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Thermal Energy Networks: An Overview and Project Examples

Sue Dougherty
August 31, 2022

"In order to decarbonize the State's building stock by mid-century, New York will have to quickly move beyond a building-by-building approach to a neighborhood-by-neighborhood approach, developing carbon neutral communities."

– NYSERDA Strategic Outlook (2022-2025)

Success would mean:

> Develop and maintain new clean energy infrastructure

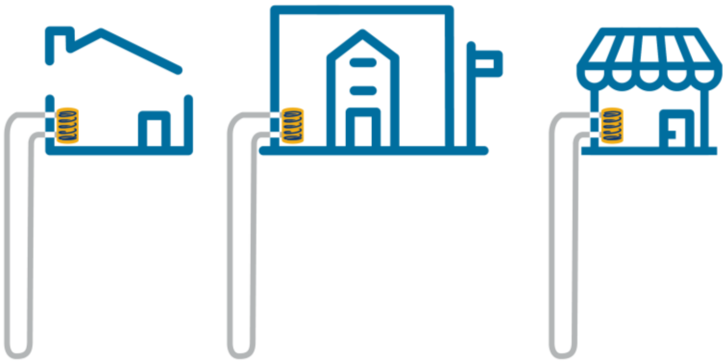
> Establishing a transition strategy for utilities to shift to being clean thermal energy providers as we downsize gas systems

> Leverage unique position of municipalities and utilities to scale business models in partnership with existing market players

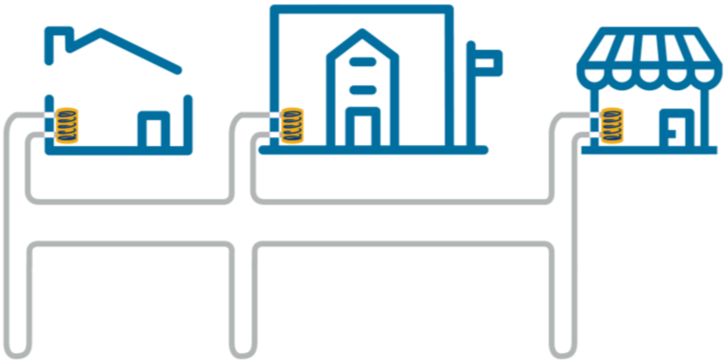
> Create new clean, high-paying energy jobs in construction and maintenance of loop systems

> Provide lower operating cost to residents and businesses with less strain on the electric grid during peak times

What’s a district-style configuration?



Individual-Building-style



District-style: Neighboring buildings are linked via connector pipes to share thermal resources.

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When to consider a district-style approach

- Group of buildings with a variety of heating and cooling loads
  - Mixed use developments
  - Healthcare facilities
  - College campuses
  - Residential complexes
  - Downtown core with office, commercial, residential buildings
- Proximity to a viable thermal resource
  - Land space for boreholes / ground coupling
  - Water pipes or sewer mains
  - Waste heat from industrial facility or datacenter
  - Surface water: rivers, lakes, ponds

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NYSERDA support (PON 4614)

Purpose

> Funding support for project sites to determine feasibility of a district-style heat pump approach, perform a detailed design, and construct a system

Eligibility

> Project sites with 2 or more buildings and a combined conditioned space of at least 40,000 sqft *or* 10 or more buildings of any size

> System Benefits Charge (SBC) payers and non-SBC payers, including affordable housing, State/City agency buildings, and sites on Long Island

> Preference for supporting Disadvantaged Communities (DACs), Environmental Justice Communities (EJCs), Low-to-Moderate Income (LMI) customers

> Upcoming due dates to competitive solicitation:

Round #	8	9	10	11	12
Proposal Due Date	11/15/2022	2/8/2023	5/10/2023	8/9/2023	11/15/2023

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PON 4614 funding categories

Category A
"Scoping Study"
Assess feasibility of numerous options
(small, medium, large; technology X, Y, Z)
The "What" Question
Output is a preferred option

Max award: $100K

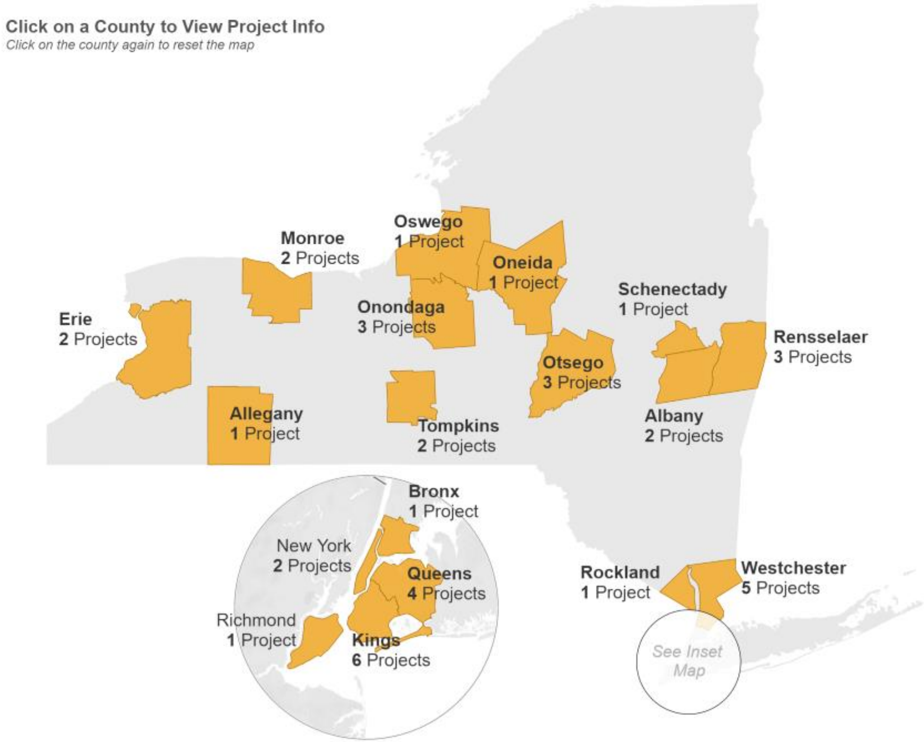
Category B
"Detailed Design Study"
Drill-down on preferred option
(create blueprints, obtain bid prices)
The "How" Question
Output is a shovel-ready project

Max award: $500K

Category C
"Construction"

Max award: $4M

PON 4614 projects



- Round #1-5 projects
- 39 project sites
- Project factsheets / summaries on website

Portfolio with Variety of Learning Opportunities

Multiple Owners — Existing

CONSTRUCTION

- Two nodes at non-abutting redevelopment zones: City of Troy

FEASIBILITY

- Entire city: City of Oneonta
- Central core downtown: City of Syracuse
- A few adjacent blocks with low-rise buildings: City of Utica
- A handful of single family homes in conjunction with a nearby commercial building: Northland Community in Buffalo
- Rochester District Heating Cooperative
- Existing and new buildings at SUNY Oneonta owned by DASNY and SUNY
- Cluster of residential and commercial buildings in downtown Albany: Sheridan Hollow
- Office buildings in lower Manhattan using Hudson River for thermal resource: Brookfield Place
- Cluster of residential, office, and retail buildings in Ithaca
- Mix of buildings in Southeast Albany using Hudson River for thermal resource
- Cluster of single family homes in Ithaca

Multiple Owners — New Construction/Gut Rehab

FEASIBILITY

- A few adjacent blocks with low-rise buildings and high-rise towers: Innovation Queens
- Redevelopment of industrial buildings at Oneonta Railyards
- Large cluster of residential buildings using surface water in Long Island City

Single Owner — Existing

DESIGN

- Campus lacking district thermal: The Children's Village in Dobbs Ferry

FEASIBILITY

- Campus with existing district steam: Rockefeller Center
- Campus with some existing district steam and some thermally-islanded buildings: Barnard College in Manhattan
- Campus with existing district steam in midst of conversion to hot water: University of Rochester
- Campus lacking district thermal: Phelps Hospital in Sleepy Hollow
- Campus looking at pilot (subset of buildings): Syracuse University, Wagner College in Staten Island
- Campus looking at numerous mini-districts (nodes): Pratt Institute in Brooklyn
- Campus looking to leverage MTA pumped water: Spring Creek Towers (formerly known as Starrett City) in Brooklyn
- Campus looking to leverage surface water body as thermal resource: Masonic Temple in New Rochelle
- Campus with existing steam: SUNY Oswego
- Campus with mix of existing systems including steam and WSHPs: Houghton College
- Campus in Niskayuna

Single Owner — New Construction/Gut Rehab

CONSTRUCTION

- New mixed-use buildings: Greenpoint, Brooklyn development
- New affordable housing, mixed-used: LCOR Coney Island

DESIGN

- New construction on campus with residential and office buildings: Watchtower Bible and Tract Society
- New mixed-use buildings in Harlem
- Gut rehab mixed-use buildings repurposing large industrial tanks for thermal storage in Syracuse

FEASIBILITY

- New construction mixed-use buildings looking to leverage surface water body as thermal resource: Pratt Landing in New Rochelle
- New construction mixed-use buildings looking to leverage hybrid (ground source, air source, wastewater) as thermal resource: Gowanus Green in Brooklyn, The Peninsula in The Bronx, Fleet Financial in Queens
- Gut rehab mixed-use buildings looking to leverage surface water body as thermal resource: Silo City in Buffalo
- New construction using Flushing Bay as thermal resource: Willets Point in Queens

Multiple Owners | Single Owner

Existing | New Construction/Gut Rehab

Next steps

> Share results of PON 4614 Scoping Studies

> Continue outreach to municipalities, campus-owners, and affordable housing

> Utility Thermal Energy Networks and Jobs Act signed on 7/5/22

– Work with utilities to identify pilot opportunities, define ownership models

> Attending the NESEA BuildingEnergy NYC conference on 9/15?

– ***Session:*** *Breaking Ground on Geothermal and Thermal Energy Networks: A Pathway for Urban Areas*

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Thank You

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1515 SURF AVENUE

Near Coney Island waterfront
463 Unit Multi-Family Housing
139 Affordable Units
11,000 ft^2 Ground Floor Retail

ECOSAVE
YOUR NET ZERO PARTNER

Developer	LCOR
Architect	Studio V Architecture
MEP Engineer	MGE Engineering
Geothermal Design Builder	Ecosave

- Elimination of 12,000 MBH of fossil fuel boilers for heating and domestic hot water
- Eliminated 800 Ton cooling tower for water source heat pump system
- Elimination of gas fired pool heater
- 60% + Energy savings versus base ASHRAE 90.1 2016 design for multi-family housing
- All Electric New Construction Multi-family Facility

NYSERDA Award under Category C – Construction - $1,621,019

Raymond Johnson PE
Executive VP Engineering & Construction

ECOSAVE
YOUR NET ZERO PARTNER

Largest Geothermal Heat Pump Project in NYC – All Electric HVAC

- Extended range horizontal and vertical water source heat pumps
- CO_2 heat pump DHW heating system
- Dedicated heat pump DOAS system with heat recovery wheels
- Swimming pool serves as a heat sink providing free heat
- Construction commenced September 2021
- Anticipated project completion Spring 2024

Geothermal Closed Vertical Loop Drilling

- Cooling Dominant Multi-family Housing Complex
- Total 153 well borefield with 20 feet spacing
- 500 feet vertical borefield depth
- Construction below foundation of housing complex

ADVANTAGES OF COMMUNITY GEOTHERMAL HEAT PUMP LOOPS

- Geothermal Heat Pump Loops provide highest HVAC system Efficiencies and Lowest Operations and Maintenance Cost
- Premium HVAC technology for electrification and net zero emissions
- Community GHP loops provide scale to reduce installation cost
- Buildings with diverse heating and cooling load profile provide diversity to balance, optimize and downsize borefield sizing
- Provides fuel diversity and reduces summer electric peak
- DHW Heat pumps in multi-family buildings enables balancing and reducing borefield sizing in cooling dominant buildings
- GHP district loop can free up prime real estate inside building and on roof
- Quieter operation and more reliable system with highest efficiencies

DESIGN & IMPLEMENTATION CHALLENGES

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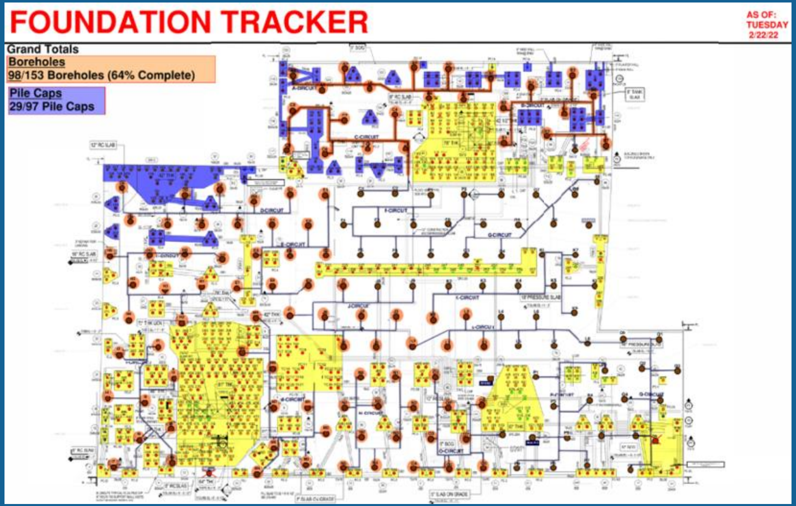
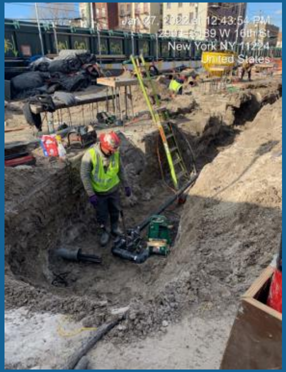


Constrained footprint

- Borefield below buildings and garage
- Loops and manifolds between concrete foundation elements.
- Project Scheduling critical
- Surveying critical
  - Ensure drilling is done in correct locations
  - Maintain required separation from foundation elements



DESIGN & IMPLEMENTATION CHALLENGES

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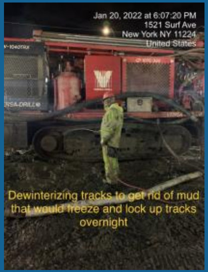
Winter Drilling

- Drilling and looping equipment freeze protection
- Freeze protection of installation



Inconsistent Geology

- Requires adaptation in drilling techniques and materials
- Drilling fluid and protective casing.
- Drilling bits

PROJECT STATUS

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Work Progress June to August 2022

- Fusing of 8-inch pipes
- Building construction progress above loops
- Pressurizing of geothermal loops
- Backfilling after installing loops

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LESSONS LEARNED

- New construction easier to adopt than retrofit existing system
- Accurate load modelling of building and bore-field for geothermal loop
- Optimal facility have load diversity
- Facilities who consider life time operations & maintenance in lieu of first cost
- Facilities located in States where state legislation and local laws drive decarbonization efforts
- Facilities which have corporate ESG, carbon/ emission reduction goals and want clean energy solutions
- District loops with diverse building heating and cooling loads are ideal for optimizing loop sizing

THANK YOU

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NESEA
NORTHEAST SUSTAINABLE ENERGY ASSOCIATION

NYSERDA PON 4614

Overview of progress to date

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Tony Amis

SVP

August 31st, 2022

Endurant Energy Status of PON 4614 works

8 projects In progress

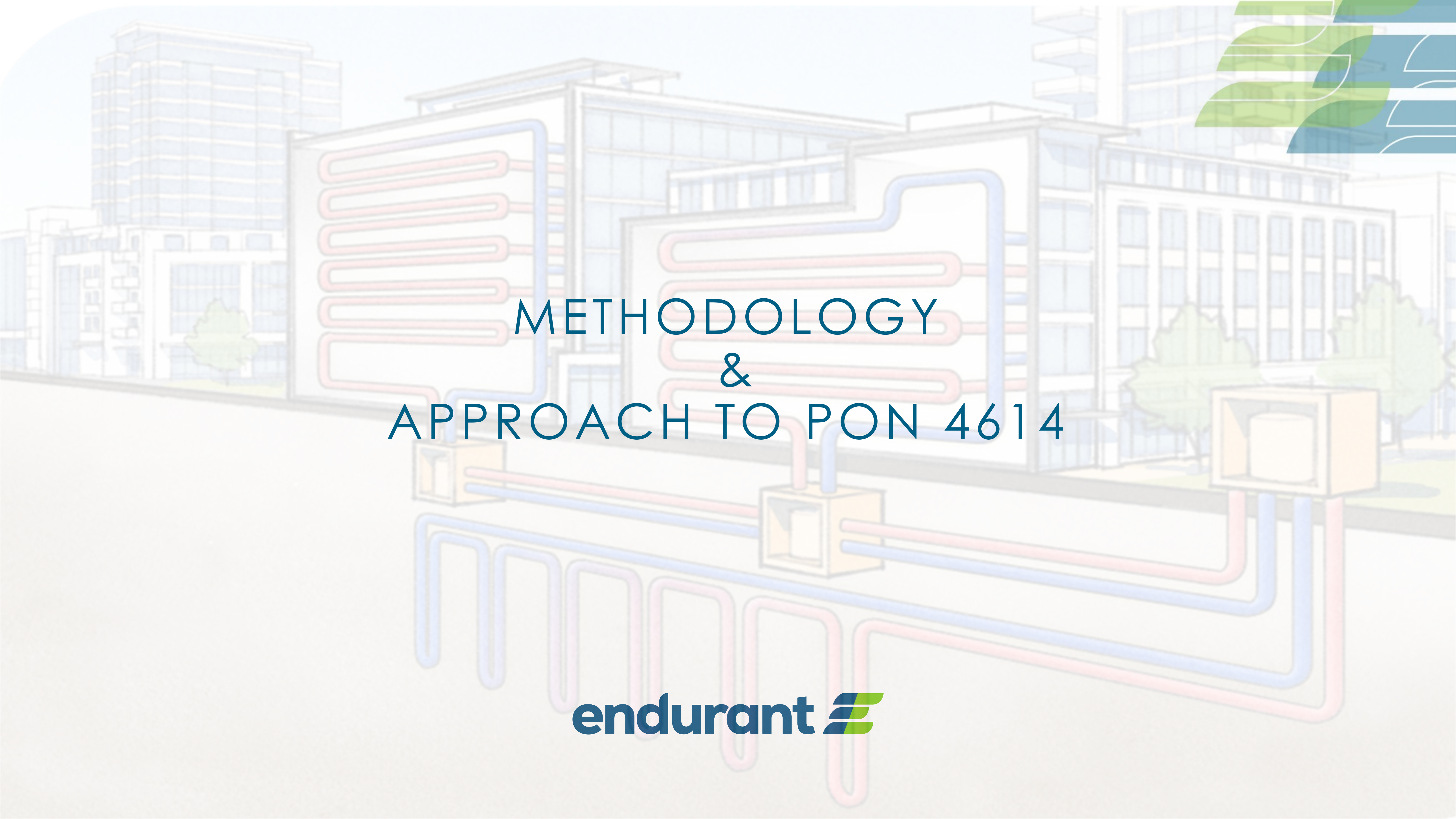
- 6 projects completed to Final Report status
- 2 remaining projects with analysis completed being drafted into final reports
- Projects included
  - Retrofit of existing buildings
  - Multi-family buildings
  - Affordable Housing
  - University campus conversion

Geo solutions explored have included:

- 500’ boreholes
- Energy piles
- Sewage Heat transfer
- Heat exchange using pumped water from MTA
- Most combined with ASHP’s





METHODOLOGY
&
APPROACH TO PON 4614

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Develop & Understand Project scope

Developing a district energy concept

- Quantify the following costs and benefits against business-as-usual
  - Capital cost
  - Utility cost
  - Maintenance cost
  - Carbon emissions
  - Regulatory requirements
  - Additional value streams
- Thermal technologies considered:
  - Ground source heat pump
  - Air source heat pump
  - Wastewater heat exchange
  - Surface water exchange
- Additional technologies considered:
  - Solar PV
  - Battery Energy Storage
  - EV Charging

ESTABLISHING THE BASELINE

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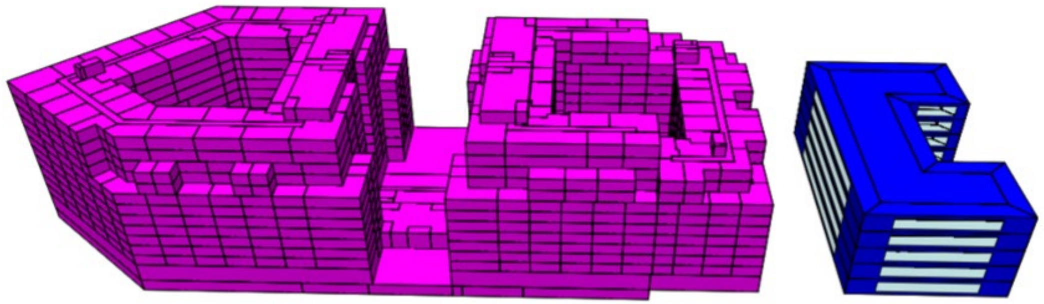
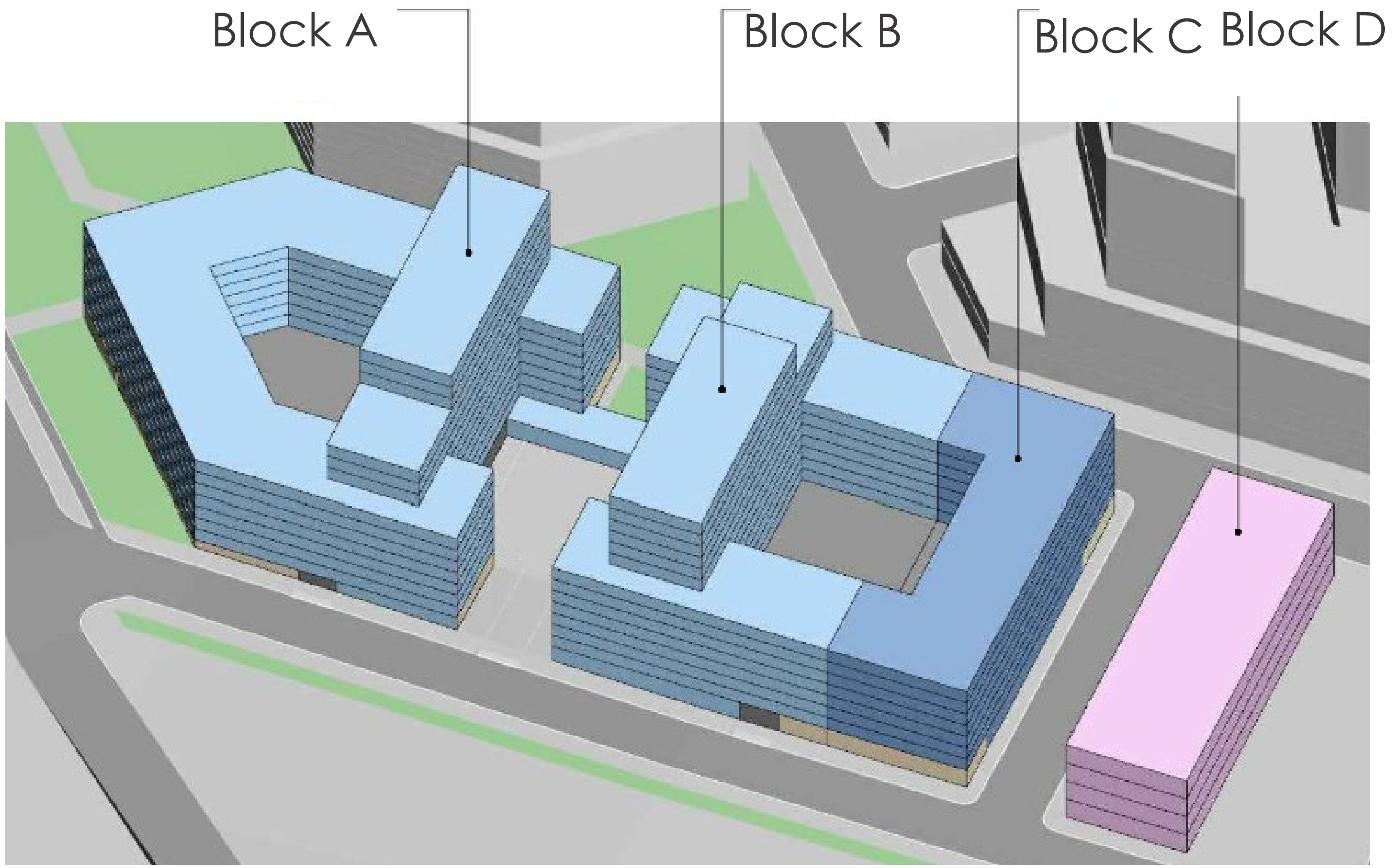
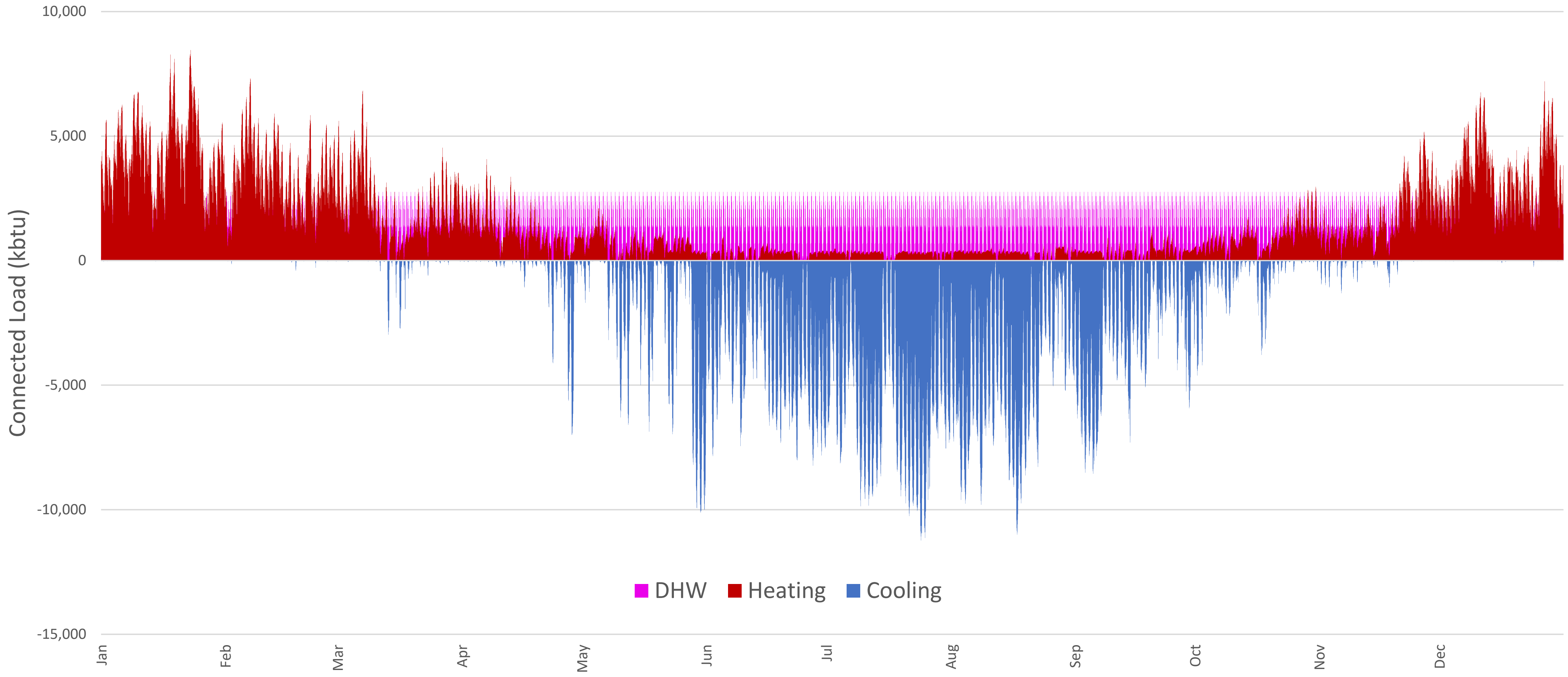
Modelling approach

- Space by space model using IES VE 2019 energy modelling software
- Generating Energy Models for each block in the development
- 8760 model of heating, cooling, and domestic hot water (DHW) demand for each building





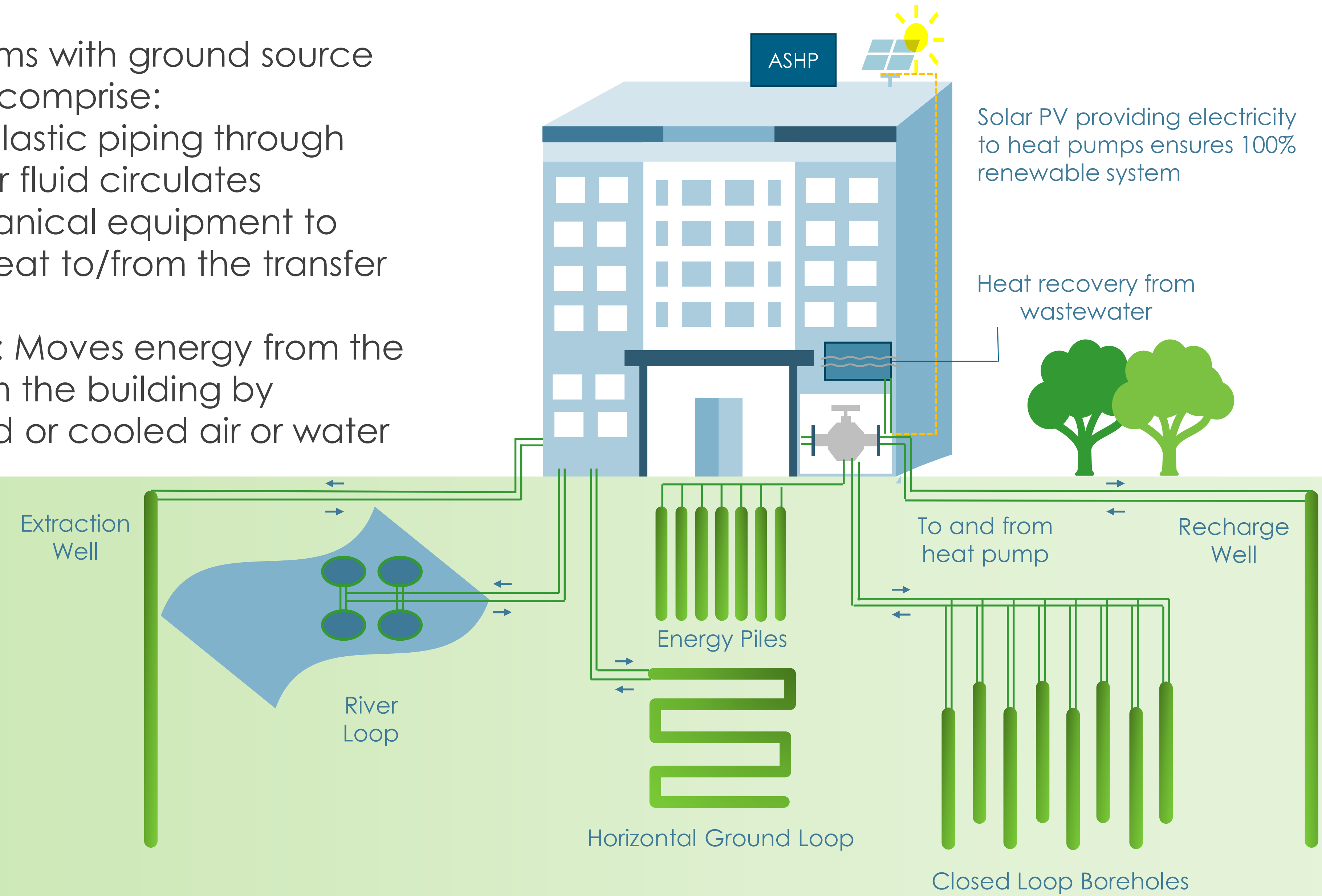
Modelling results



Zero-carbon geo-exchange systems provide base-load heating & cooling

Geo-exchange systems with ground source heat pumps (GSHPs) comprise:

- **Heat exchanger**: plastic piping through which heat transfer fluid circulates
- **Heat pump**: mechanical equipment to accept or reject heat to/from the transfer fluid
- **Distribution system**: Moves energy from the heat pump to/from the building by circulating warmed or cooled air or water



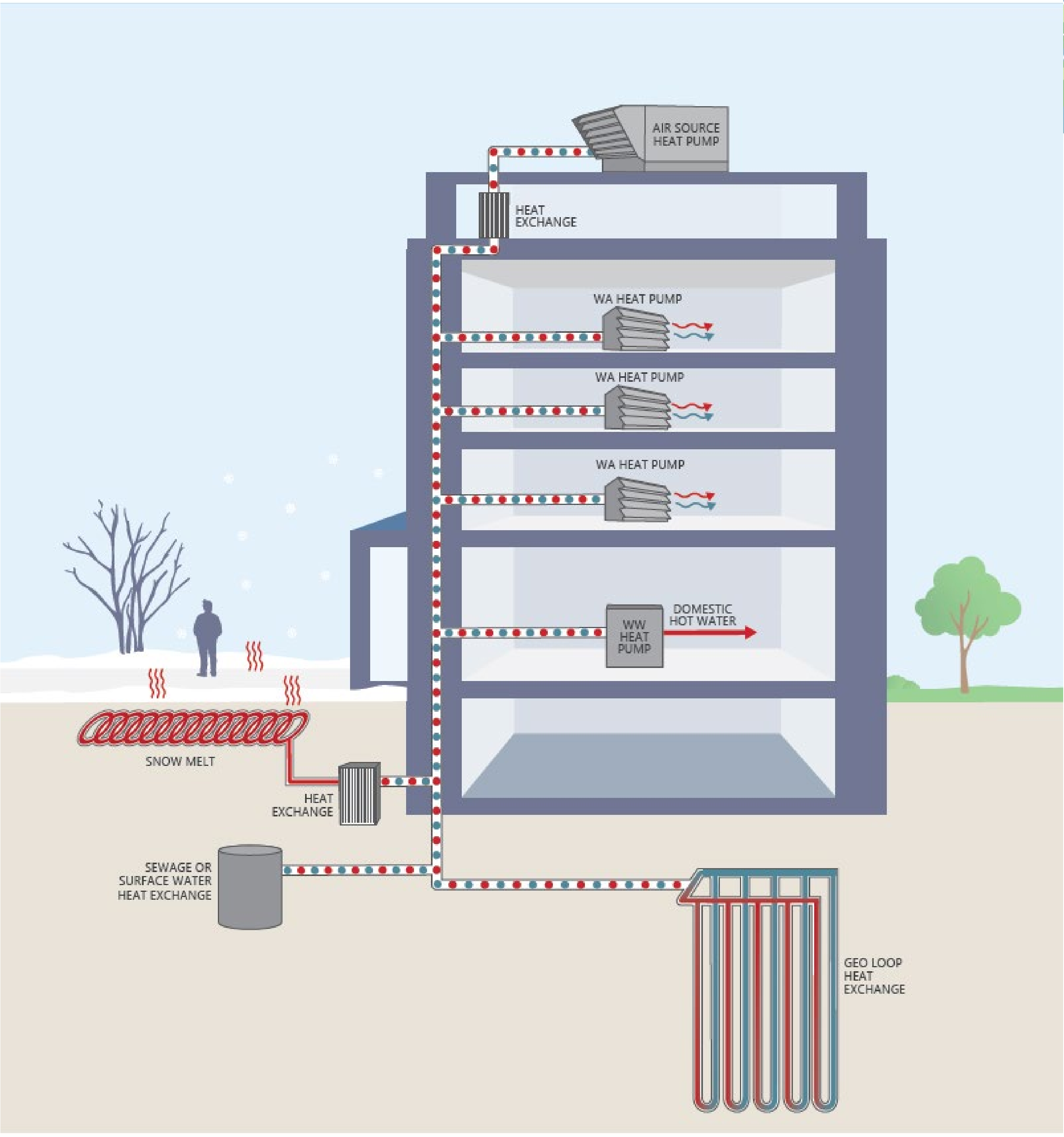
Decentralized plant

Pros:

- 2-pipe condenser loop distribution:
  - Reduced investment cost for site trenching and lateral piping
  - Reduced investment cost at building level
- Flexibility at building level:
  - Utilize 2-pipe distribution to spaces
  - Supplemental assets can be localized (ASHP)

Cons:

- Less opportunity for "true" simultaneous load
- Larger investment in equipment:
  - Less opportunity for economies of scale
  - Redundancy/resiliency requirements localized
- Increased potential for maintenance (more compressors)



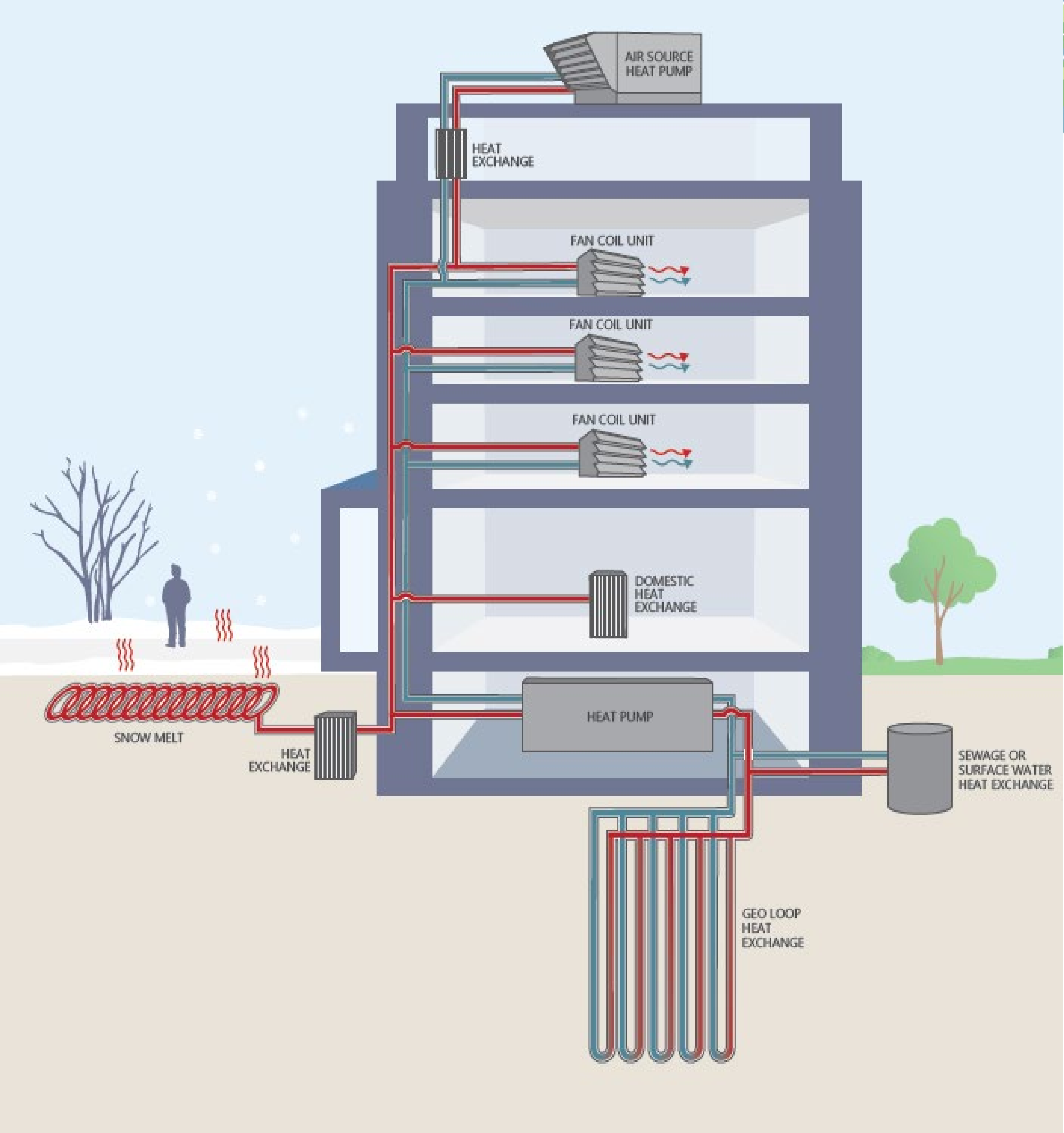
Central plant

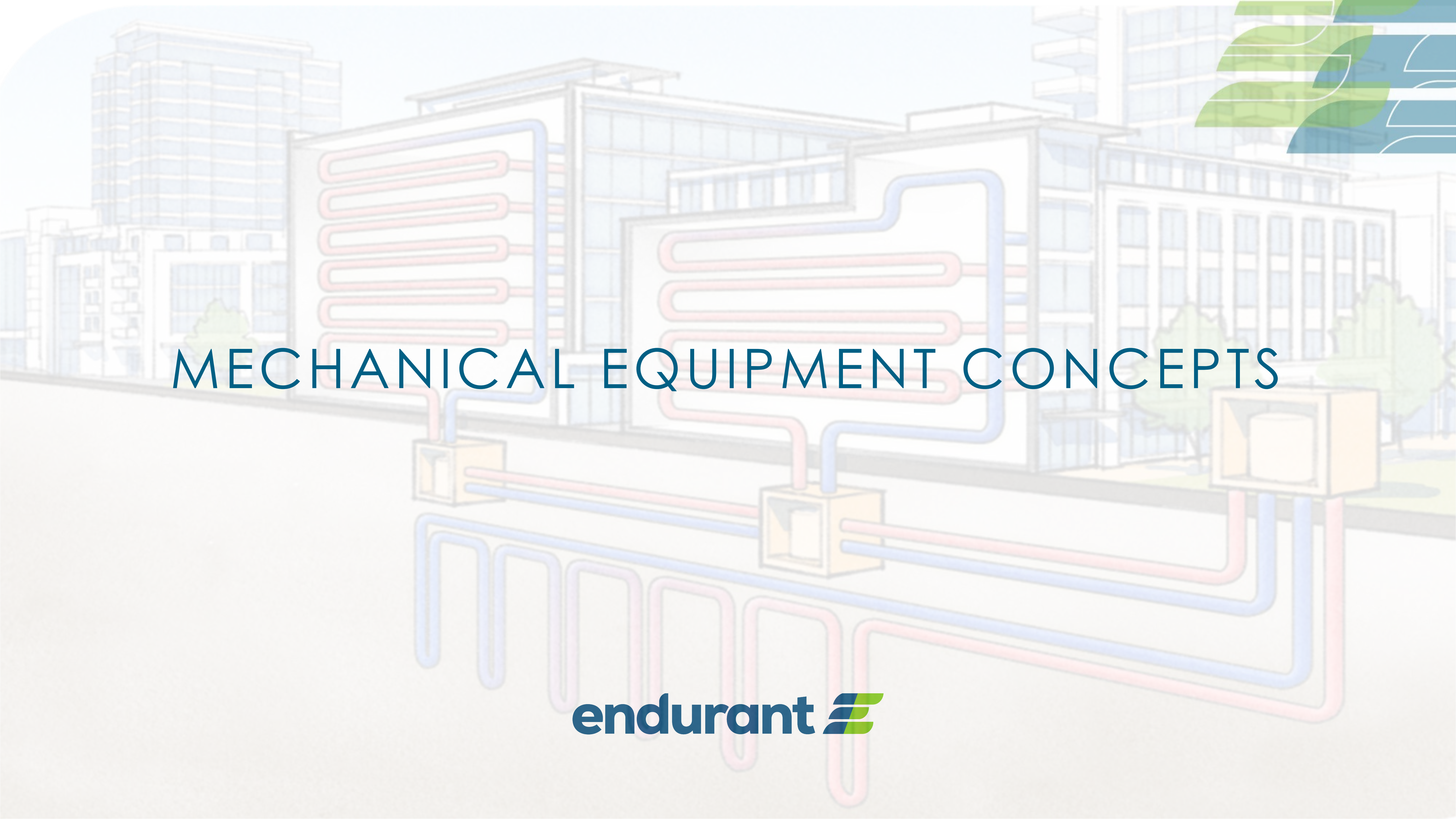
Pros:

- Economies of scale on plant equipment
- More efficient dispatch of plant assets
- Reduced maintenance (fewer compressors to service)
- Greatest opportunity for simultaneous load

Cons:

- Requires greater existing space allocation or new building
- 4-pipe distribution:
  - Increased investment cost for site trenching and lateral piping
  - Increased investment cost at building level
- Increased opportunity for thermal losses in distribution





MECHANICAL EQUIPMENT CONCEPTS

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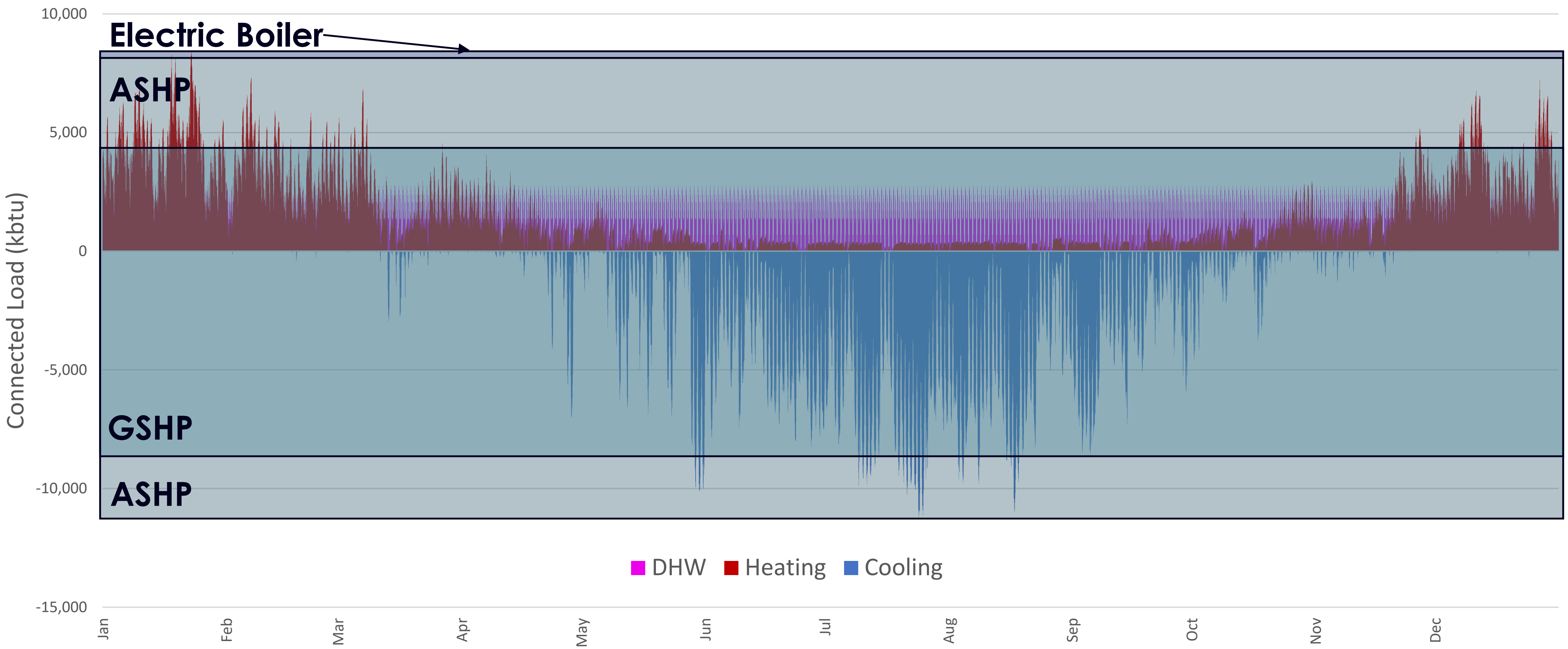
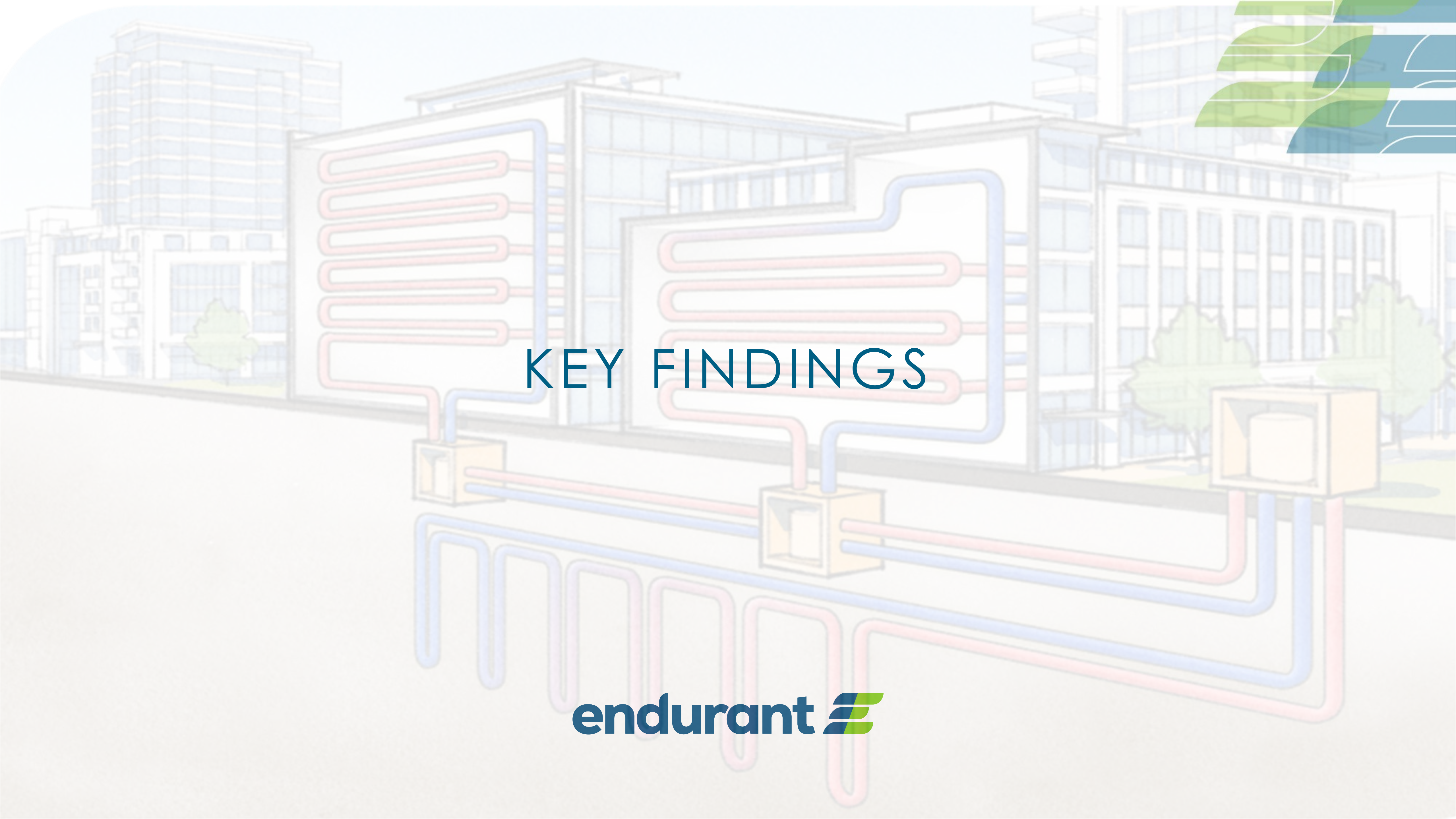
Equipment dispatch strategy - energy pile solution



Annual Load Served by Each Asset (Building A, B, & C)							
	Simultaneous		Geothermal		ASHP		Electric Boiler
Thermal Demand	CLG	HTG	CLG	HTG	CLG	HTG	HTG
% Annual Load Served	31%	21%	47%	42%	23%	37%	0.2%

KEY FINDINGS



Endurant Energy Status of PON 4614 works

Key findings reported when using ground sourced heat pump solutions

Business as Usual (Gas fired Boilers & variable refrigerant flow(VRF) cooling)

- Electrical usage increases moderately when displacing Gas in new build
- 31% CO_2 Savings
- 44% OPEX Savings based on 30year lifecycle cost

Business as Usual (All electric building)

- Electrical usage dropped between 44 and 50% when using GSHP compared to all VRF(ASHP)
- 47-53% CO_2 Savings
- 30 - 53% OPEX Savings based on 30year lifecycle cost

Business as Usual (retrofit and steam)

- Electrical usage increased substantially on renovation of existing buildings in one case by 1430%
- Up to 70% CO_2 Savings
- 43% OPEX Savings based on 30year lifecycle cost

Endurant Energy Status of PON 4614 works

Key findings – Feedback from Developers

Despite studies demonstrating significant advantages of ground source heat pump solutions

- Clean heat Incentives play a key role in making solutions economically viable
- VRF solutions and package terminal heat pumps remain a preferred go to solution
- Early adopter concerns about a solution not used or installed before by Developers team
- Regulatory hurdles seem insurmountable in some cases
    - District loops crossing over highways and sidewalks
    - Heat from sewage
    - Lake/ river loop solutions

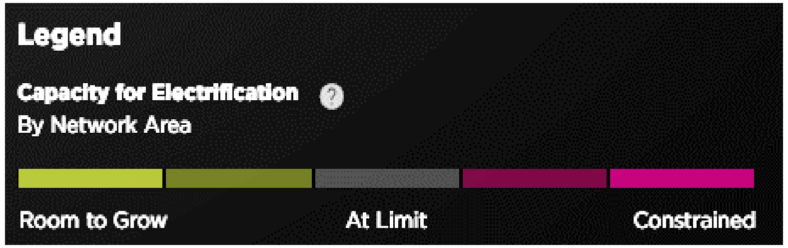
Geothermal and VRF Comparison

Metric	Geo	VRF	
Capital Cost	🟡	🟢	*Geothermal capital costs are higher, however additional incentive availability supports rapid project paybacks*
Futureproof	🟢	🟠	*Hydronic distribution is the most futureproof distribution system and high efficiencies hedge against future carbon and utility demand costs and possible phase down of VRF refrigerants over next decade*
Efficiency	🟢	🟡	*A hybrid geothermal system achieves a 45% reduction in energy consumption compared to VRF with domestic hot water (DHW) boiler*
Carbon Savings	🟢	🟡	*A hybrid geothermal system achieves a 45% reduction in carbon emissions compared to VRF with DHW boiler*
Toxicity	🟢	🔴	*VRF circulates toxic refrigerants through residential spaces, whereas hydronic systems circulate water through residential spaces*
Innovation	🟢	🟡	*Energy piles are an incredibly cost-effective innovation that yields a significant benefit to project operations and the community*
Operating Cost	🟢	🟡	*The efficiencies of a geothermal system support utility cost savings and maintenance savings*
Metering	🟡	🟢	*VRF systems have better packaged metering products, however hydronic systems can also be fitted to meter consumption*

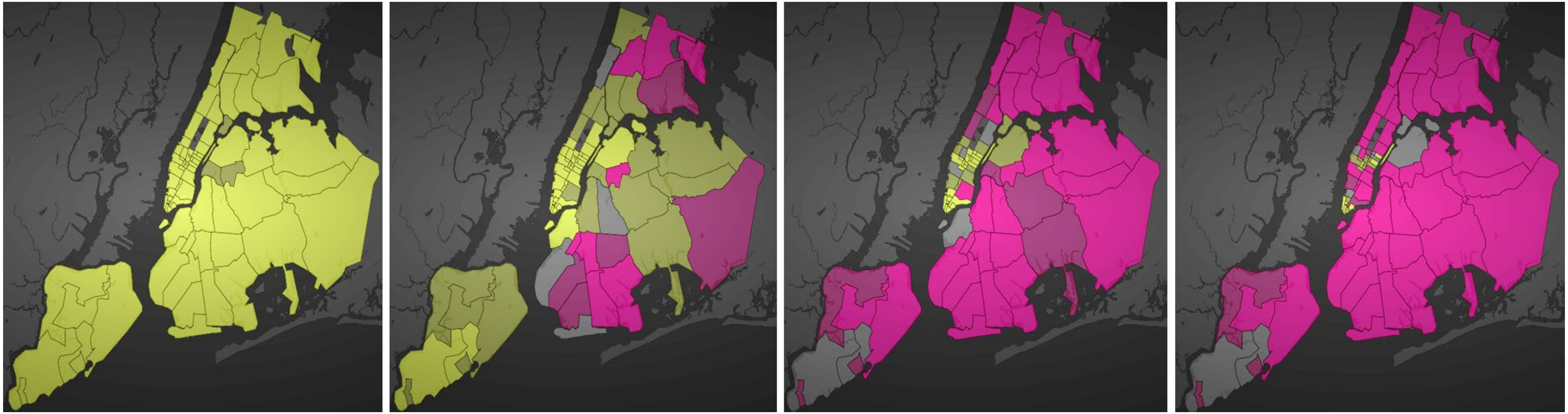
Note: The comparison assumes a geothermal system with hydronic distribution

Grid Demands as NYC Electrifies

Concern if we do not see greater uptake of geothermal solutions and sticking to the usual!



- VRF solutions and package terminal heat pumps remain a preferred go to solution
- Our study showed electrical usage dropped between 44 and 50% when using GSHP compared to all VRF(ASHP)



0% **30%** **60%** **90%**

Source: Urban Green Council – Grid Ready Mapping Tool (https://maps.urbangreencouncil.org/?_ga=2.11401779.649653248.1661779473-493388574.1661779473)

THANK YOU

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