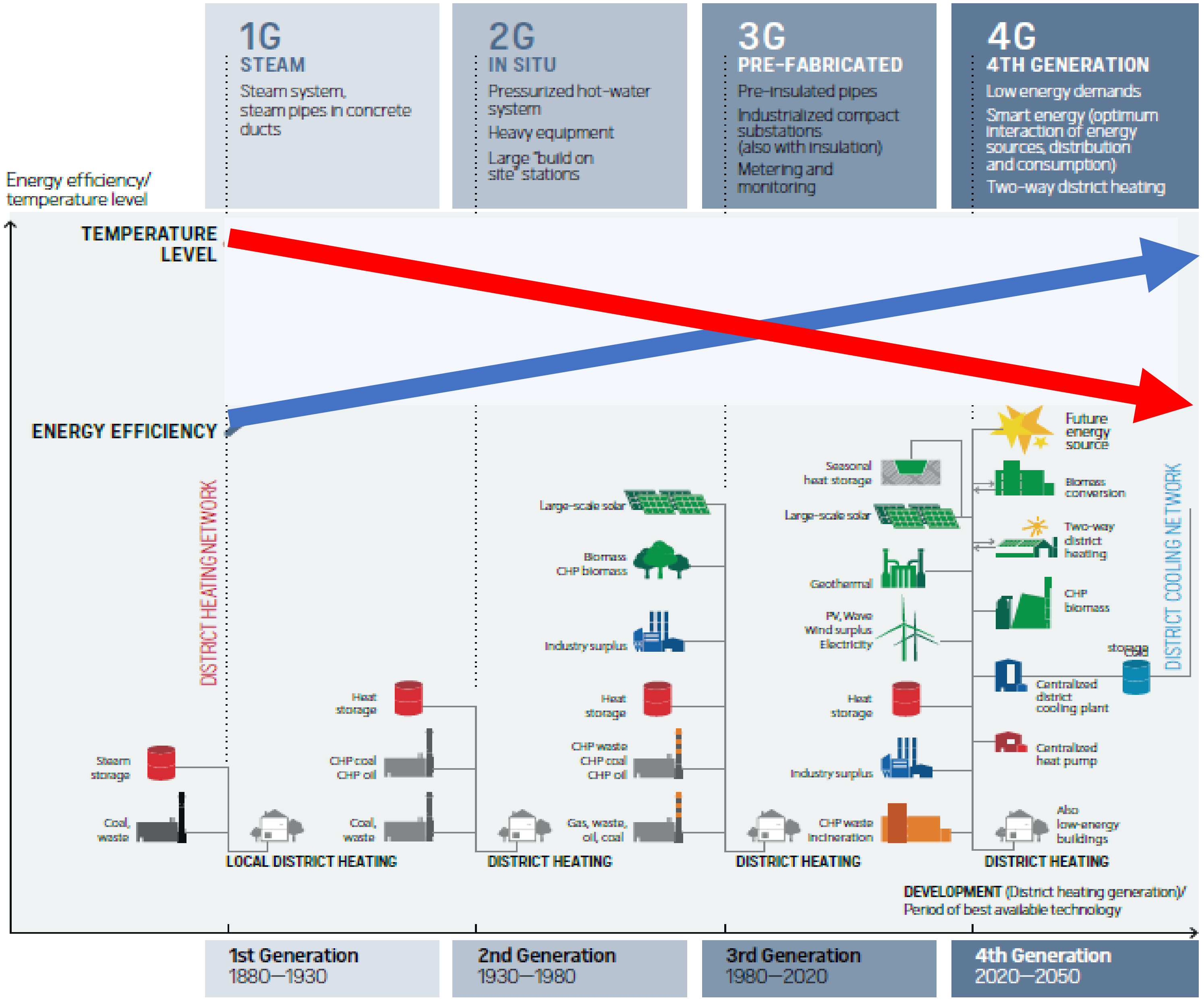
Community Scale Energy Systems

Underground network of pipes aggregate heating and cooling needs

Aggregated thermal loads allows application of technologies and fuels not feasible for individual buildings

Increases fuel flexibility, rate stability, and reliability

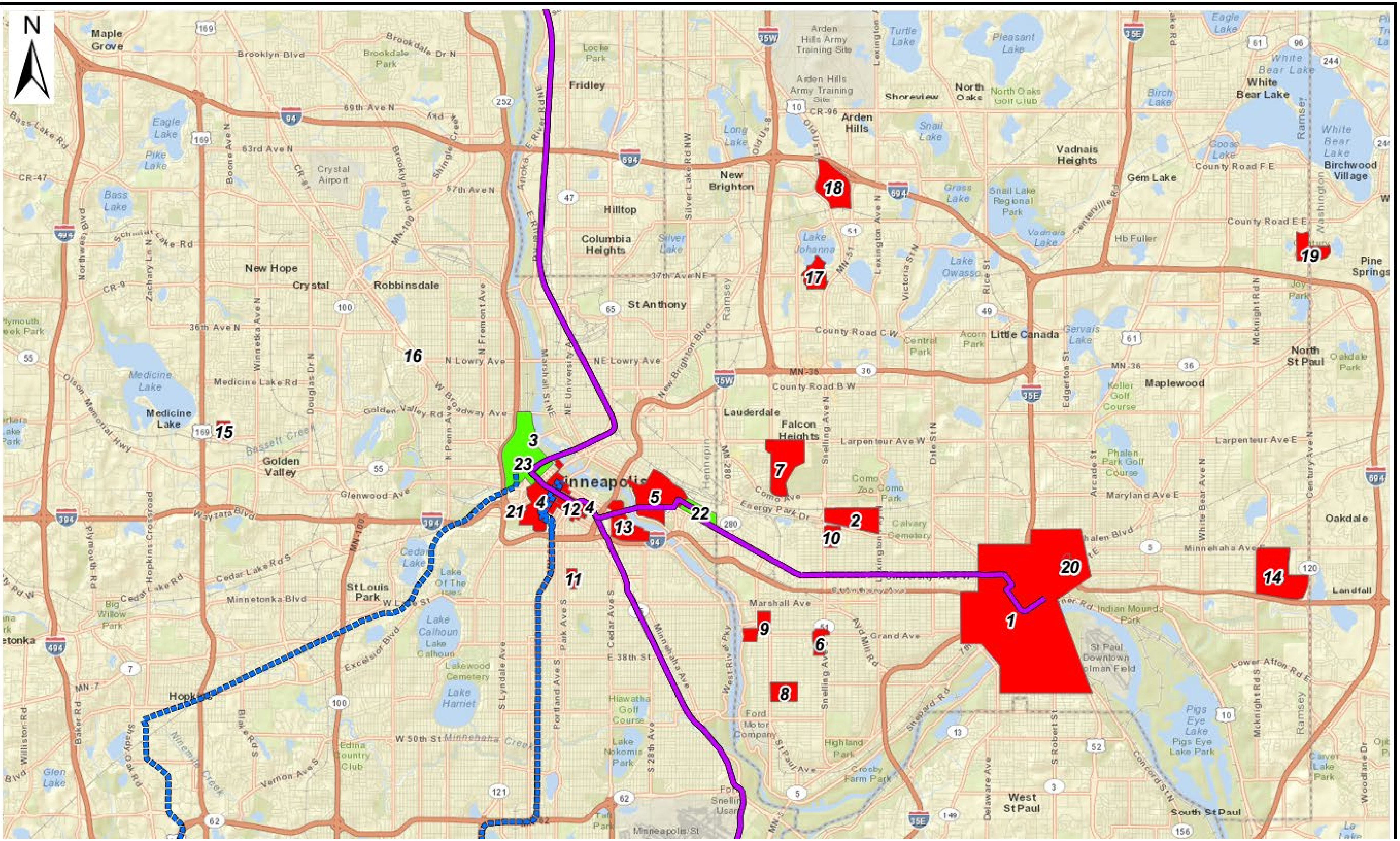




Integration & Renewables

Carbon/GHG Reduction

Source: Aalborg University and Danfoss District Energy, 2014



Twin Cities District Energy Systems

- Existing (21)
- Proposed (3)

Existing and Proposed Rail Corridors

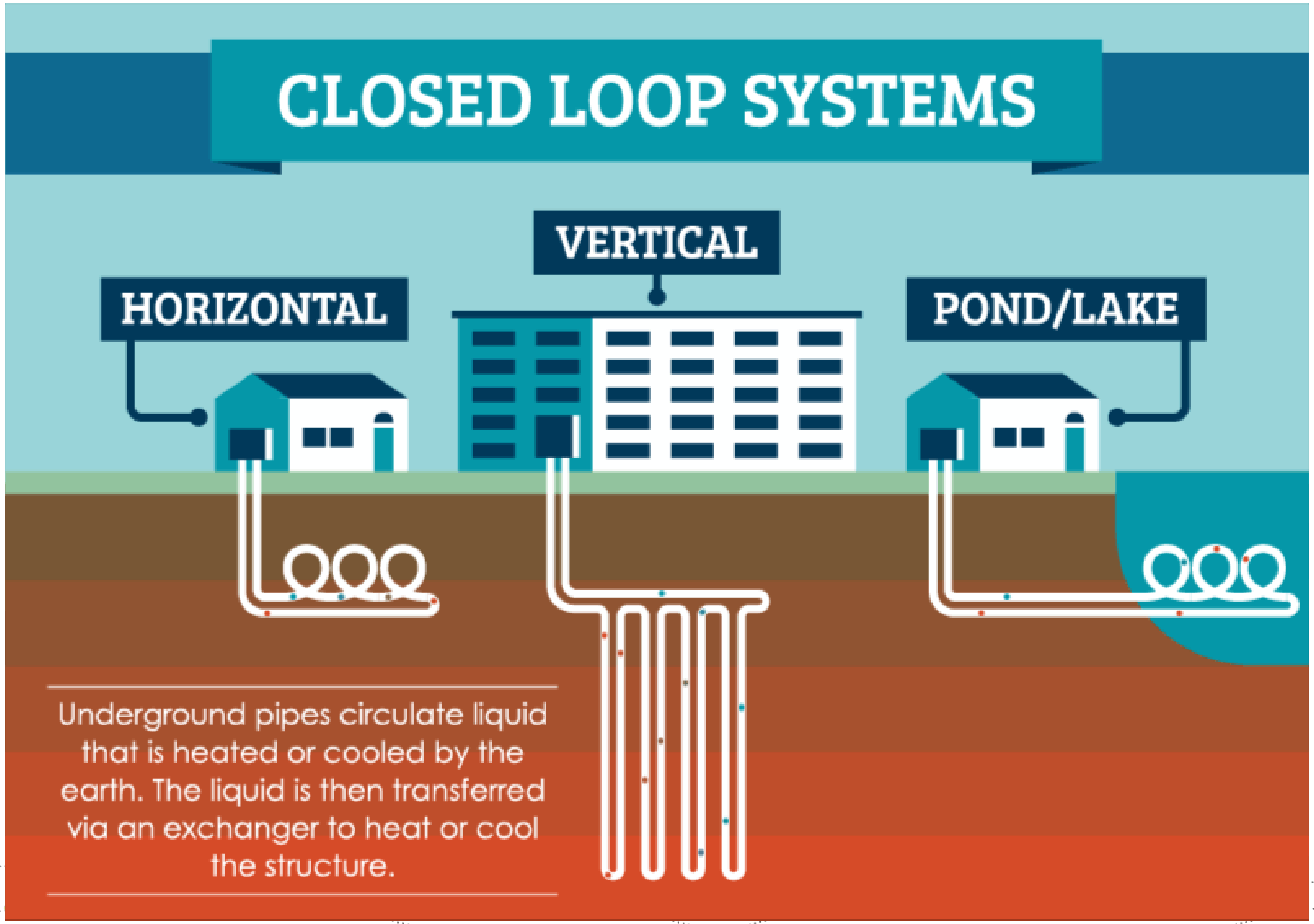
- Existing Alignments
- Proposed Alignments

System	District Energy System
1	District Energy St. Paul
2	Energy Park Utility Co.
3	NRG District Energy (Star Tribune)
4	NRG District Energy
5	University of Minnesota
6	Macalester College
7	University of Minnesota
8	College of St. Catherine
9	University of St. Thomas
10	Hamline University
11	Abbott Northwestern Hospital
12	Hennepin County Energy Center
13	Augsburg-Fairview
14	3M Campus
15	General Mills
16	North Memorial Hospital
17	Northwestern College
18	Bethel University
19	Century College
20	Metropolitan State College
21	Metropolitan State University
22	Towerside

Renewable Thermal

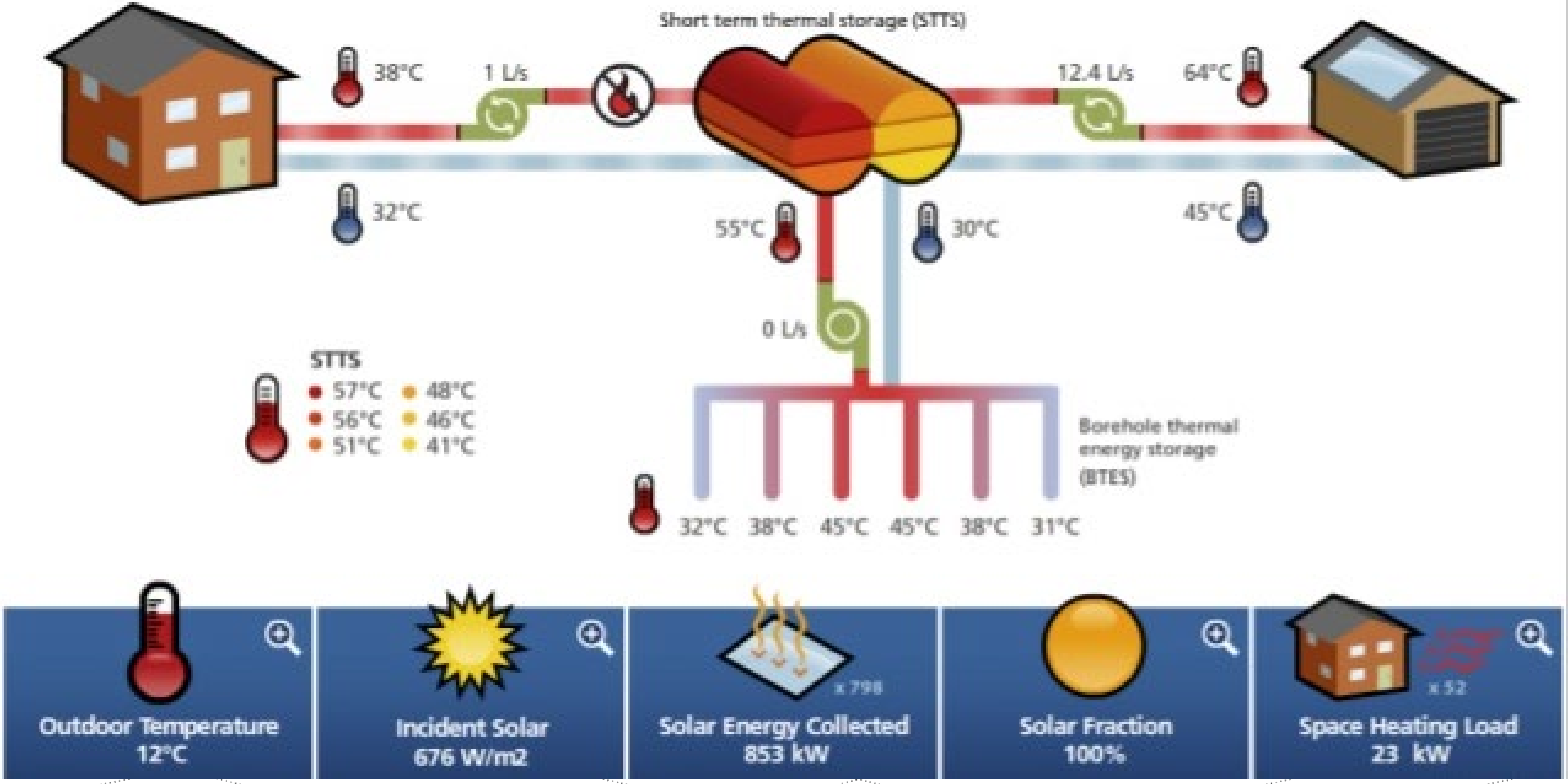
Geoexchange Systems Utilizing Geothermal, Sewer, Solar, and Storage

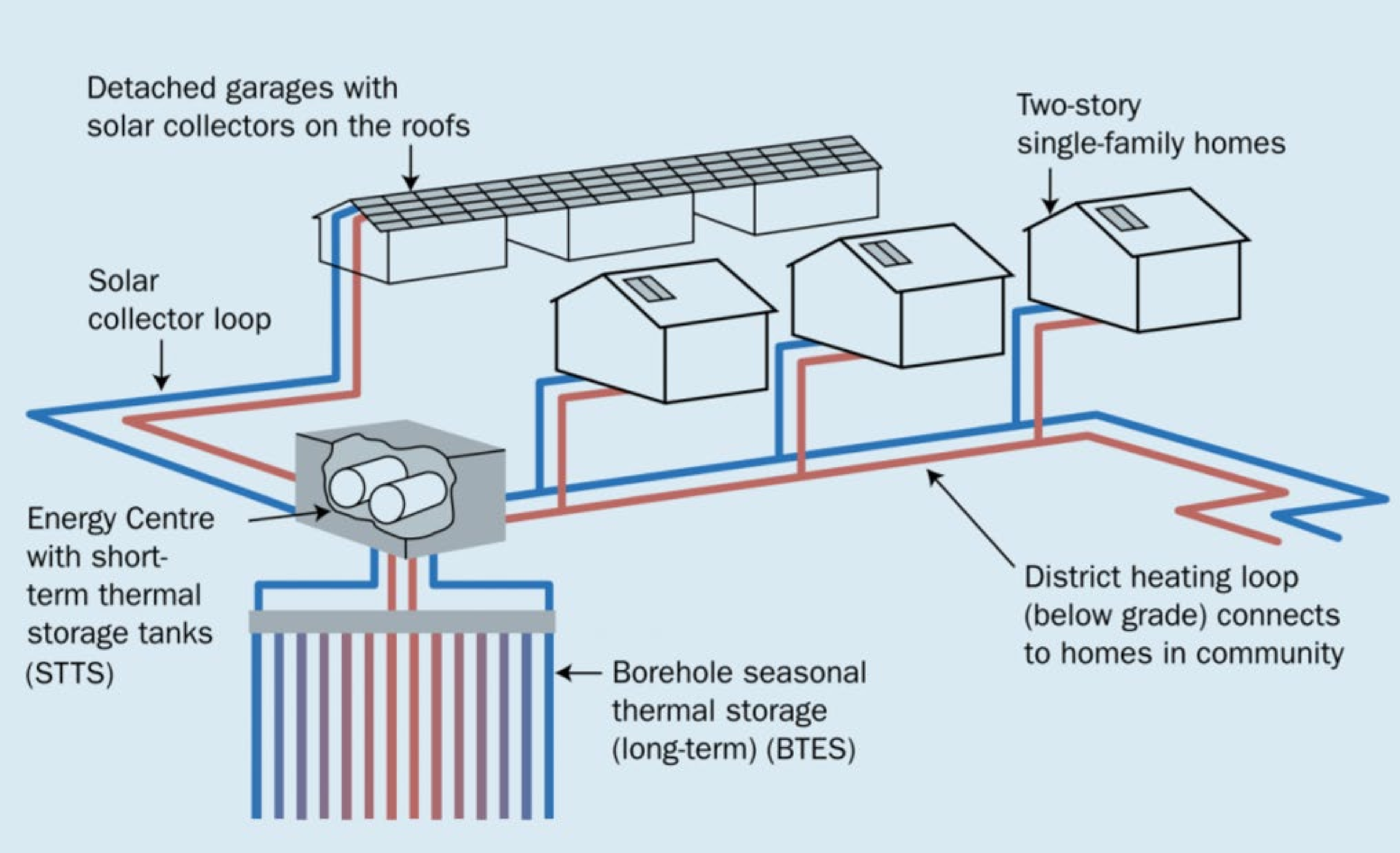
Geothermal District Systems



Source: SaveOnEnergy.com

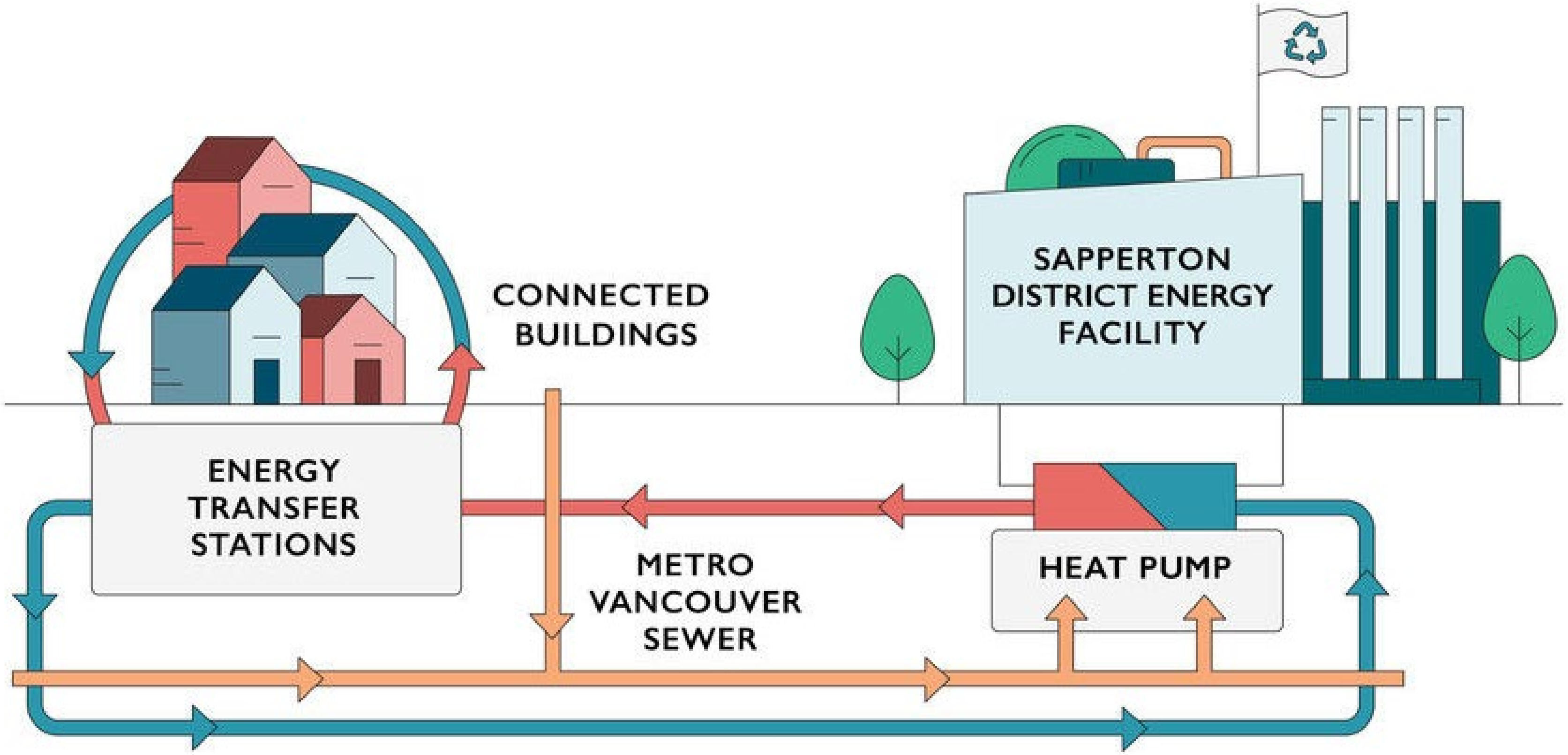
Drake Landing Solar Community in Alberta, Canada



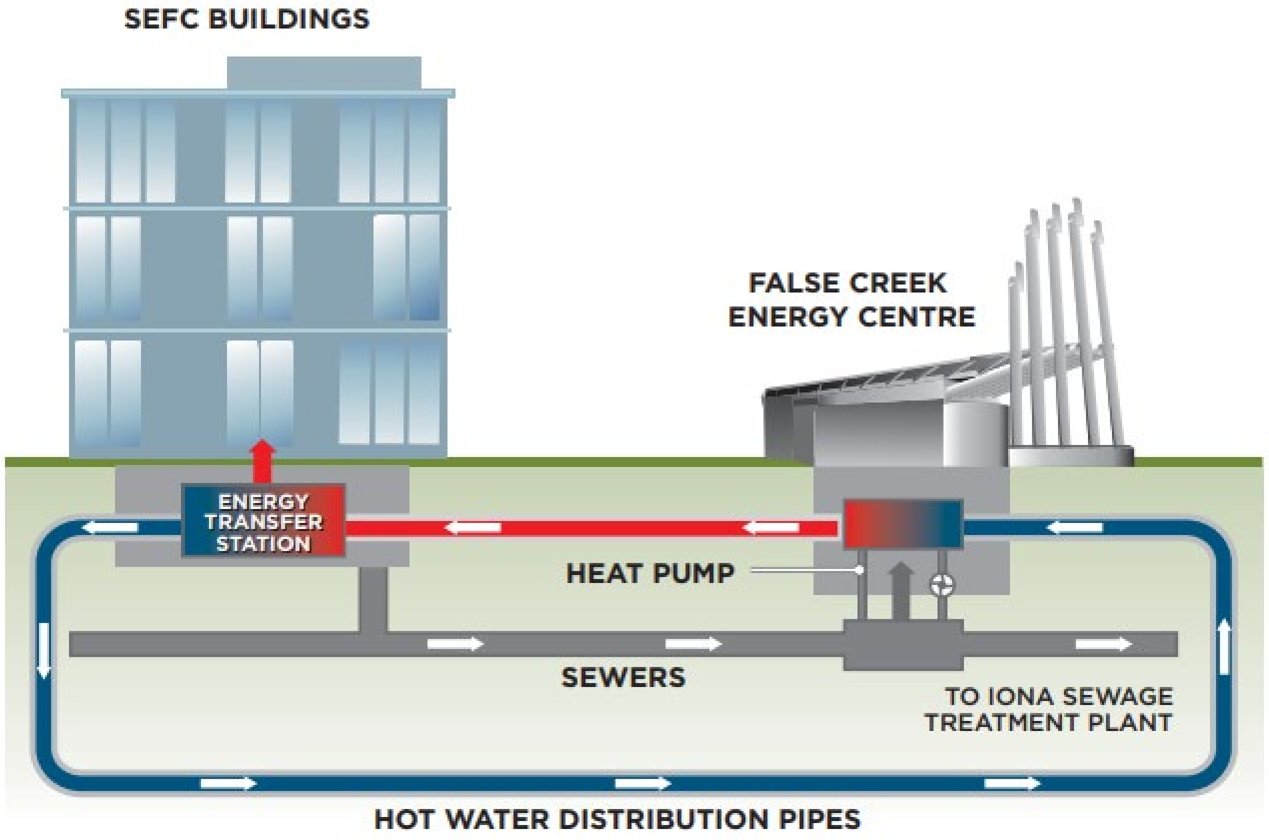


Detached garages with
solar collectors on the roofs
Two-story
single-family homes
Solar
collector loop
Energy Centre
with short-
term thermal
storage tanks
(STTS)
District heating loop
(below grade) connects
to homes in community
Borehole seasonal
thermal storage
(long-term) (BTES)

Sapperton District Energy System – Sewer Exchange (British Columbia, Canada)



False Creek Energy Centre in Vancouver, BC, Canada



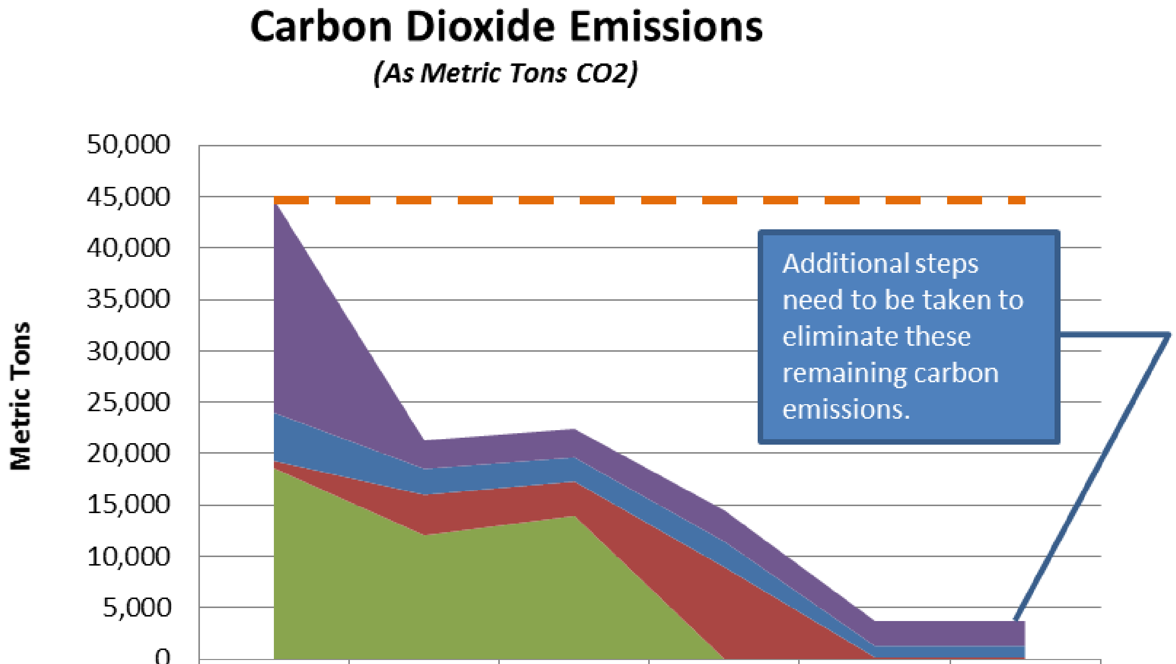
Modernizing and Decarbonizing Existing Systems

District Energy St. Paul

35% CO2 reduction between 2005 and 2018

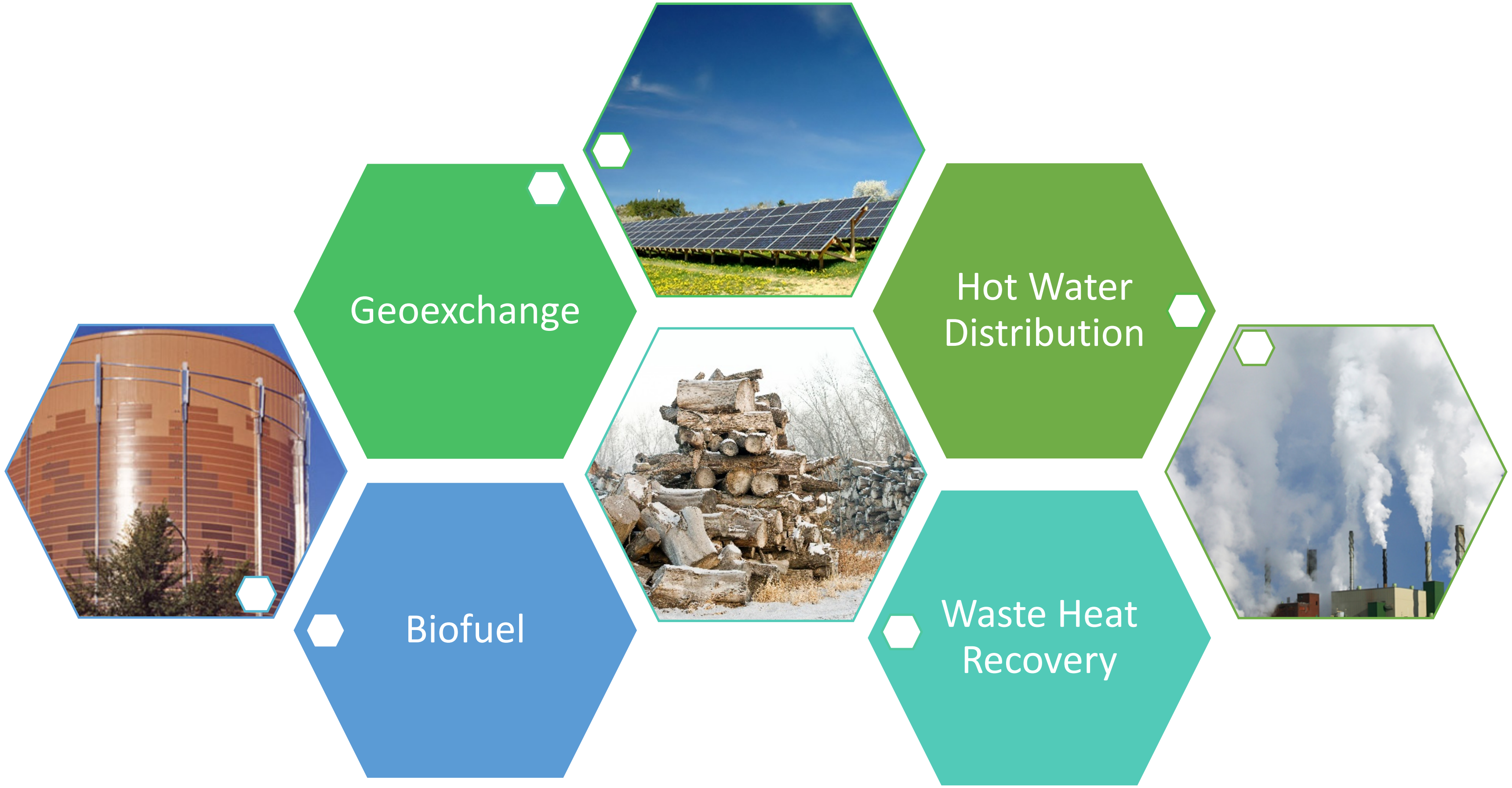
70% anticipated after coal retirement (2019 and 2020 data pending)

Oberlin College



	2007	2013	2014	2015	2020	2025
Electric	20,720	2,777	2,790	3,030	2,450	2,450
Natural Gas Other	4,693	2,516	2,333	2,493	1,082	1,082
Natural Gas Central Plant	710	3,943	3,347	8,933	191	191
Coal	18,570	12,054	13,934	0	0	0
Total CO2	44,693	21,288	22,404	14,456	3,724	3,724
2007 Baseline	44,693	44,693	44,693	44,693	44,693	44,693
% Reduction (2007 Baseline)	0%	52%	50%	68%	92%	92%

Roadmap to Carbon Neutrality Campus Program

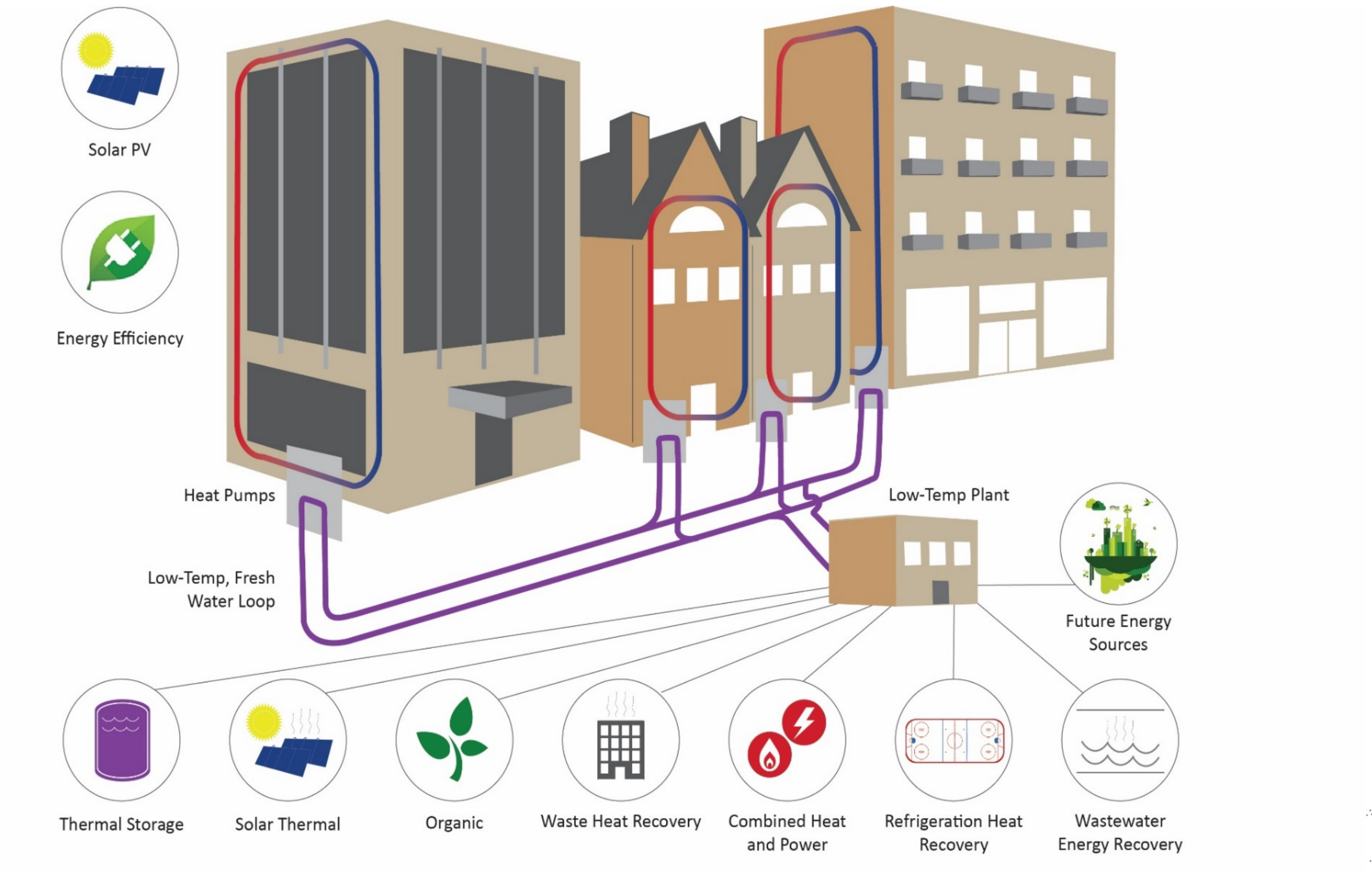


New Community Development Systems

Net Zero Aspirations

Towerside Innovation District

Vision for an Adaptable Energy System



Aquifer Thermal Energy Storage – What is it?

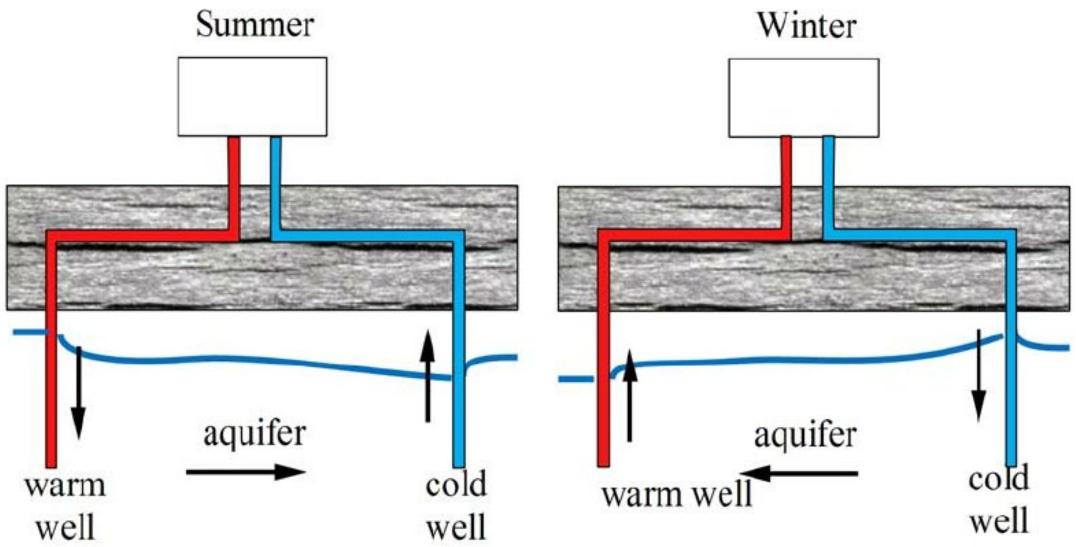
ATES is an open-loop geothermal technology.

It relies on temperate water in the aquifer that can be used to heat buildings in the winter and as a loop to remove heat from buildings in the summer.

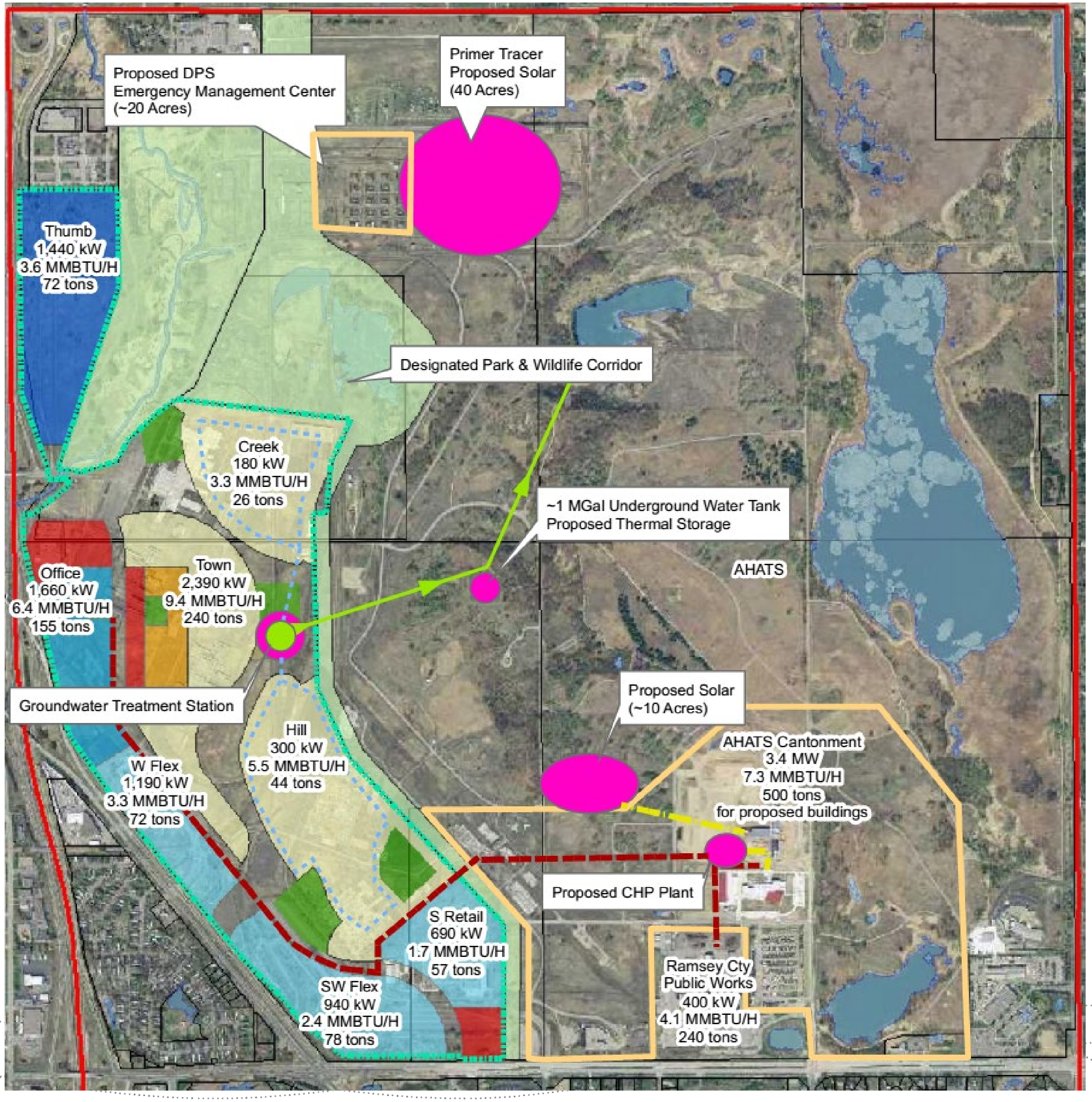
Bores are drilled into the aquifer to interface with the temperate water source.

Then a secondary water loop carries that water to buildings in supply/return pipes underground.

Once the water reaches the buildings, a heat exchanger is used to heat or cool the building loop.



Rice Creek Commons Energy Master Plan (as presented in 2015)



Groundwater Treatment Station

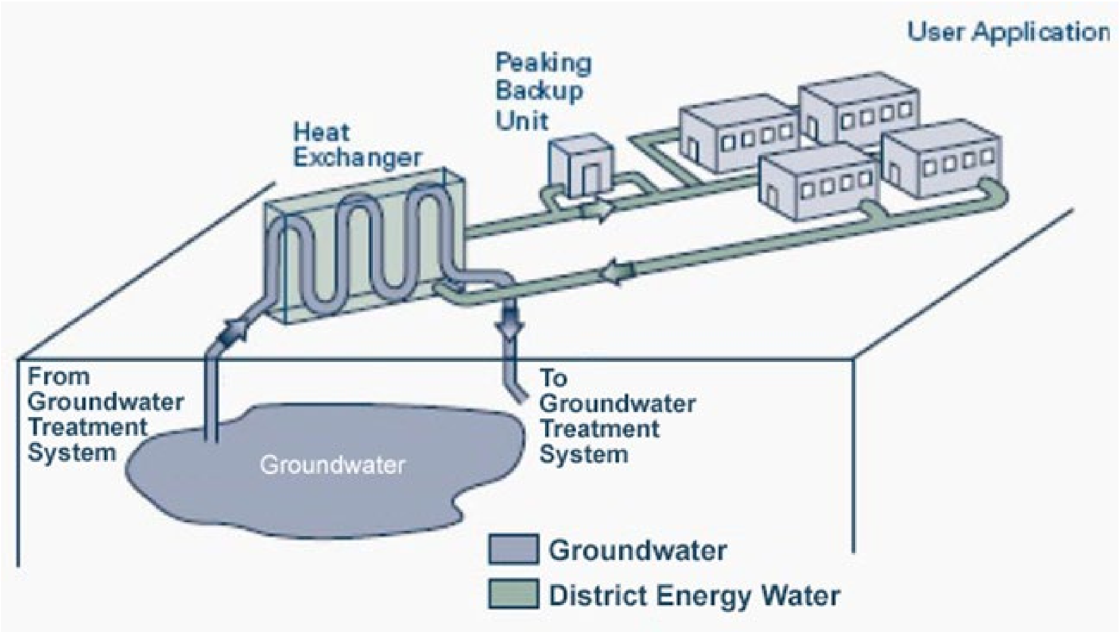
2 MGD pumping for 25-30 years minimum

Thermal energy transfer substation

Provide heating and cooling to residential neighborhoods

Avoid natural gas infrastructure

Micro-hydro electrical offset for pumping

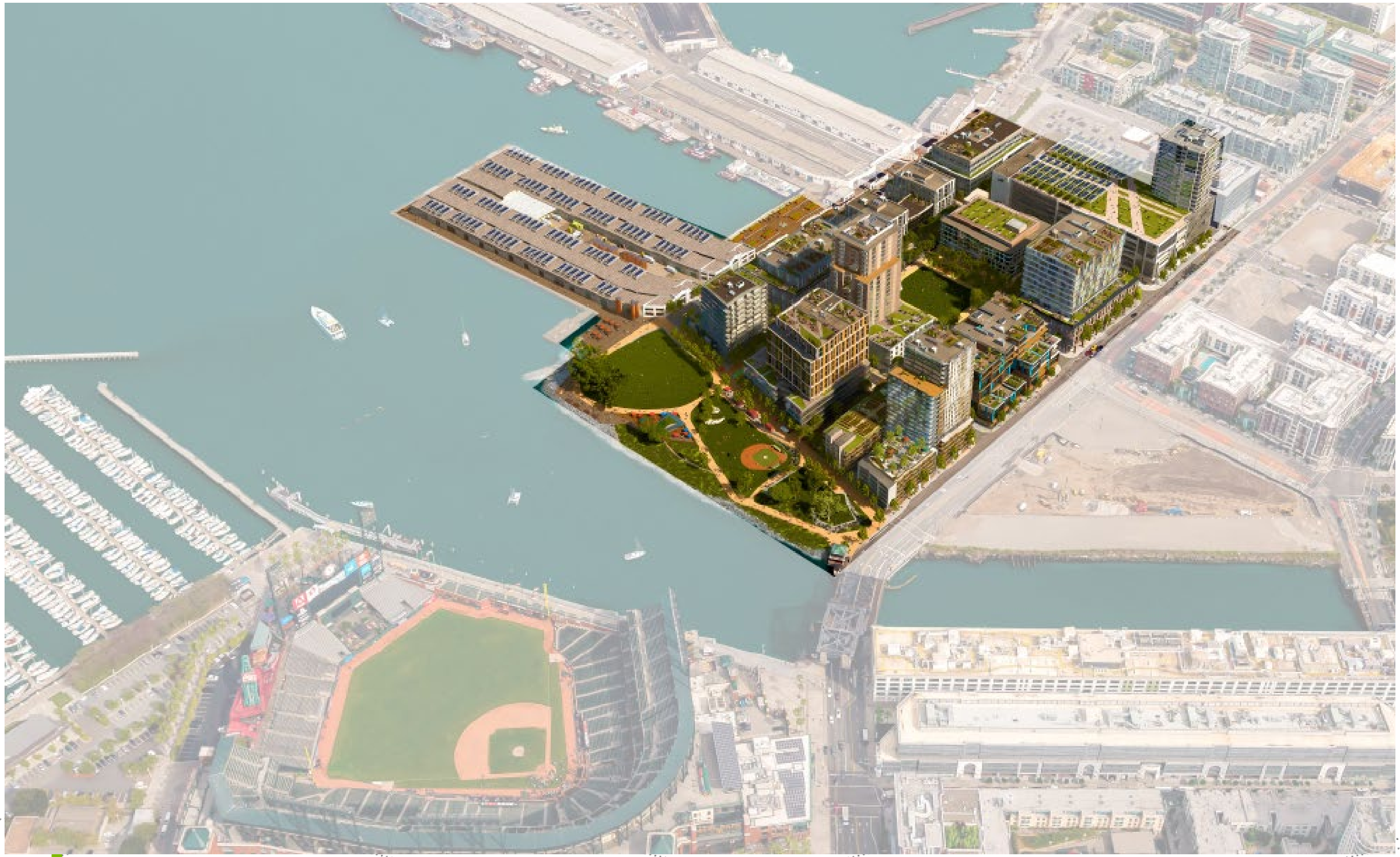


70% Reduction in CO2 Emissions

	Traditional Scenario Annual CO^2 Emissions	Recommended Scenarios Annual CO^2 Emissions	Annual CO^2 Reductions	% Reduction
Solar PV	7,524 tons	0 tons	7,524 tons	100%
CHP	3,581 tons	2,905 tons	676 tons	19%
Low Temp District Energy	1,057 tons	747 tons	310 tons	29%
Totals	**12,162 tons**	**3,652 tons**	**8,510 tons**	**70%**

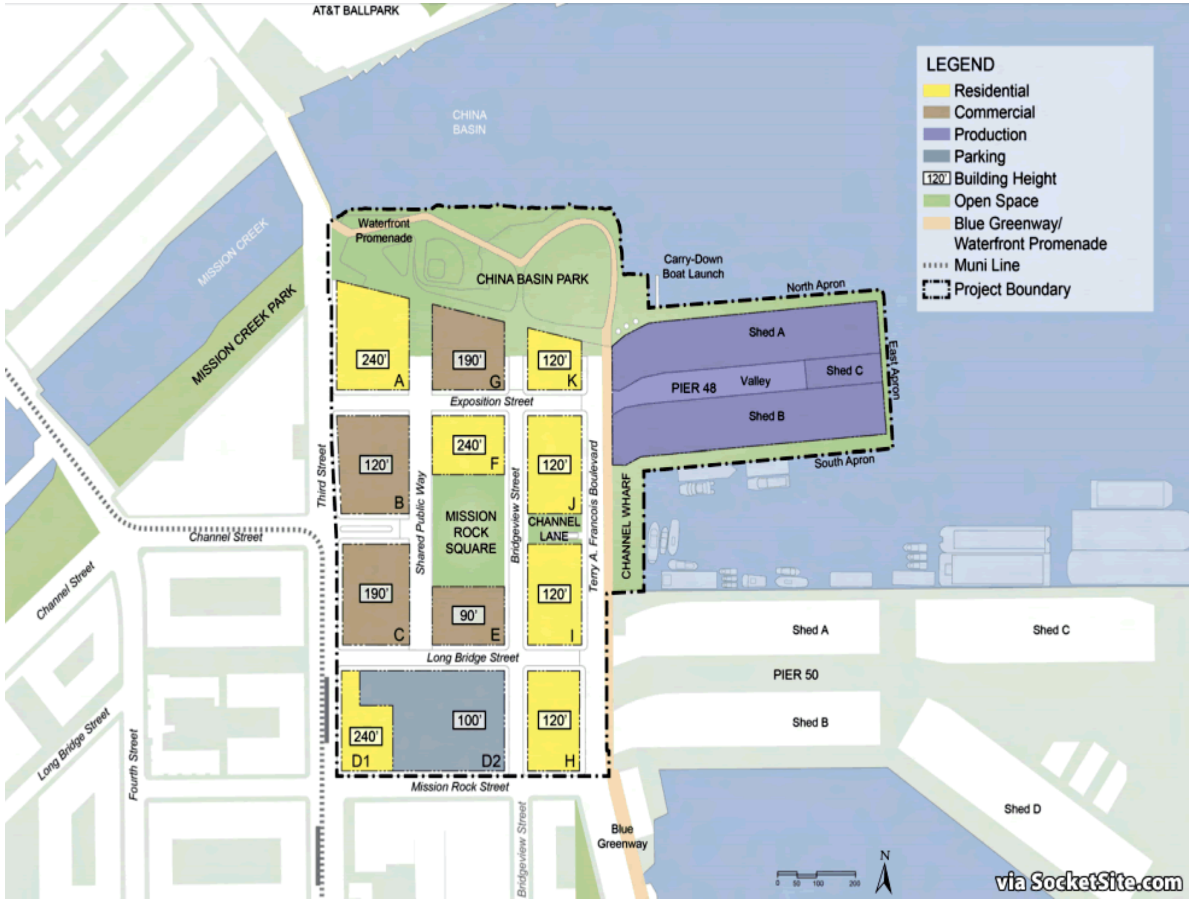
Equivalent of removing over 1,600 automobiles off the road annually

Mission Rock in San Francisco, California



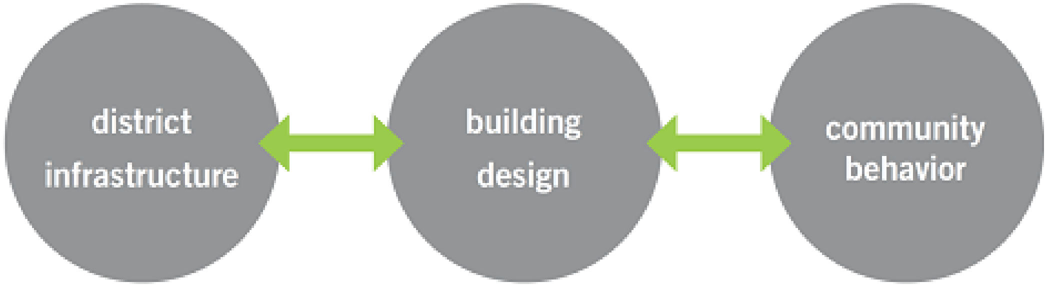
Mission Rock Development

- 28-acre site owned by the SF Port Authority
- 3.5 million square feet of mixed-use development
- San Francisco Giants as the Master Developer
- Ever-Green Energy as the developer, operator, and manager of the district energy system



Mission Rock Development Goals

ECODISTRICT GOALS



ENERGY

20-26% better than ASHRAE 90.1-2010

- Central Energy Plant for heating, cooling, and hot water
- Tenant sub-metering and real time information
- Tenant committments to reduced plug-loads

WATER

Zero potable water use for non-potable applications

- 33-47% Reduction in GHG emissions
- Water efficient fixtures
- Centralized graywater system
- Potential for bay source cooling

WASTE

25-50% increase in waste diversion over SF baseline

- User education to increase waste separation
- Source control programs to limit sale of landfill materials

TRANSPORTATION

7% Reduction in carbon emissions from automobile use

- Improved transit services
- Improved bike facilities and network
- Improved walking connections and experience
- TMPs

Saving 2.5 Million Gallons of Water/Year

BAU:	2.5 million gallons/year
DE:	0 million gallons/year

Saving 490,000 Gallons of Sewage/Year

BAU:	490,000 gallons/year
DE:	0 million gallons/year

Saving 30,000 MMBtu of Natural Gas/Year

BAU:	30,000 MMBtu/year
DE:	8 MMBtu/year

Total CO2 Savings 1,600 Tons

BAU = Business as Usual with individual generation in each building; DE = District Energy

Key Enablers for Renewable/Carbon-Free Thermal

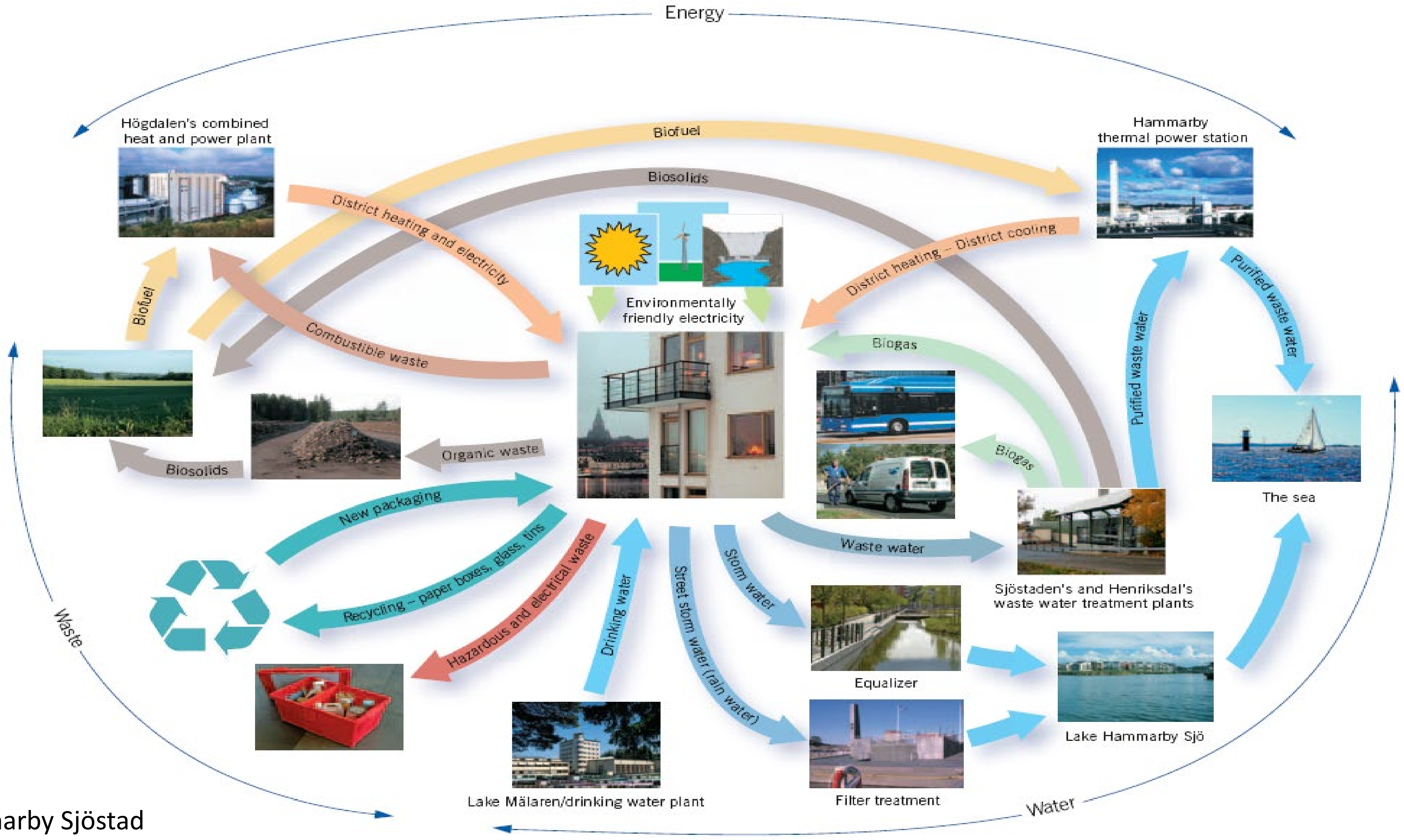
Policy Measures

- Integration into Renewable Portfolio Standards
- Renewable thermal credits
- Carbon pricing
- Sales tax exemptions and rebates
- Financing incentives

14 states have integrated renewable thermal standards in their RPS

It is critical that any stimulus or Green New Deal packages include funding for renewable or carbon-free thermal technologies.

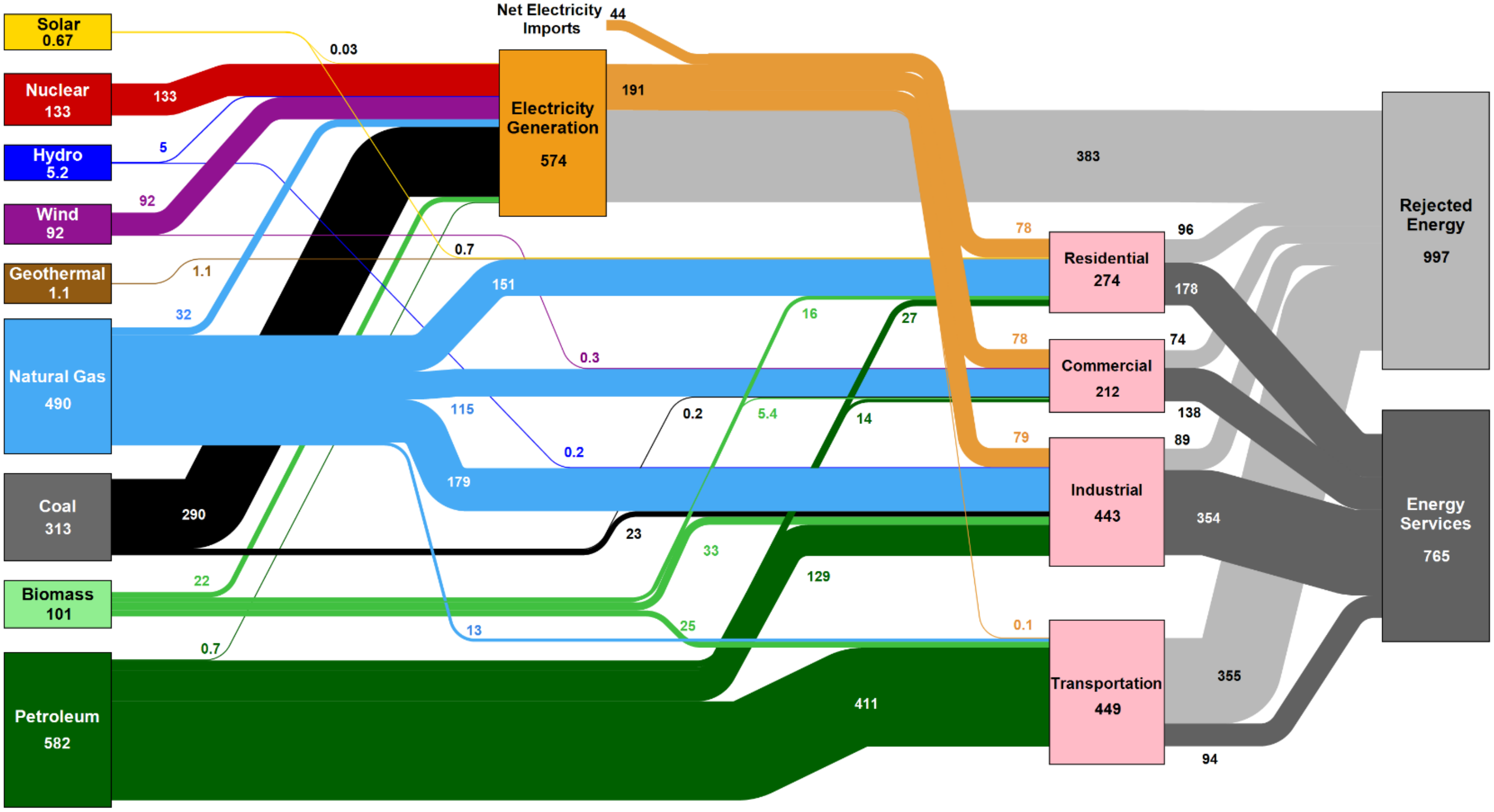
Symbiotic Integrated Systems



Source: Hammarby Sjöstad

Minnesota Energy Consumption in 2014: ~ 1762 Trillion BTU

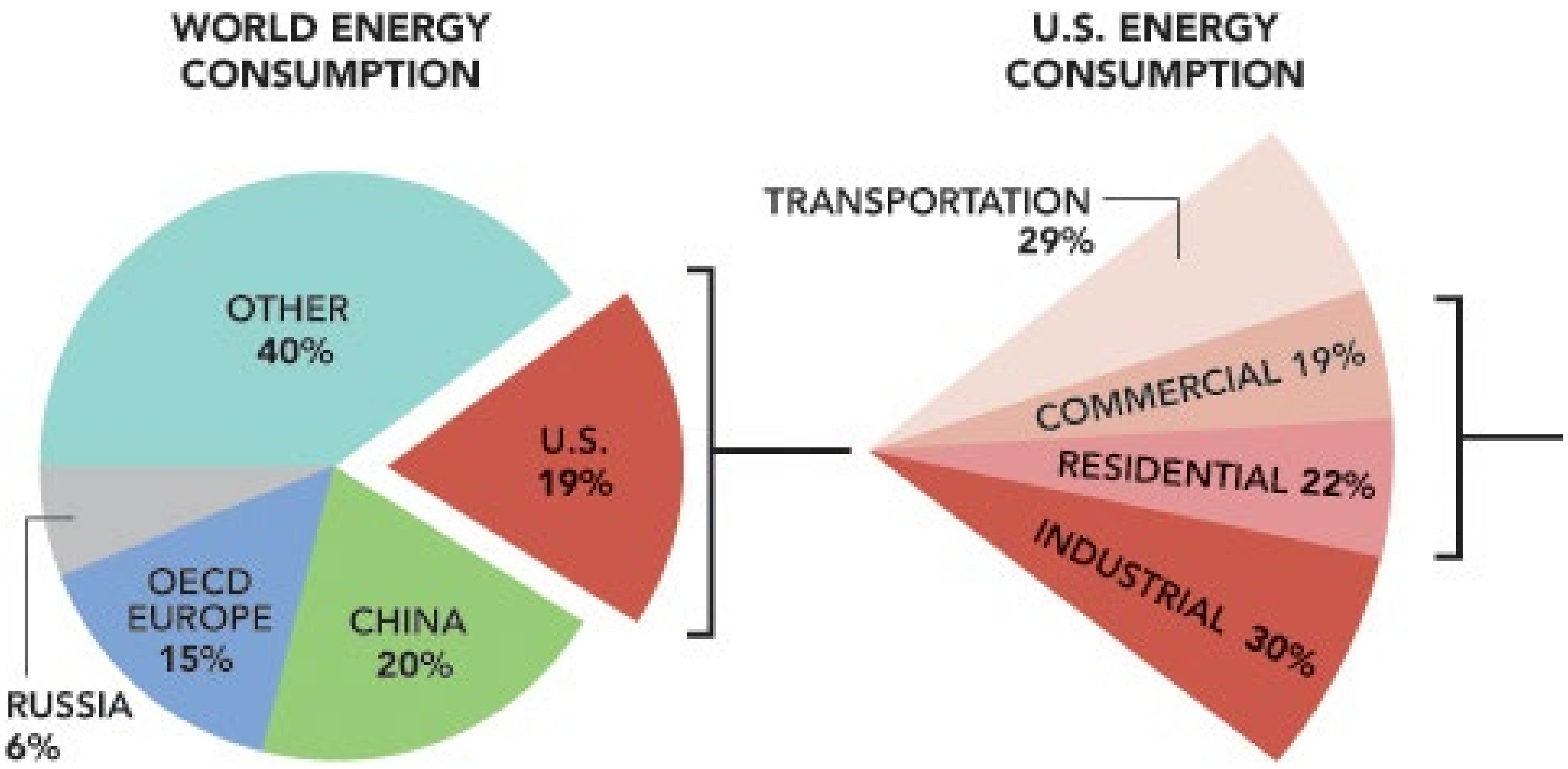
Lawrence Livermore National Laboratory



56.6%

43.4%

Source: LLNL July, 2016. Data is based on DOE/EIA SEDS (2014). If this information or a reproduction of it is used, credit must be given to the Lawrence Livermore National Laboratory and the Department of Energy, under whose auspices the work was performed. Distributed electricity represents only retail electricity sales and does not include self-generation. EIA reports consumption of renewable resources (i.e., hydro, wind, geothermal and solar) for electricity in BTU-equivalent values by assuming a typical fossil fuel plant heat rate. The efficiency of electricity production is calculated as the total retail electricity delivered divided by the primary energy input into electricity generation. End use efficiency is estimated as 65% for the residential sector, 65% for the commercial sector, 80% for the industrial sector, and 21% for the transportation sector. Totals may not equal sum of components due to independent Rounding. LLNL-MI-410527



41% of U.S. Primary Energy

Source: U.S. Department of Energy, Buildings Energy Data Book

Decarbonizing Minnesota's Natural Gas End Uses

Meeting 5

April 10th, 2020

Via Zoom

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