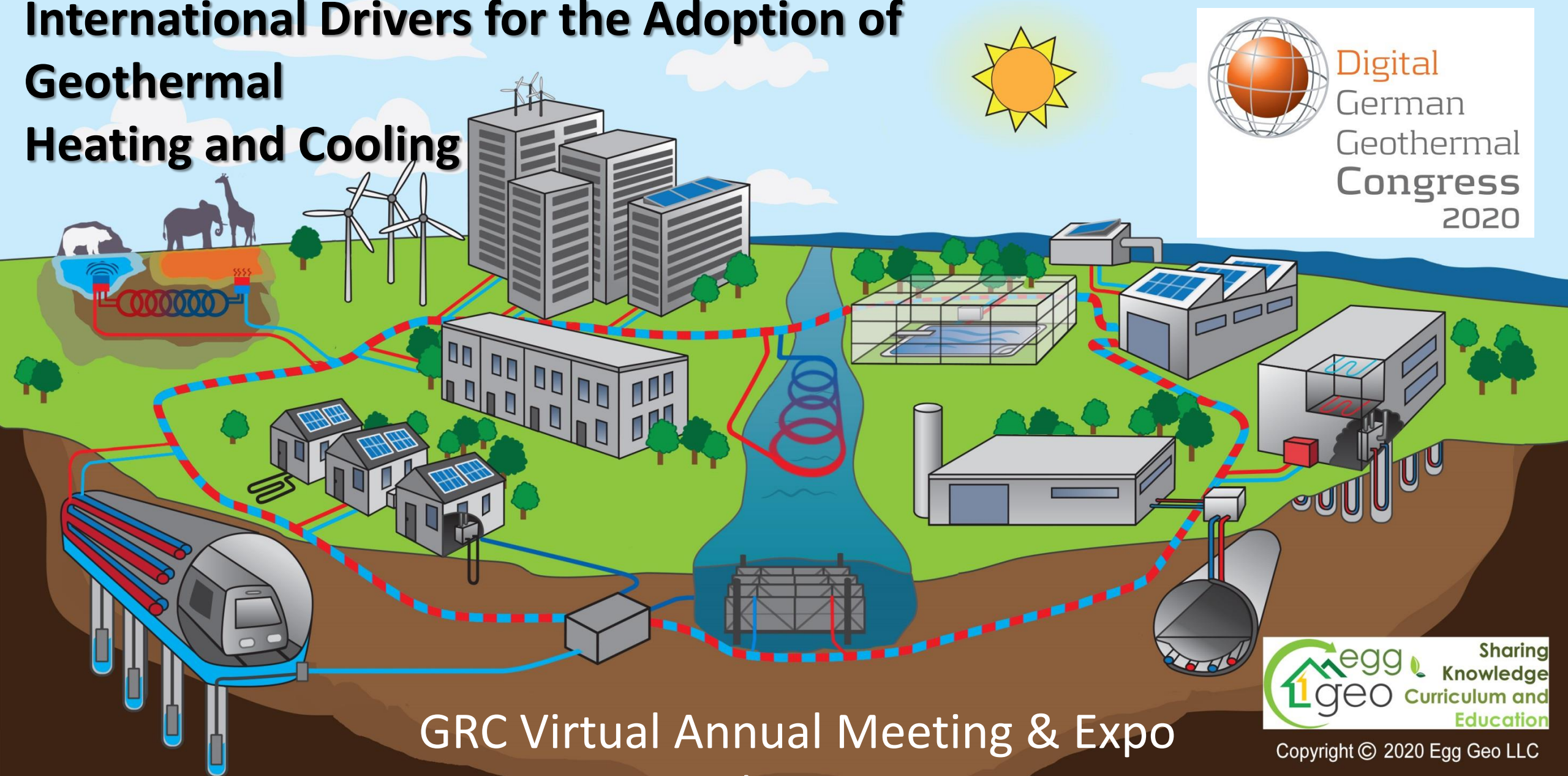


International Drivers for the Adoption of Geothermal Heating and Cooling



Digital
German
Geothermal
Congress
2020



GRC Virtual Annual Meeting & Expo
November 09, 2020



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Driver #1: Decarbonization -- Where is the CO2 coming from?

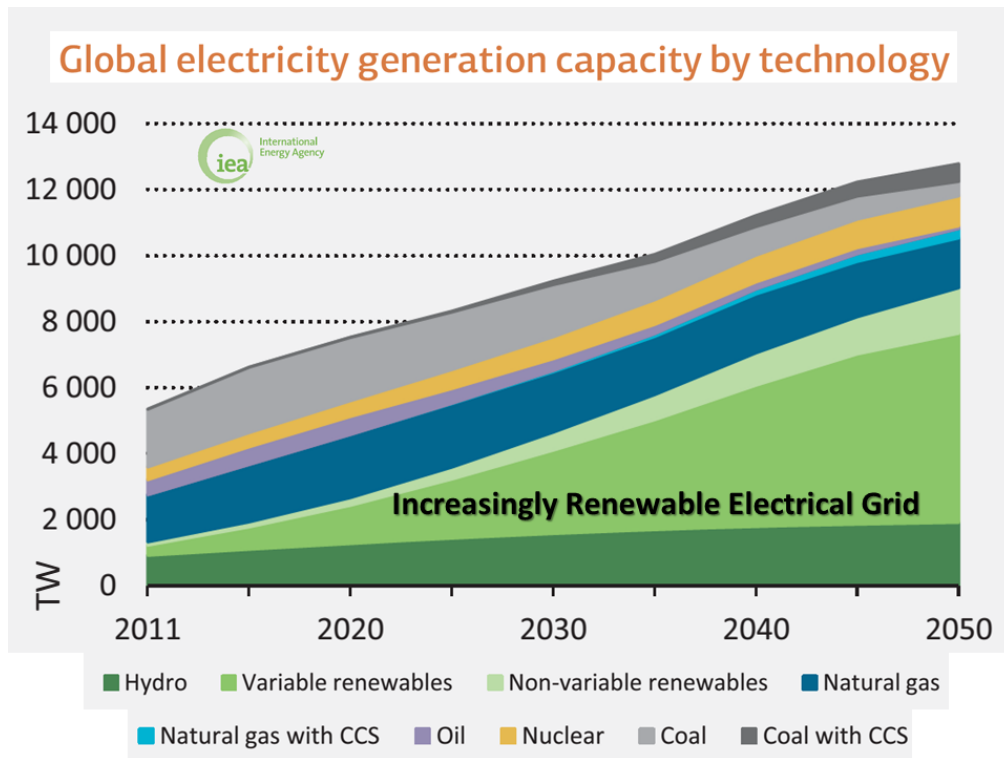


About 45% of emissions come from burning fossil fuels to make energy, including heat and electricity. "Having a fully electric house without a gas line is the direction we want to go," Vancouver City Engineer, Brady Faught said. <http://bit.ly/3az90pd>

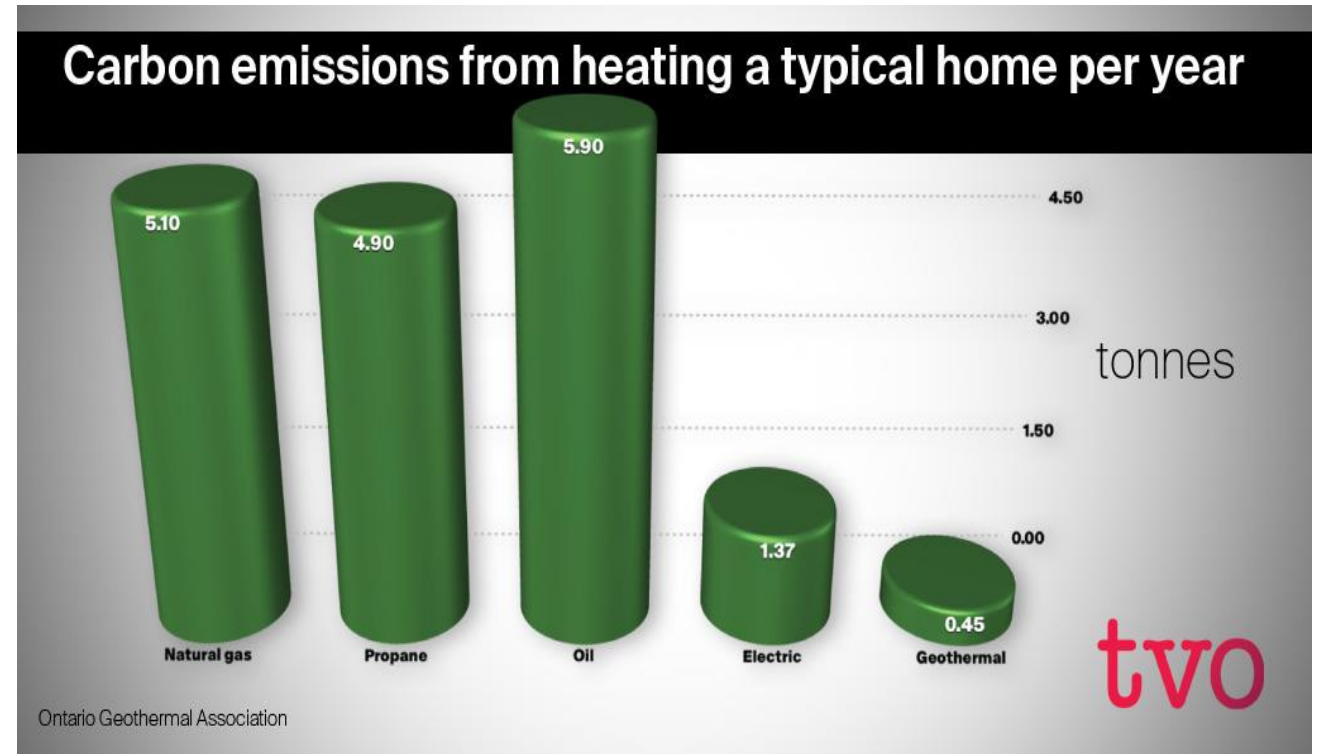


Geothermal heat pumps help us attain the goal of No on-site emissions, and provide the majority of "site-sourced" energy from the earth...& they manage electrical loads perfectly.

Emissions Comparison Between Combustion Heating and Electric Heat Pumps (Includes Plant Emissions)



The Electric Grid is “Greening” Continuously



All Electric Heat Pumps result in Low Emissions

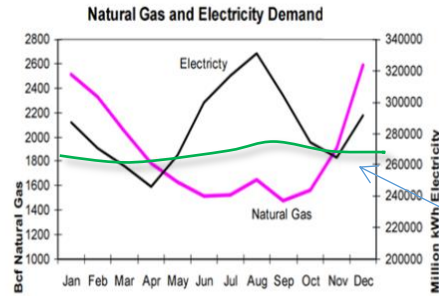
Driver #2: Electrification and Load Management – Electrical Loads are “leveled out” using GHPs

Benefits of Geothermal Heating and Cooling

nationalgrid
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Utility Benefits

- Highly efficient heating and cooling systems.
- Potentially a cost-effective option to defer capital commitment for utility gas and electric infrastructure.
- Reduces electric peak demand, improves load factor and improves the efficiency of the electric delivery system.
- Gas peak load reductions.

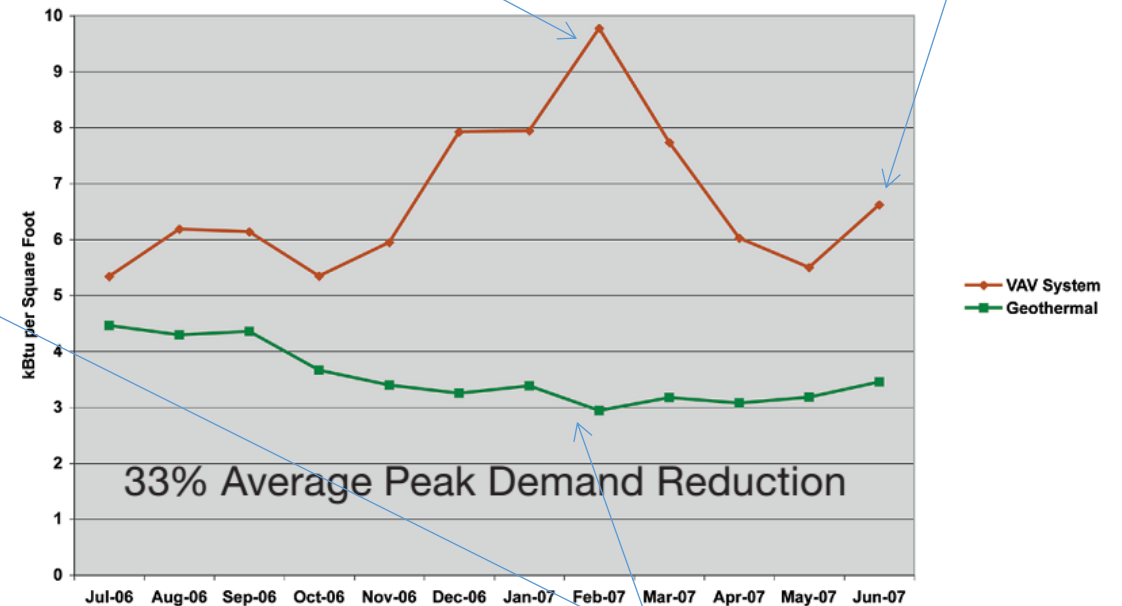


Ref: Gas Technology Institute, GRI 03/0173



13

Air Source Heat-Pumps tend to “peak” in the winter, as well as the summer

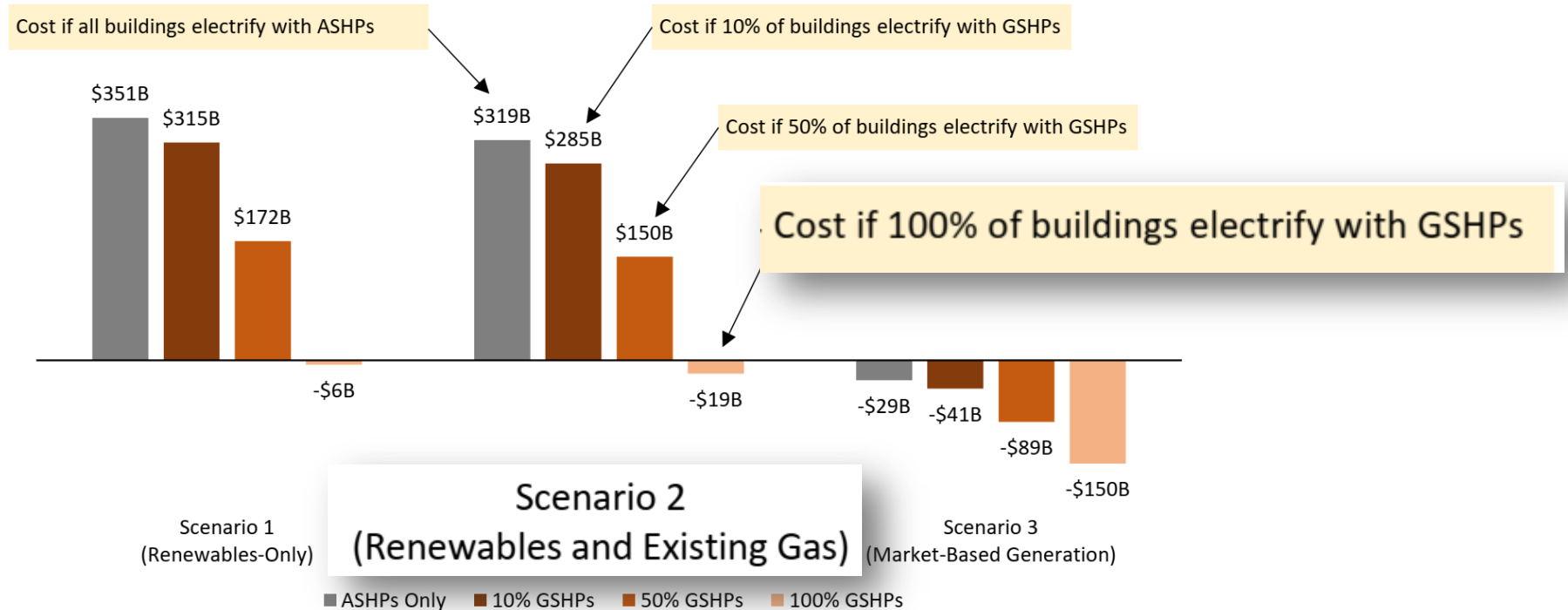


Ground Source Heat-Pumps Shave Both Summer and Winter Peaks

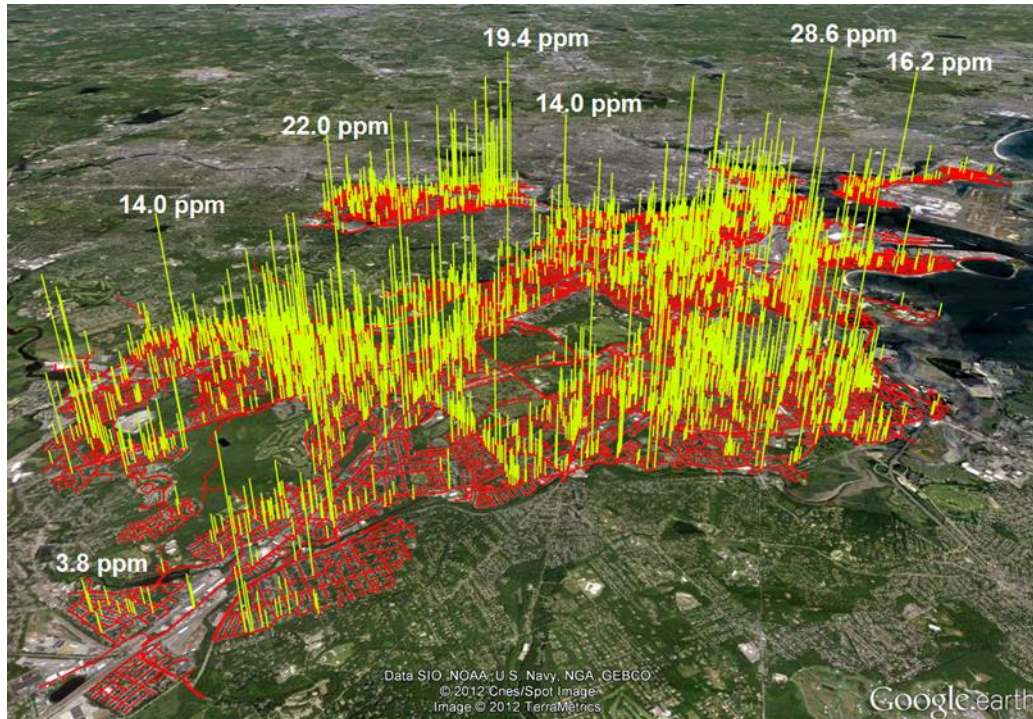
Combination Gas-Heat & Electric-Cooling Peaks in the Summer

The Benefits of Ground Source Heat Pumps for Beneficial Electrification

Figure 4. Total Cumulative Incremental Costs from 2020 to 2050 with GSHPs Included (\$Billions)

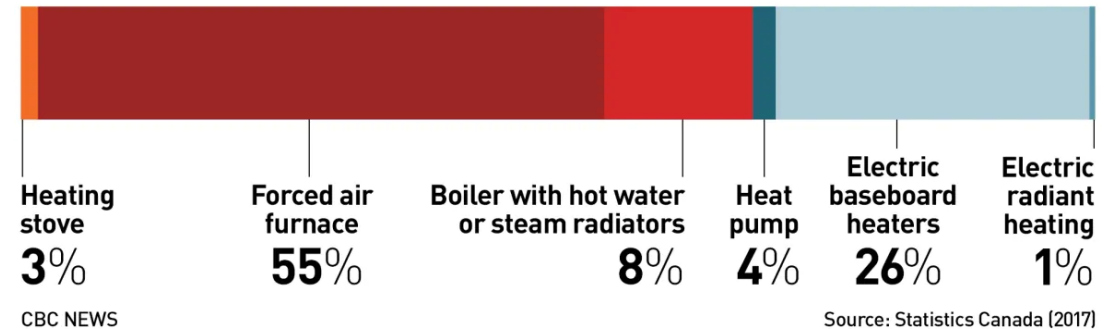


Some facts from studies in the Northern Climates: Boston, MA



66% of buildings use combustion to heat

Primary heating systems and type of energy



Combustion Heating + Carbon Emissions

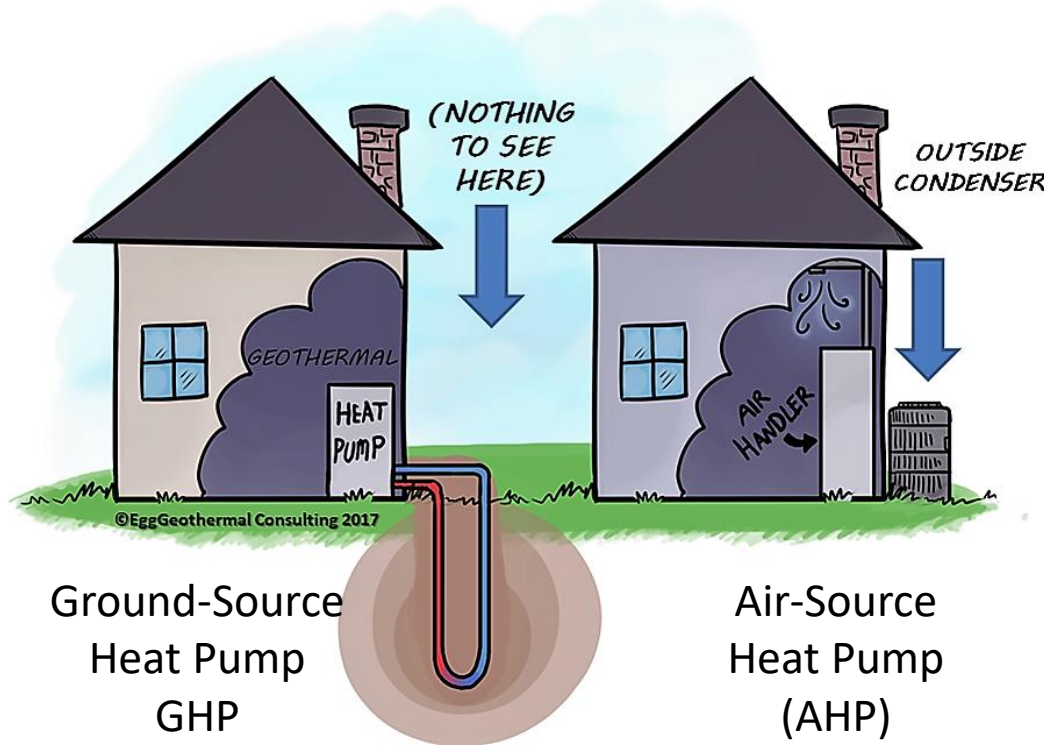
Natural Gas Leakage in Pipelines: MA. Unburnt natural gas is far more damaging by a factor of 84 than combusted natural gas

How air-source and ground-source heat pumps help with Building Decarbonization

Both use "Renewable Energy"



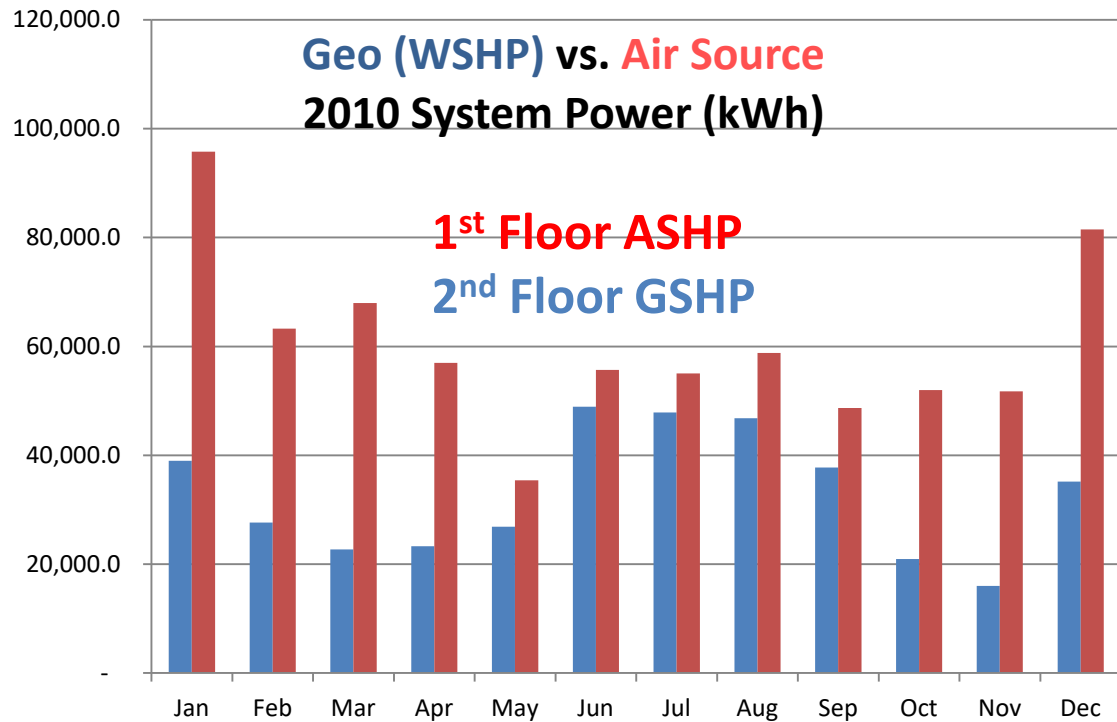
Nothing outside



Remote Outside Condenser

Understanding efficiency; the ASHRAE Building in Atlanta

Ground-coupled HPs consume less energy than air-source HPs, but can be more expensive (Earth Coupling)



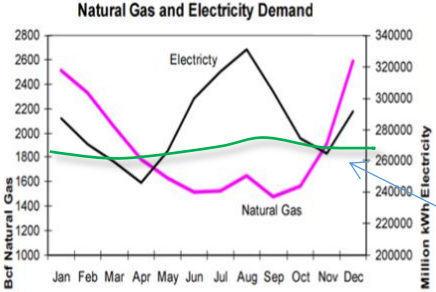
Power Consumption at ASHRAE Bldg, Atlanta



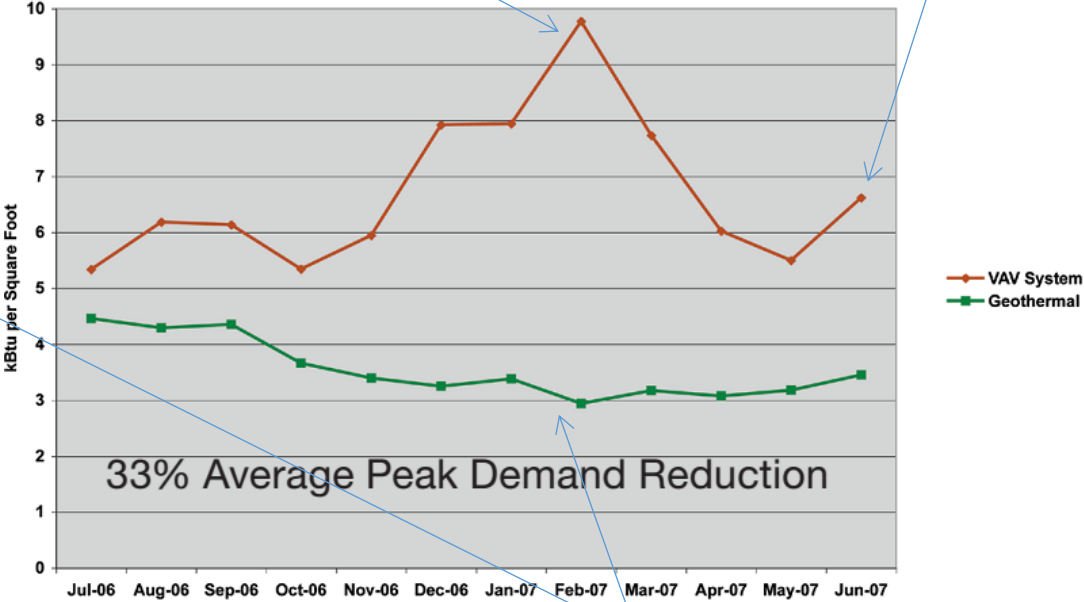
Electrical Load is “leveled out” using GHPs

Benefits of Geothermal Heating and Cooling nationalgrid HERE WITH YOU. HERE FOR YOU.

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Air Source Heat-Pumps tend to “peak” in the winter, as well as the summer



Combination Gas-Heat & Electric-Cooling Peaks in the Summer

Ground Source Heat-Pumps Shave Both Summer and Winter Peaks

Beneficial Electrification Means:

Building Electrification

MORE COMFORTABLE HOMES



LESS MAINTENANCE



SAFER AND EMISSIONS FREE



MUCH LOWER OPERATING COSTS



1. More Comfortable Homes
2. Less Maintenance
3. Safer & Emissions Free
4. Much Lower Operating Costs

National Grid and Eversource are advocating for Geothermal Micro Grids through their respective PSCs

- On Friday, July 31, 2020, [National Grid](https://inkd.in/d86S5F2) filed a new rate case with the Public Service Commission. Part of the testimony is a 69-page "Future of Heat" document in which the company proposes to install shared ground loops for geothermal heating and cooling systems. <https://inkd.in/d86S5F2>

"In our homes and offices, we are paying simultaneously to heat and cool different areas and processes. See what happens to efficiency when this energy is shared."



Jay Egg
Author/Expert/Consultant/Speaker

On Friday, July 31, 2020, #NationalGrid filed a new rate case with the Public Service Commission. Part of the testimony is a 69-page "Future of Heat" document in which the company proposes to install shared ground loops for geothermal heating and cooling systems. <https://inkd.in/d86S5F2> Thank you to #NY-GEO for the share! #Geothermal #Districtcooling #Districtheating

38 · 3 Comments

Reactions

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National Grid and Eversource are advocating for Geothermal Micro Grids through their respective PSCs

- To accomplish this, the Gas Leaks Allies, including HEET, worked together with legislators to create the For a Utility Transition to Using Renewable Energy legislation, or the FUTURE bill ([H.2849/S.1940](https://www.mahouse.gov/bills/2023/H.2849)).
- https://ma.mothersoutfront.org/mass_mof_legislation_team
- The FUTURE bill would create a renewable thermal credit market for gas utilities, allows them to bill for BTUs, and gives them a path to evolve into renewable energy companies.



Legend

Site Layout

ATES wells

250 0 250 500 750 1000 ft



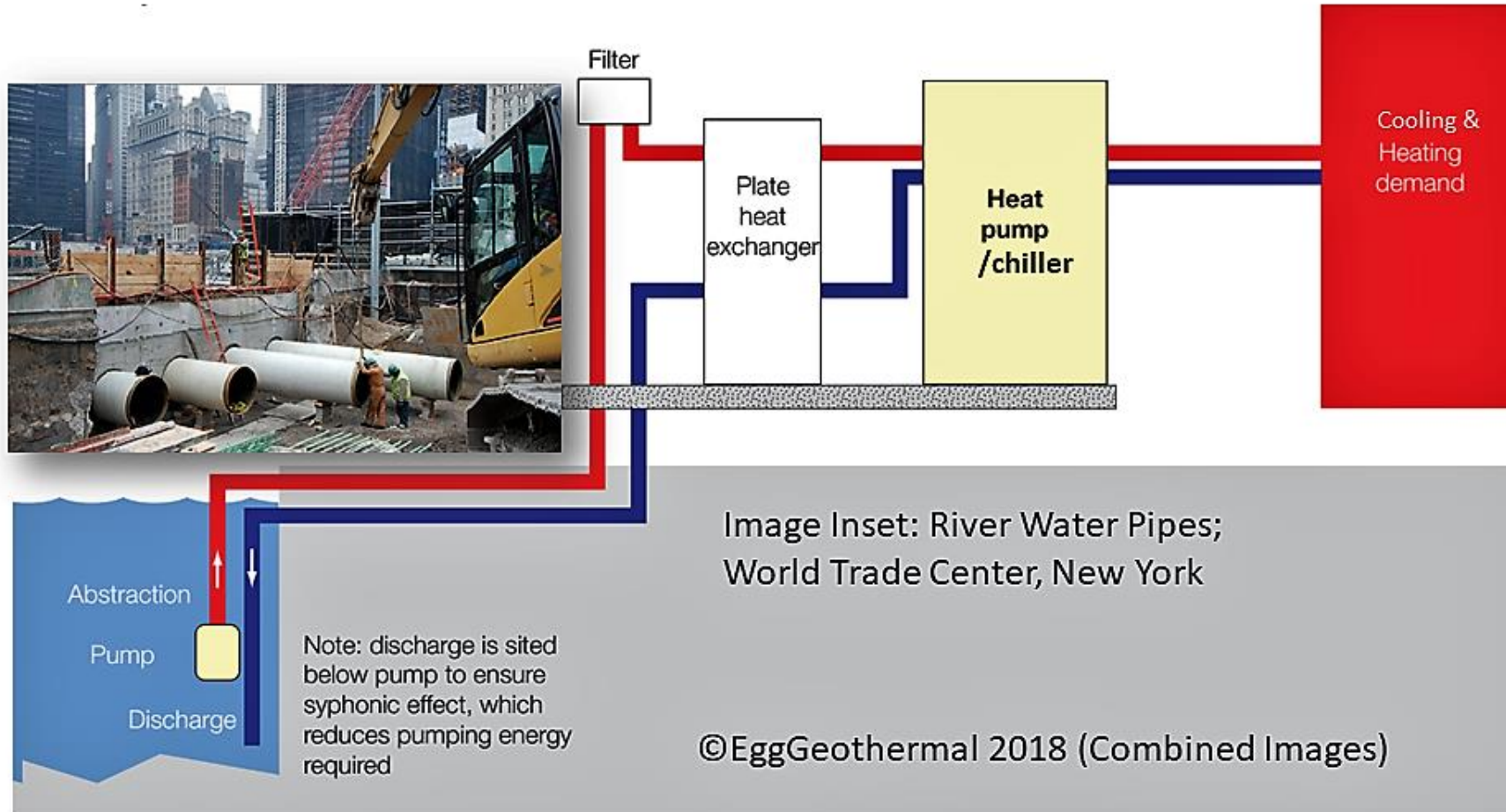
Opportunities for Geothermal Exchange



Surface Water Exchange

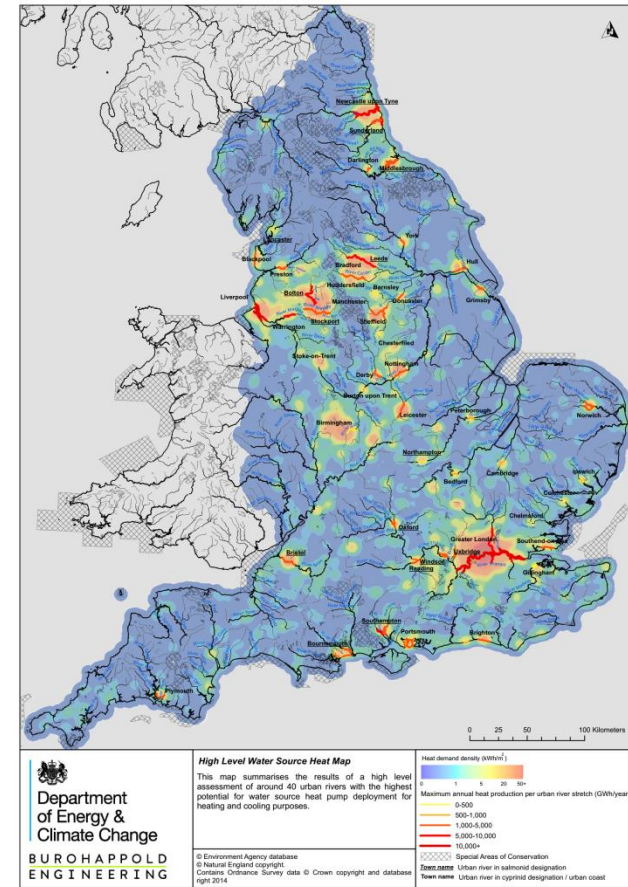
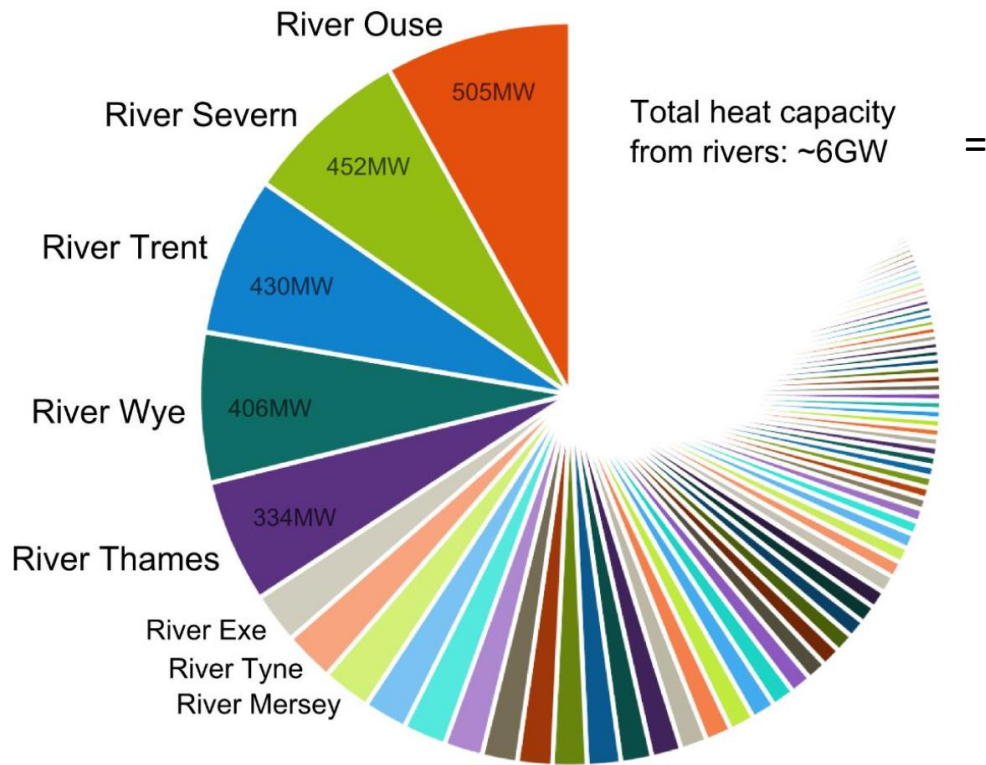


Surface Water Geothermal Exchange



(Reproduced courtesy of the Royal National Lifeboat Institution)

UK studied surface water thermal capacity and found that much of its heating and cooling needs can be met through Surface Water Exchange

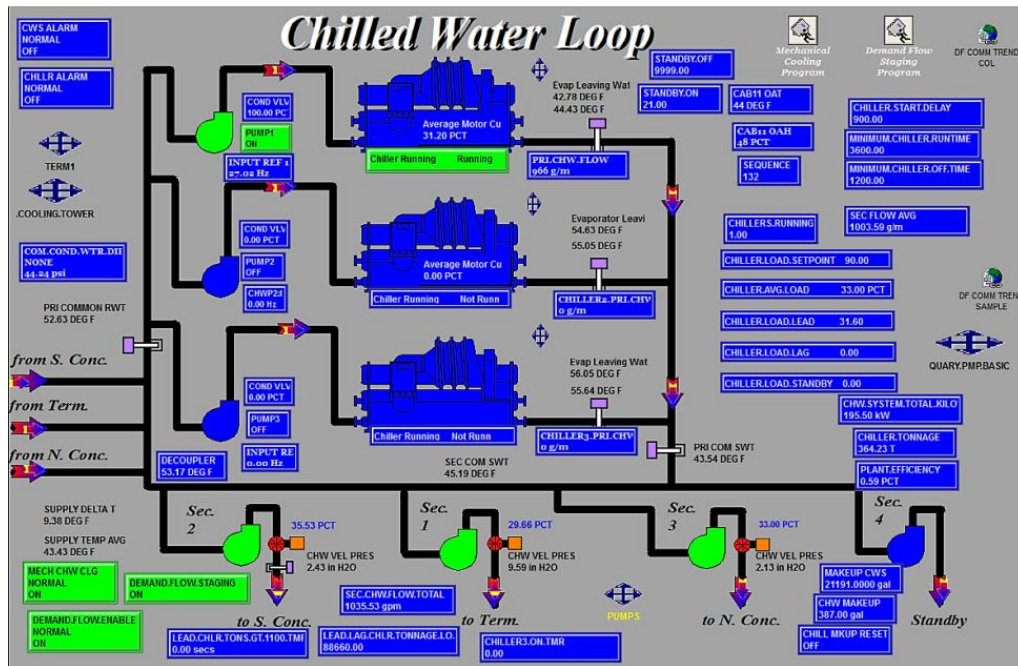


The heat capacity given in the table is for abstraction from rivers only. These locations could also extract heat from either coastal or estuarine waterbodies.

River and Surface Water GEO Nashville Airport



Nashville Airport Lake Plate Surface Water Geothermal



Nashville Airport Lake Plate Exchangers



Assessment of National Benefits from Retrofitting Existing Single-Family Homes with Ground Source Heat Pump Systems

Table E-1. Potential Benefits of Retrofitting Existing U.S. Single-Family Homes with State-of-the-Art GHP Systems at Various Market Penetration Rates

| Estimated national benefits | Market penetration rate of GHP retrofit | | | | |
|--|---|-------|-------|-------|--------------|
| | 20% | 40% | 60% | 80% | 100% |
| Primary energy savings [quad BTU] | 0.8 | 1.7 | 2.5 | 3.3 | 4.2 |
| Percentage savings | 9.0% | 18.0% | 27.1% | 36.1% | 45.1% |
| CO2 emissions reduction [MM ton] | 54.3 | 108.7 | 163.0 | 217.3 | 271.7 |
| Percentage savings | 9.1% | 18.1% | 27.2% | 36.2% | 45.3% |
| Summer peak electrical demand reduction [GW] | 43.2 | 86.4 | 129.5 | 172.7 | 215.9 |
| Percentage savings | 11.2% | 22.4% | 33.6% | 44.9% | 56.1% |
| Energy expenditures savings [Billion \$] | 10.4 | 20.9 | 31.3 | 41.7 | 52.2 |
| Percentage savings | 9.6% | 19.3% | 28.9% | 38.5% | 48.1% |

45.3% Reduction in Carbon Emissions

56.1% Reduction in Summer Peak Electrical Demand

Notes: (MM ton, million metric ton).

Electrification Promotes Load Sharing / Diversification

Mixed-Use Heating and Cooling Loads Provide Opportunities to Share Energy

Prototype Street Segment Heating and Cooling Loads

Annual Heating and Cooling Consumption

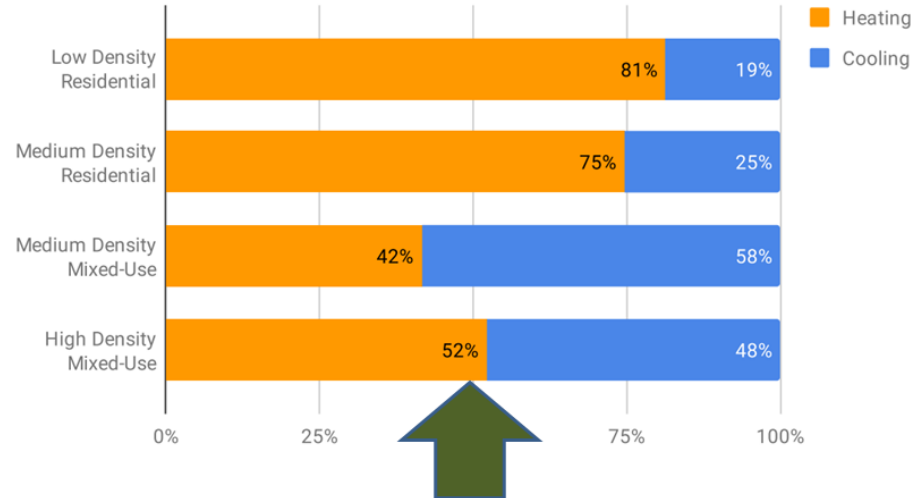


Figure III-5: Comparison of residential and commercial peak heating demand patterns

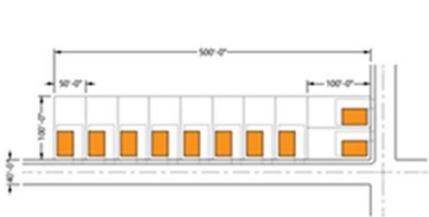


Figure III-2: Medium density residential PSS

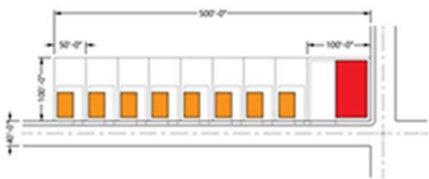
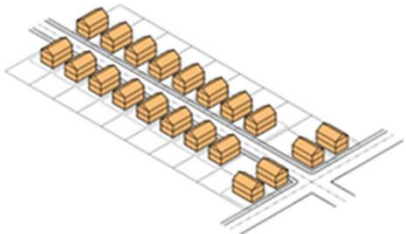


Figure III-3: Medium density mixed-use PSS

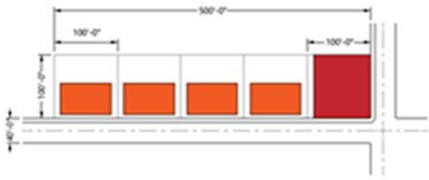
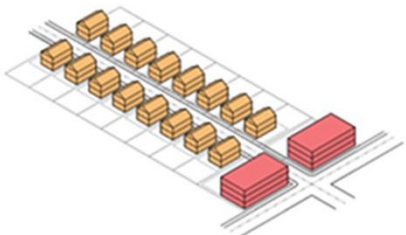
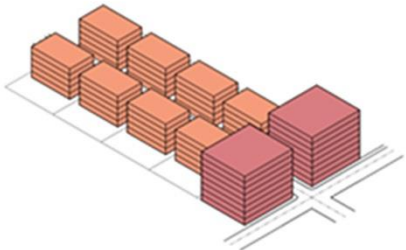
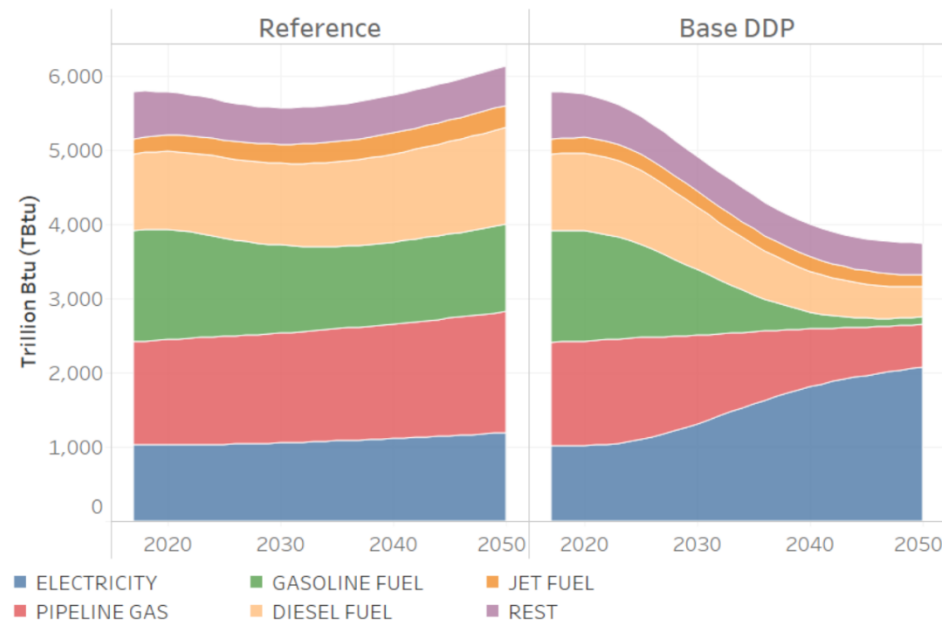


Figure III-4: High density mixed-use PSS



Beneficial Electrification-Deep Decarbonization

Figure 14. Northeast Final Energy Demand by Fuel Type



This shift to electricity as the fuel for HVAC and Electric Vehicles will cause a significant increase in the consumption of electricity, but will reduce overall energy consumption and carbon emissions

It's clear that there is a reduction in energy consumption (due partly to COP of Heat Pumps).

[Evolved Energy Research](#)

A Passion for Sharing Knowledge



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