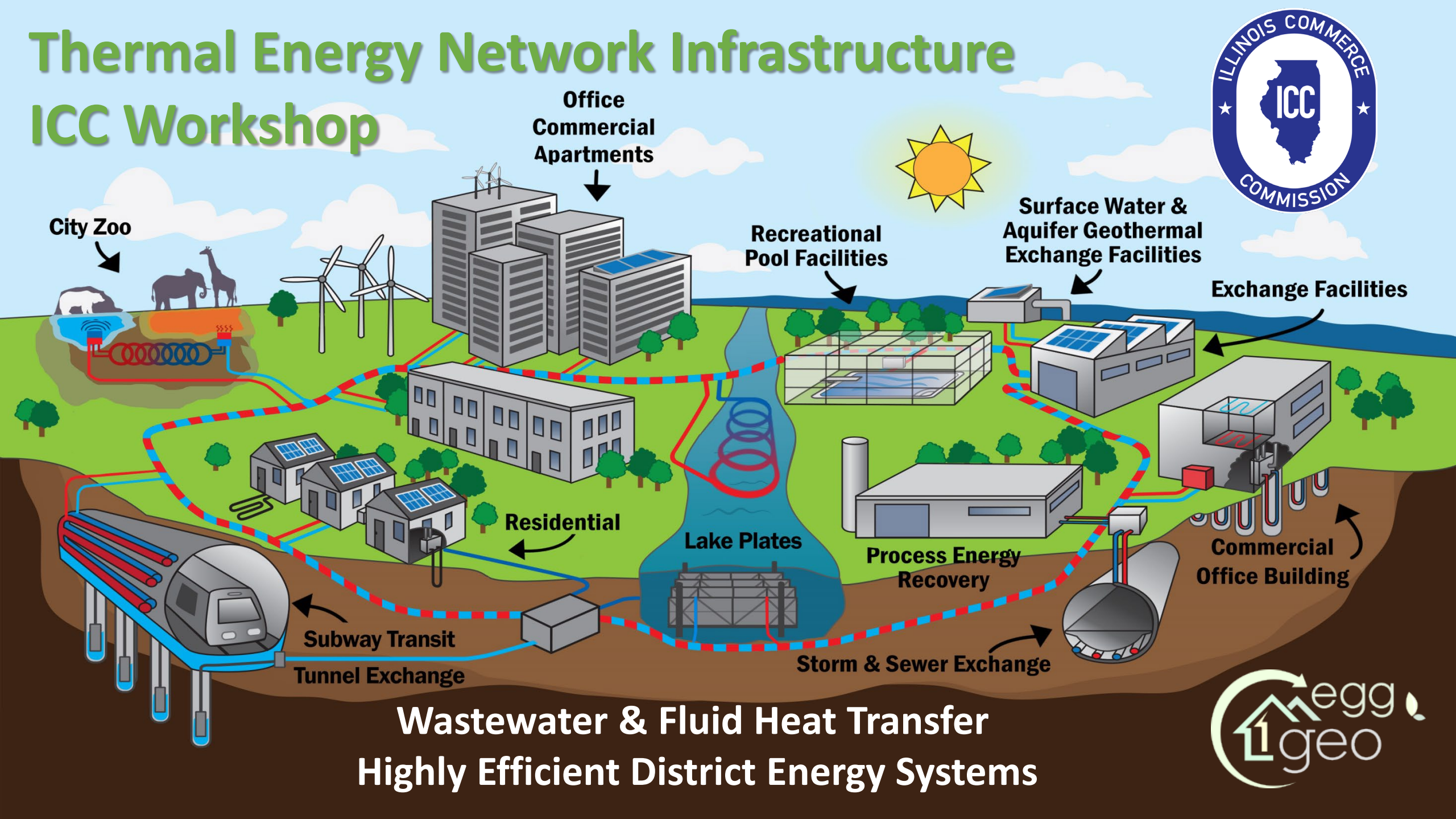
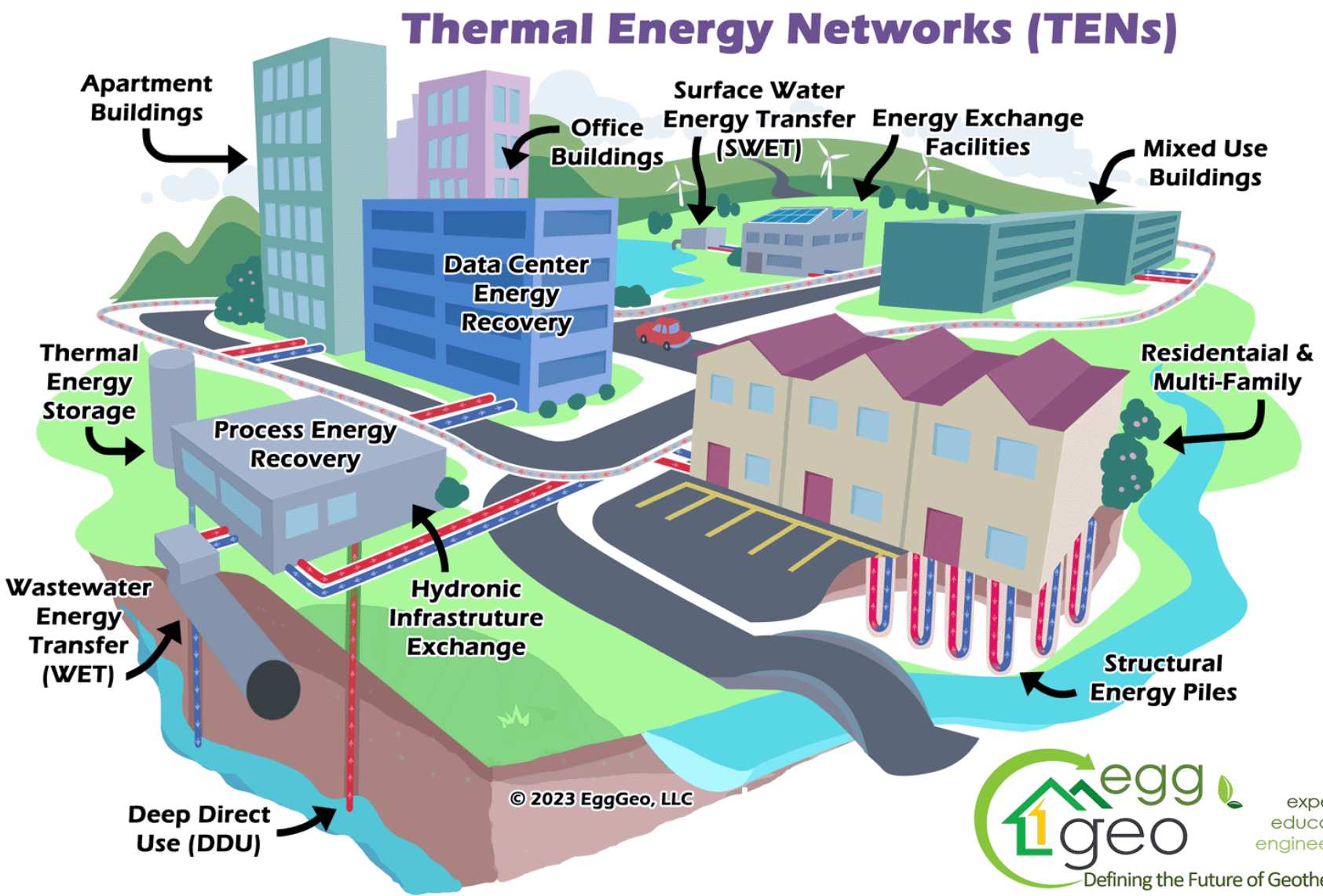
Thermal Energy Network Infrastructure
ICC Workshop



Wastewater & Fluid Heat Transfer
Highly Efficient District Energy Systems

Engineering Master-Planned Thermal Energy Networks (TENs) to Reduce GHG Emissions and Create Jobs



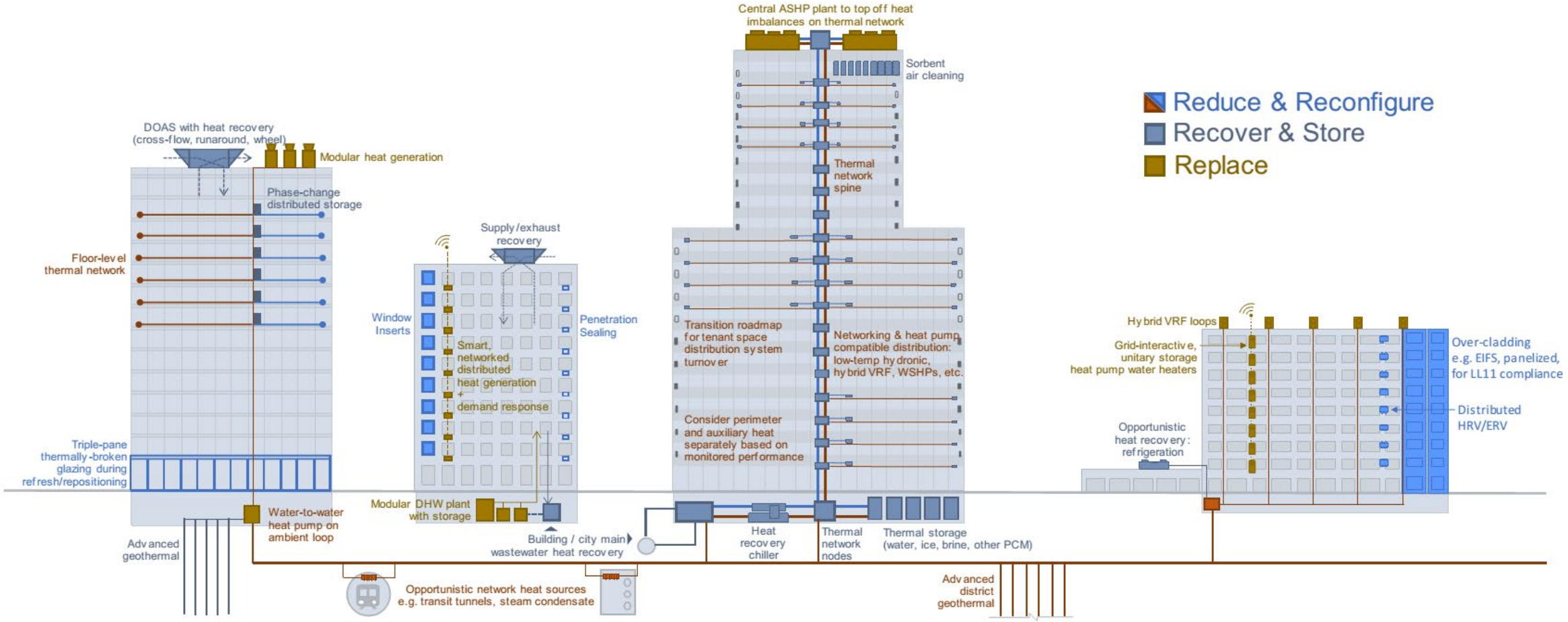
egg geo
expertise
education
engineering
Defining the Future of Geothermal

District Thermal Energy Networks (TENs)

…making thermal network heat pumps a reality for all

- No more outdoor equipment to replace
- More hurricane and storm resilient (no HVAC equipment outside)
- HVAC system longevity (a benefit of having equipment inside)
- No combustion boilers, cooling towers or furnaces (Decarbonization)
- Noticeably superior comfort in heating and cooling modes
- Remarkable system efficiency at standard equipment pricing
- Thermal Energy Network Wells /Piping are permanent infrastructure

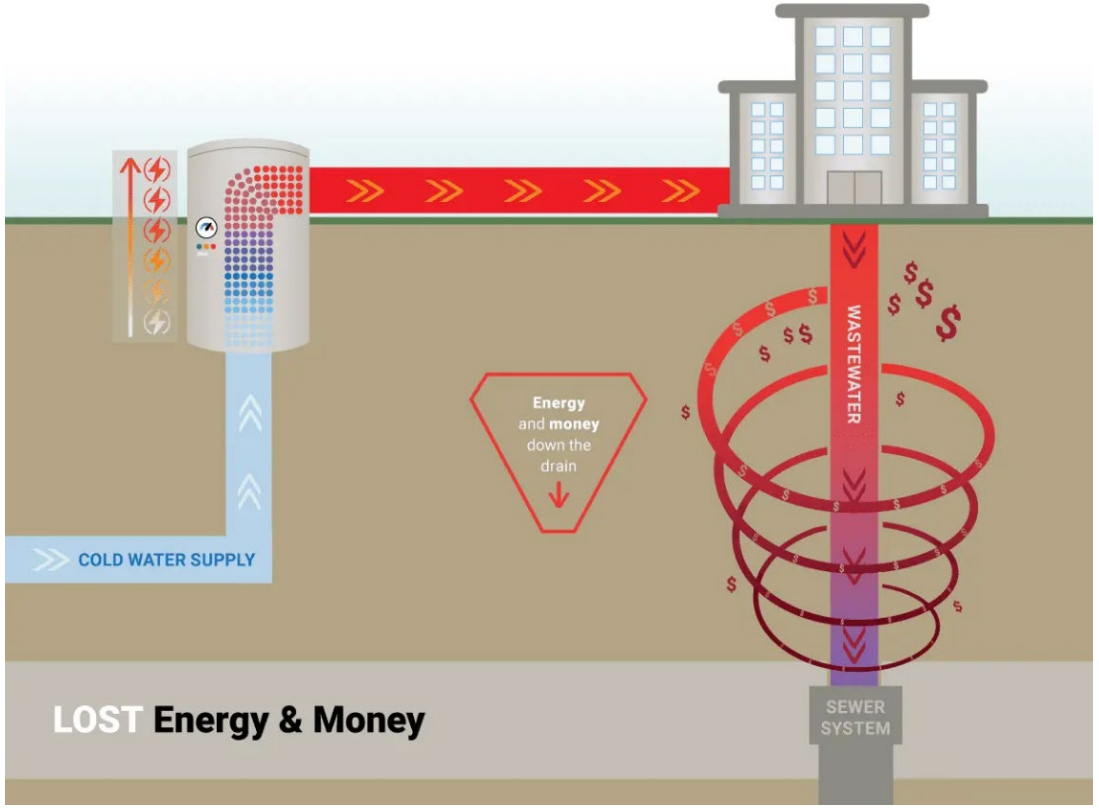
Thermal Energy Networks - Empire State; Developed for NYSERDA

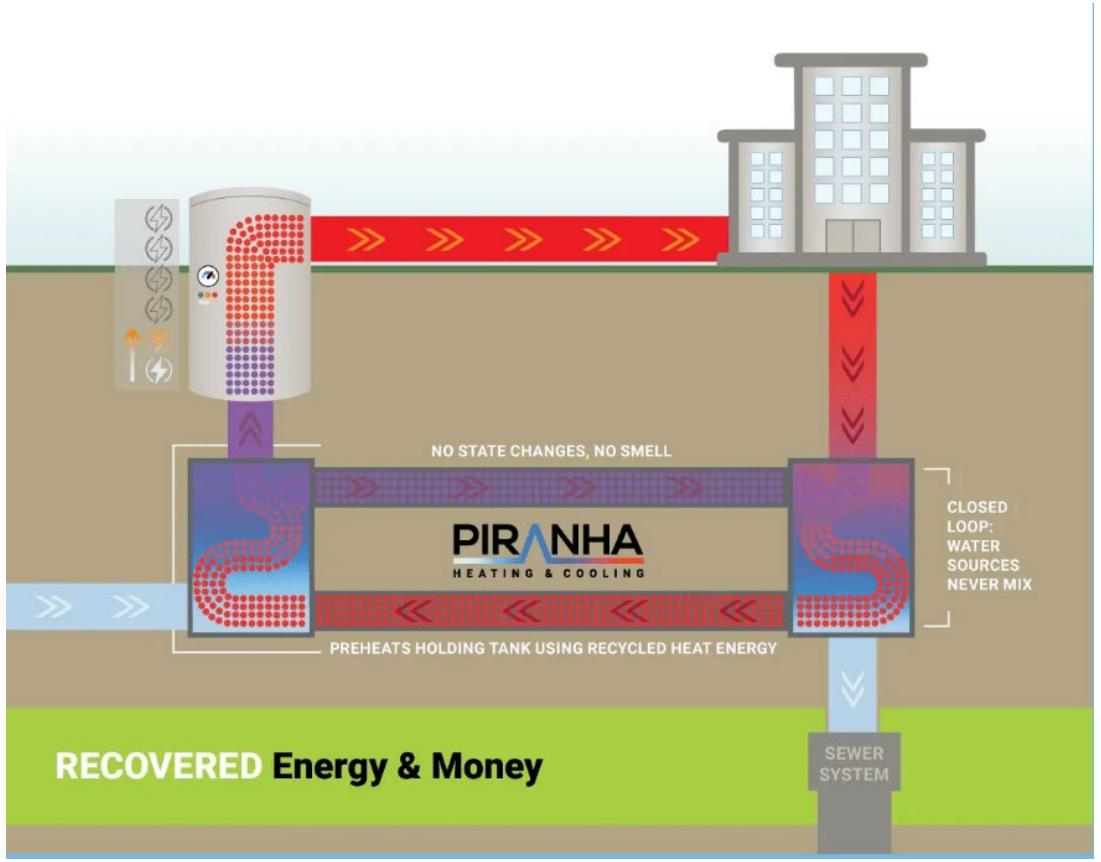


Energy Exhausted from Commercial Buildings is piped to Residential Structures

Wastewater Energy Recover (WET); the first solution.

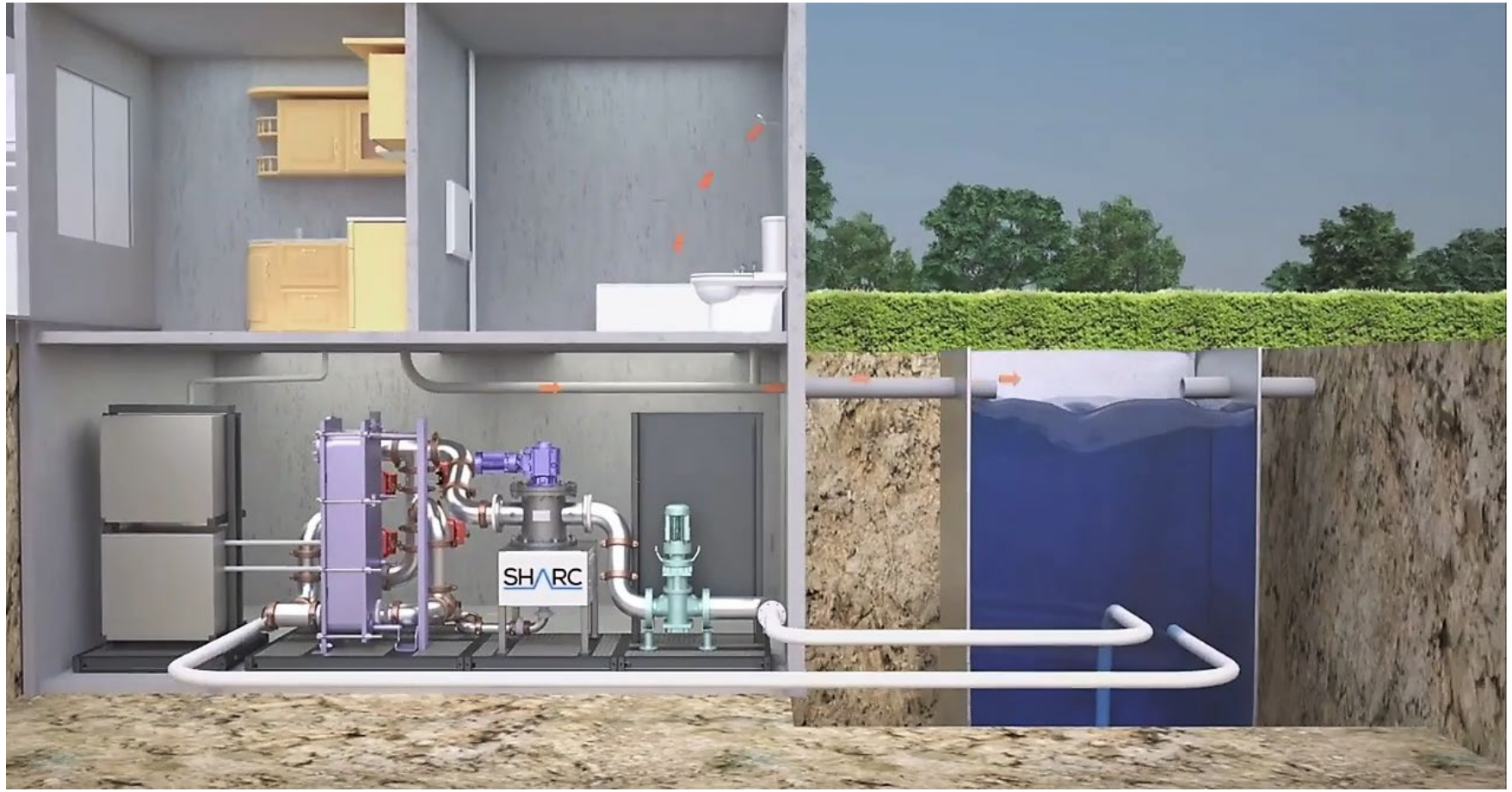
https://youtu.be/Ru0QXrM3l5o





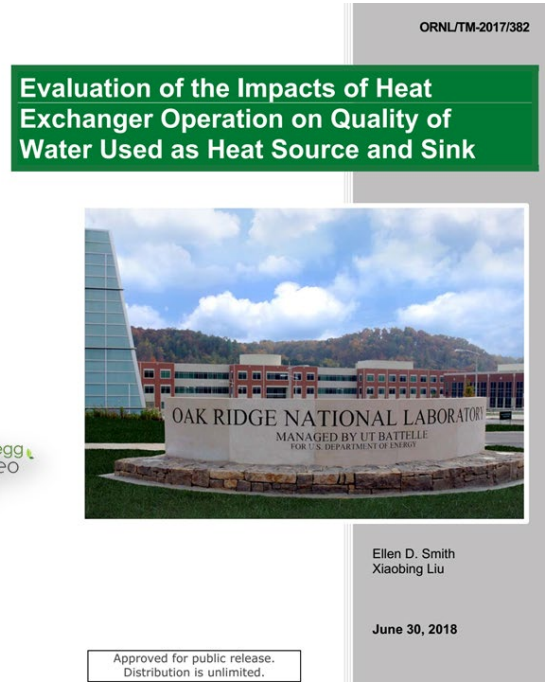
https://www.sharcenergy.com/how-it-works/

Wastewater Energy Recovery - Basics



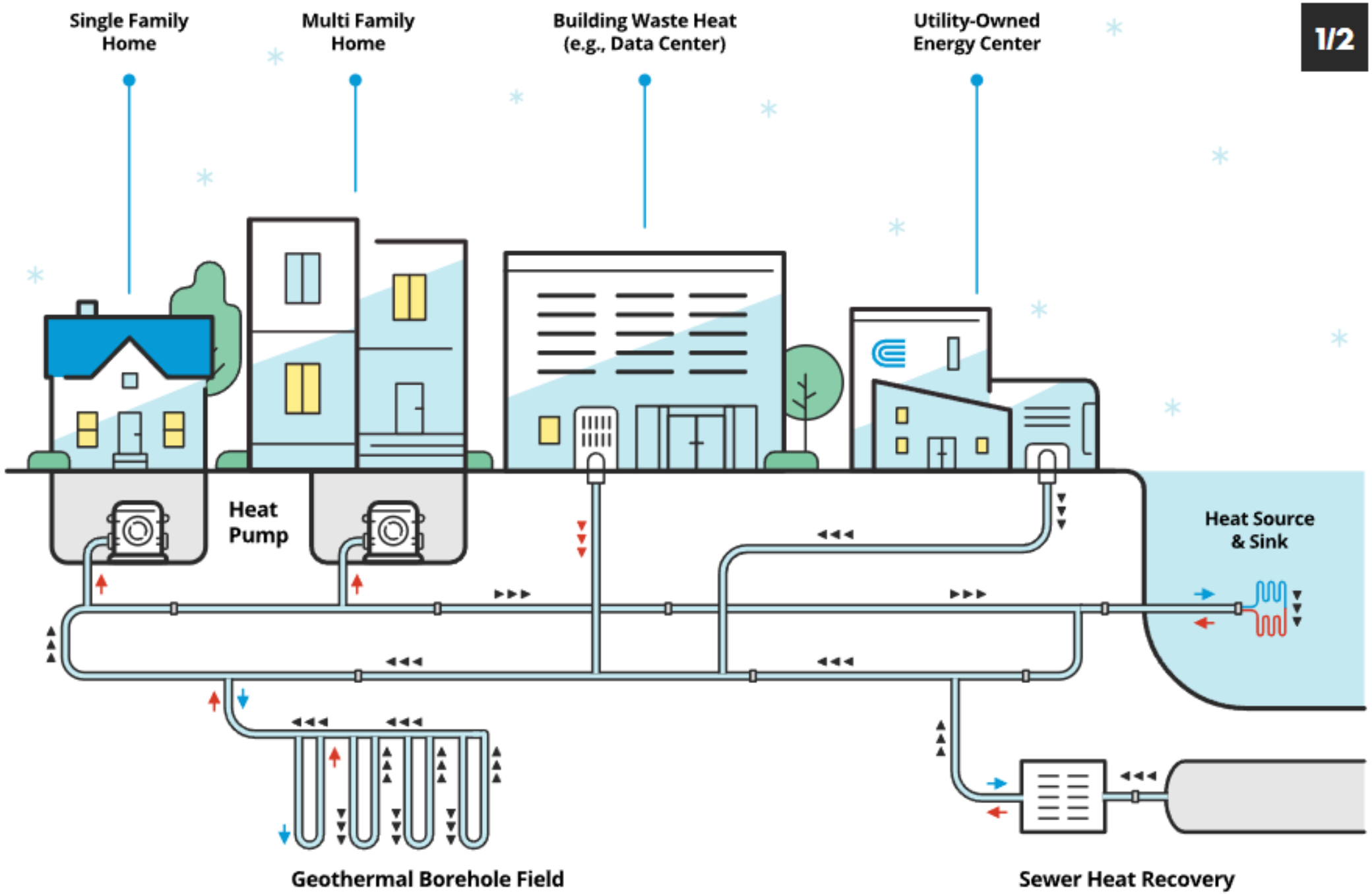
Infrastructure Coupled Geothermal Energy Exchange (Toronto & Vancouver Examples)

Drinking Water Energy Exchange >Toronto<

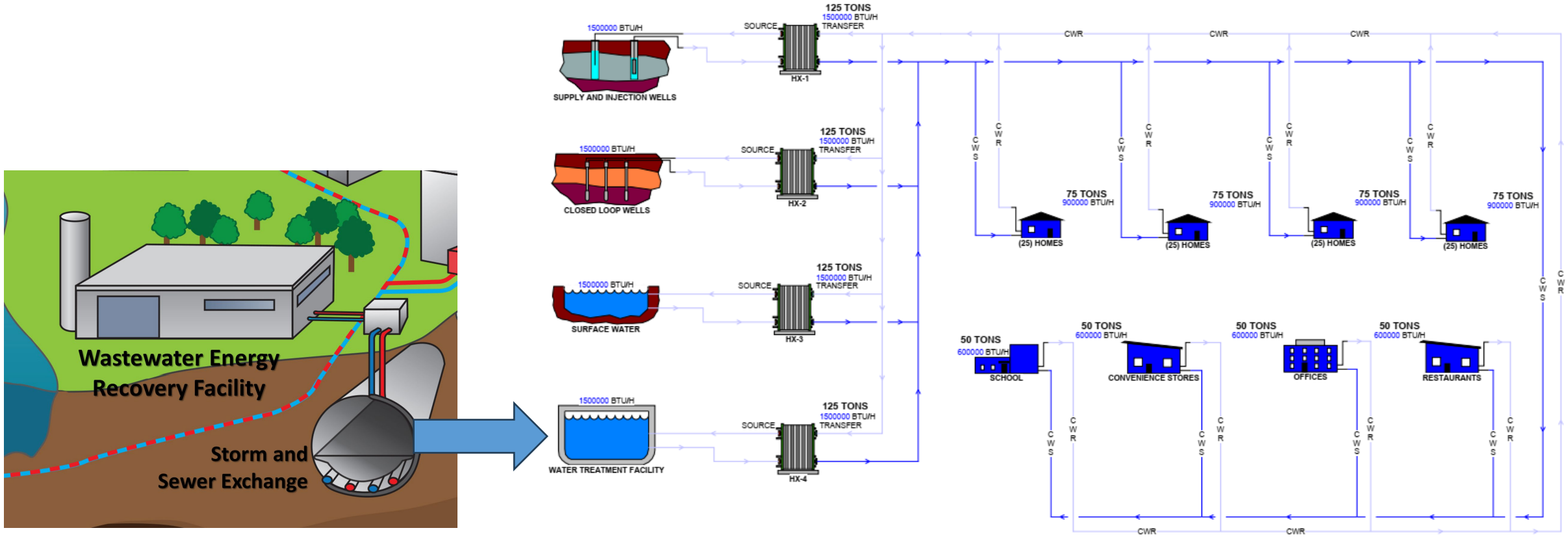


ORNL Report on Drinking Water Exchange

Wastewater Energy Exchange >Vancouver<

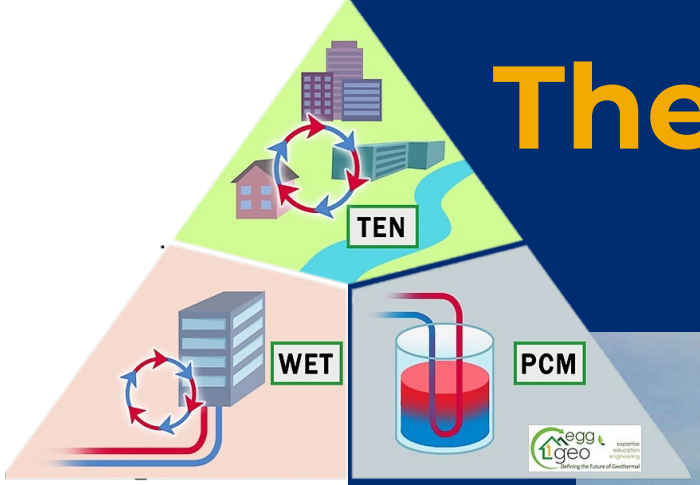

Single Family Home
Multi Family Home
Building Waste Heat (e.g., Data Center)
Utility-Owned Energy Center
1/2
Heat Pump
Heat Source & Sink
Geothermal Borehole Field
Sewer Heat Recovery

Wastewater Energy Recovery Facility



The Amalgamated Towers

3975 and 3965 Sedgwick Avenue



- *Bronx, NY*
- *425,000 SF*
- *2 affordable multifamily building built in 1968 and 1971*
- *20 stories*
- *316 apartments*

AMALGAMATED HOUSING COOPERATIVE

Project Team:

EN-POWER GROUP

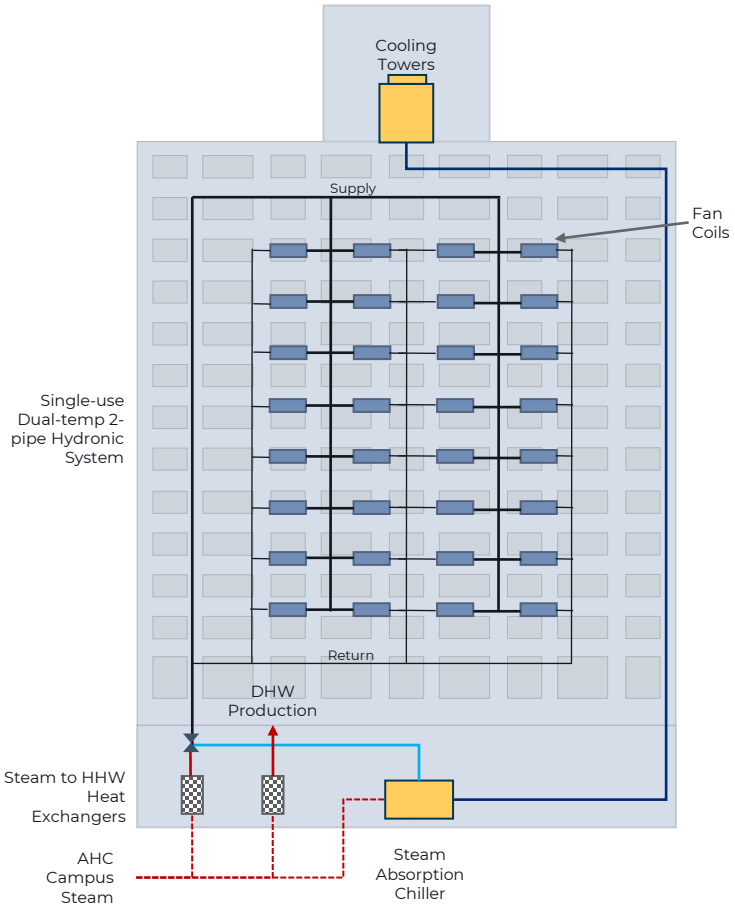
egg geo

The Towers Decarbonization Plan

Heating
Cooling
Ventilation

Key Takeaways: Affordable housing recapitalization, Tenant total cost reduction, Failing distribution infrastructures, Eliminate fossil fuel usage, Improve comfort, Resilient systems

BEFORE



2024:

Retrofit Dual-Temp Hydronic System
Existing distribution system and terminal units beyond EUL. Install new dual-use dual-temp 2-pipe hydronic piping, designed for simultaneous heating and cooling, with new FCUs in apartments.

Wastewater Energy Transfer (WET) System
Install sewage tank and use Sharc Energy heat pumps to produce heating, cooling and DHW

Ventilation System Maintenance
Cleaning and balancing of existing ventilation system

2026:

Envelope Improvements
Insulate roofs, replace windows and air seal walls.

Geothermal System
Drill geothermal boreholes on property land and install ground source heat pumps to produce heating, cooling and DHW

Submetering and Controls Upgrades

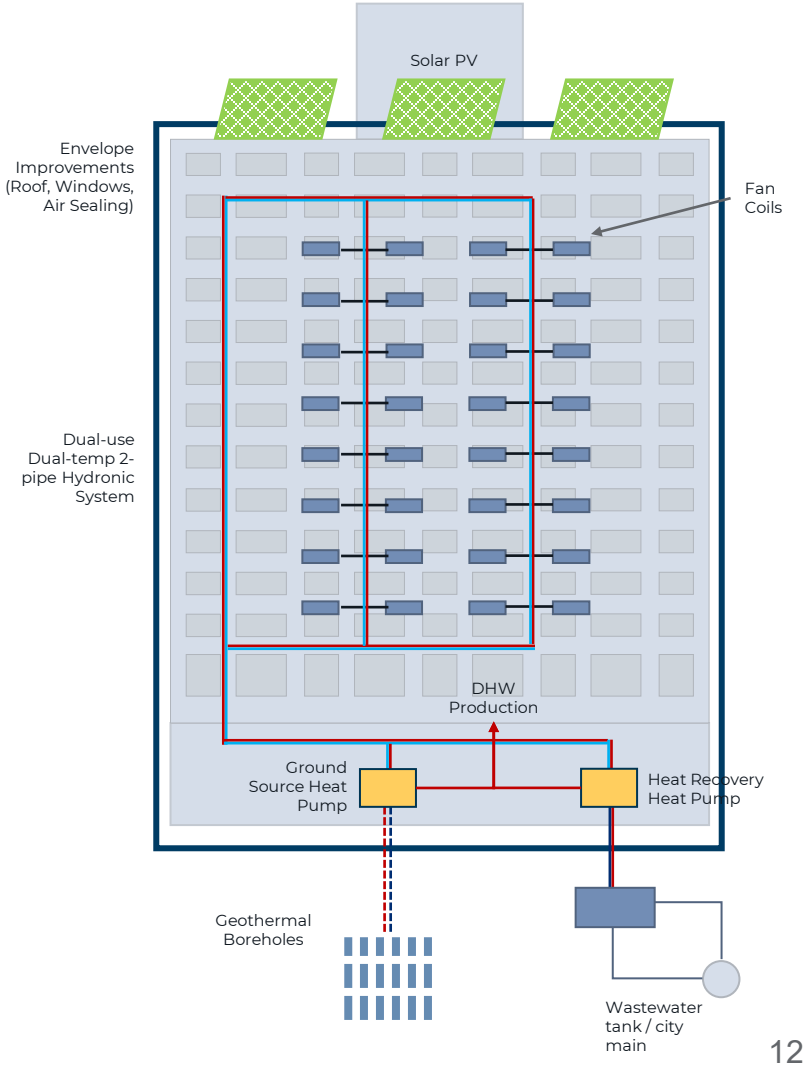
2028:

Solar PV
Take advantage of rooftop space to install solar PV system for clean electricity generation

2030+:

Laundry and cooking appliance electrification

AFTER



Making clean energy from dirty water to eliminate carbon emissions.

AMALGAMATED HOUSING COOPERATIVE

Project Team:

EN-POWER GROUP

egg geo

Disclaimer: The project plan outlined in this presentation is in its early design stage and can be subject to potential changes in the future.

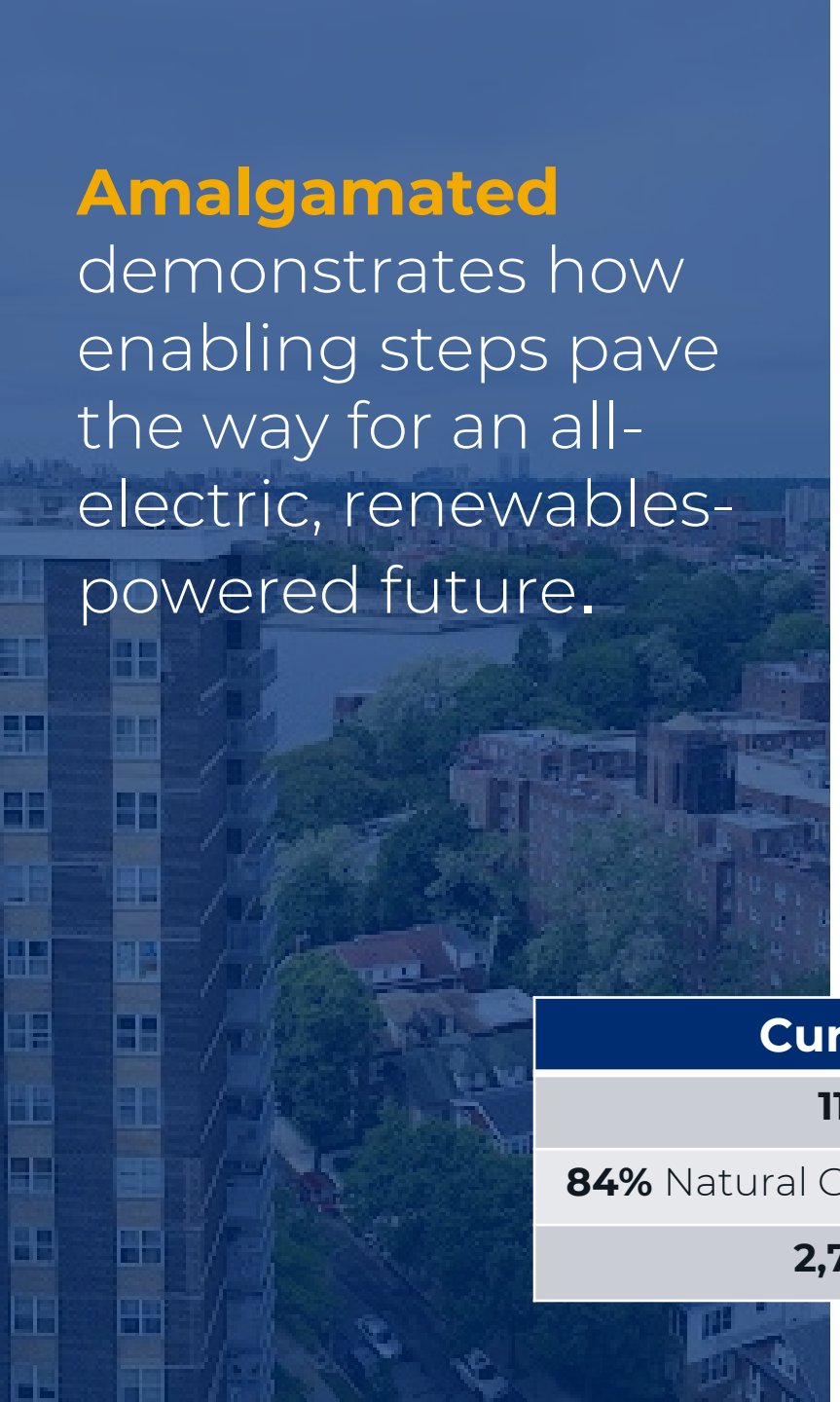
Amalgamated Housing Corporation (AHC) is the oldest limited equity co-operative in the United States. The Towers are two of 13-buildings that together comprise this multifamily campus located in the Bronx. Many of systems at the property, including the piping distribution system, are beyond useful life and in extremely poor condition, causing leaks and requiring constant repairs and maintenance. The campus uses a central gas-powered boiler plant to produce steam for heating, cooling and domestic hot water.

As part of its recapitalization cycle, the property is embarking on a decarbonization journey which will include a comprehensive retrofit of the heating, cooling and domestic hot water systems, a façade upgrade, and on-site renewable generation in the form of geothermal and solar PV.

This project will increase thermal comfort and secure utility affordability for its low-and-moderate income residents, as well as enhance the energy efficiency and climate resilience of the property.

From the full carbon neutrality roadmap, the Empire Building Challenge is funding the first two enabling measures: hydronic system retrofit and wastewater heat recovery.

NYSERDA Investment	EBC Funded Measures Private Investment	Full Roadmap Private Investment
$3 Million	**$16.6 Million**	**$27 Million**



Amalgamated demonstrates how enabling steps pave the way for an all-electric, renewables-powered future.

Enabling step: New hydronic piping

Replace the dual temperature hydronic system with new piping supplying both heating hot water and chilled water simultaneously to provide heating or cooling year-round improving tenant comfort. The measure includes new fan coil units with more efficient motors and designed for low temperature heating hot water to reduce the load on the buildings and facilitate heat pump technology integration.

Integrate different heat sources:

Wastewater heat recovery: Recapture heat from wastewater lines (sinks, showers, toilets) using a wastewater energy transfer (WET) system.

Geothermal System: Drill boreholes on property land and install ground source heat pumps (GSHP) to meet the remaining energy loads of the buildings.

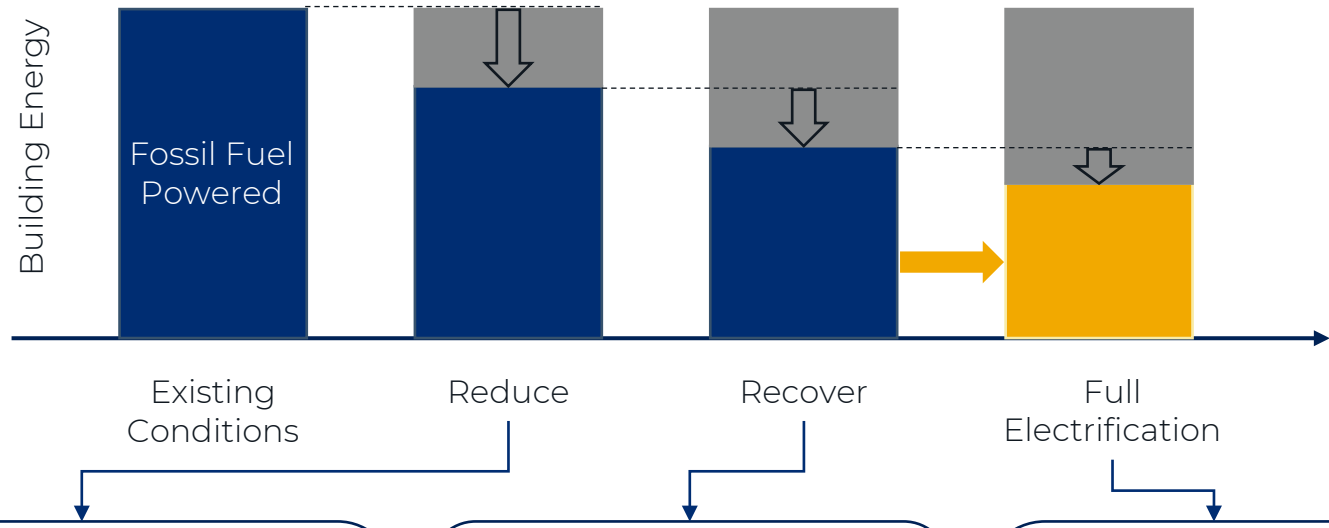
This system will use the wastewater and boreholes as heat sinks in cooling mode.

Current Baseline	Expected by 2035	
111.6 kBtu/SF/yr	**32.5** kBtu/SF/yr	↓ 71%
84% Natural Gas + **14%** Electricity + **2%** Oil	**100%** Electricity	
2,771 Ton CO2e/yr	**202** Ton CO2e/yr	↓ 93%

Resource Efficient Decarbonization (RED):

An incremental methodology and integrated design process combined with strategic capital planning creates a path towards carbon neutral buildings.

A holistic approach and phasing can make decarbonization technically and economically feasible.



Reduce Energy Load

- **New hydronic distribution:** Replace existing infrastructure that is beyond EUL and install dual-temperature 2-pipe hydronic system (in-series configuration allowing the benefits of 4-pipe system), with new FCUs in apartments. Designed with lower heating supply temperature
- **Envelope Improvements**: roof insulation, window replacement and air sealing walls
- **Ventilation Maintenance**: balancing and sealing of ventilation system to reduce exhaust air
- **Controls Upgrades**: Install modern control system to automate and optimize new heat pump systems

Recover Wasted Heat

- **Wastewater Heat Recovery:** Recapture heat from wastewater using WSHPs to produce heating, cooling and DHW. Use wastewater as heat sink in cooling mode to enable removal of old cooling towers.

Full Electrification

- **Ground Source Heat Pumps**: Drill boreholes on property land and install WSHPs to produce heating, cooling and DHW. Use boreholes as heat sink in cooling mode
- **Solar PV:** Install solar PV system on rooftop
- **Electrify Appliances:** install electric dryers and cooking equipment

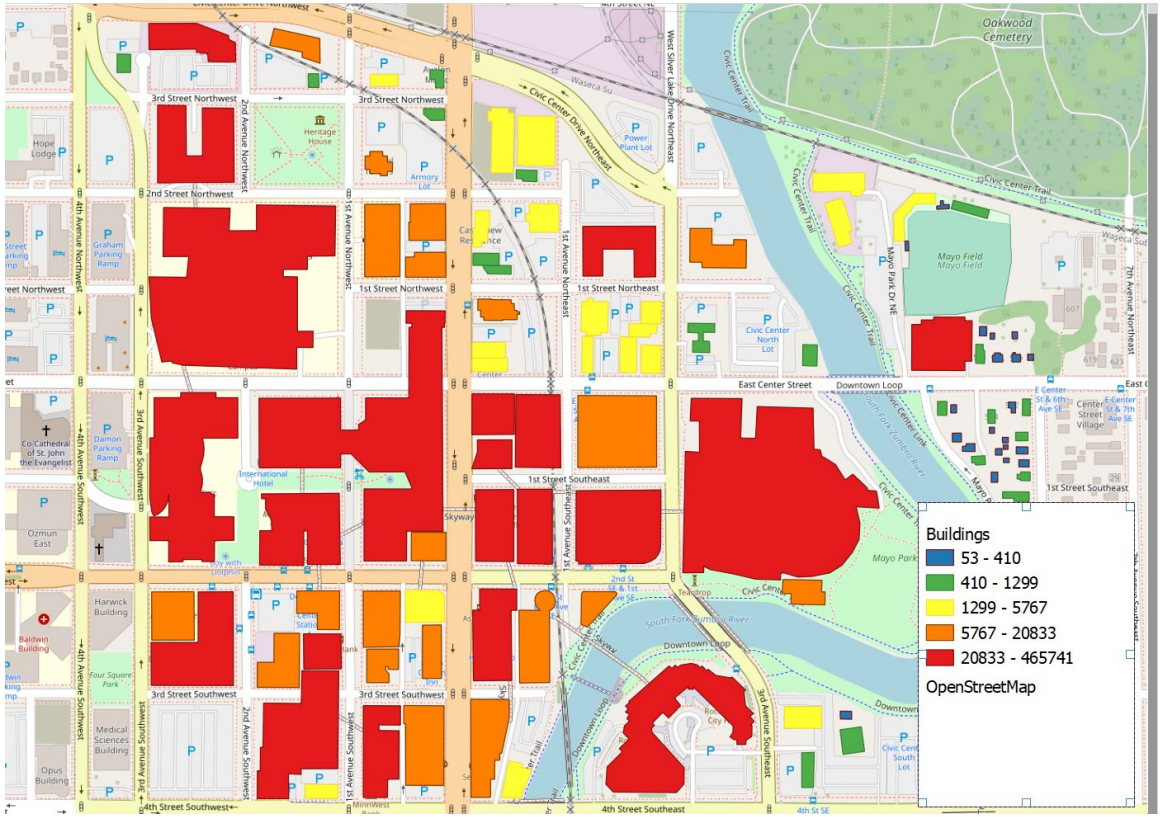
Drinking Water Energy Exchange

By Lilli Ambort and John Farrell

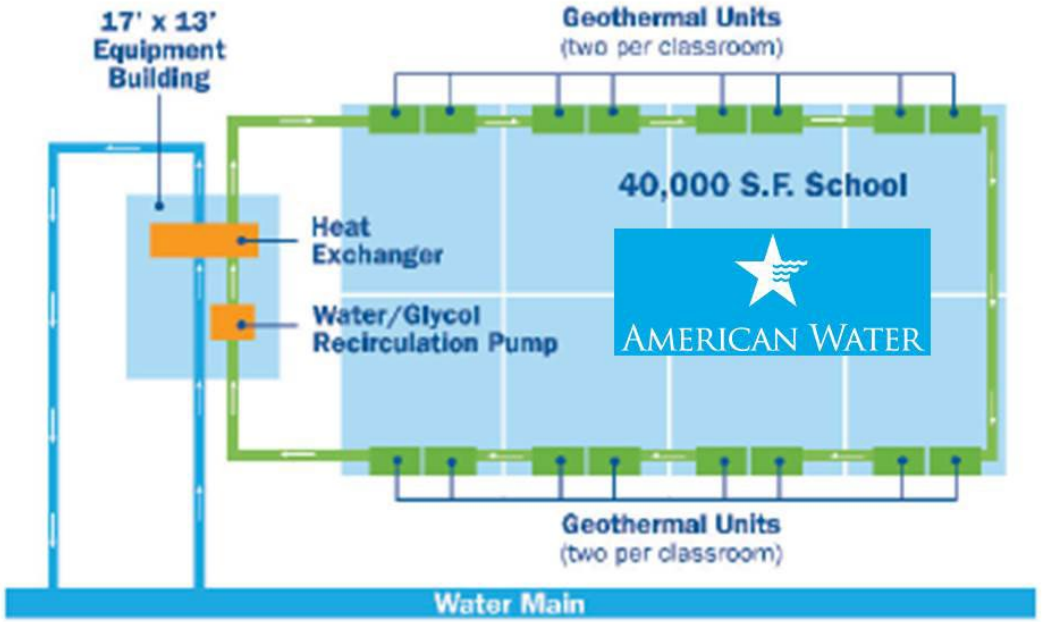
ILSR INSTITUTE FOR Local Self-Reliance

Water Main Geothermal:

Could Existing Water Pipes Replace Dirty Energy Utilities?



Geothermal System: Final Configuration



ORNL/TM-2017/382

Evaluation of the Impacts of Heat Exchanger Operation on Quality of Water Used as Heat Source and Sink

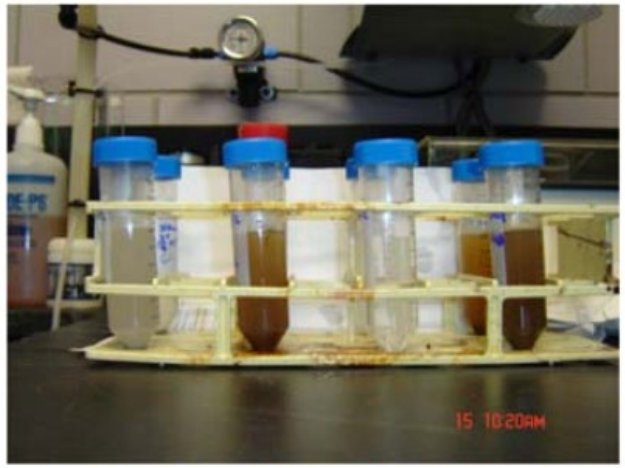
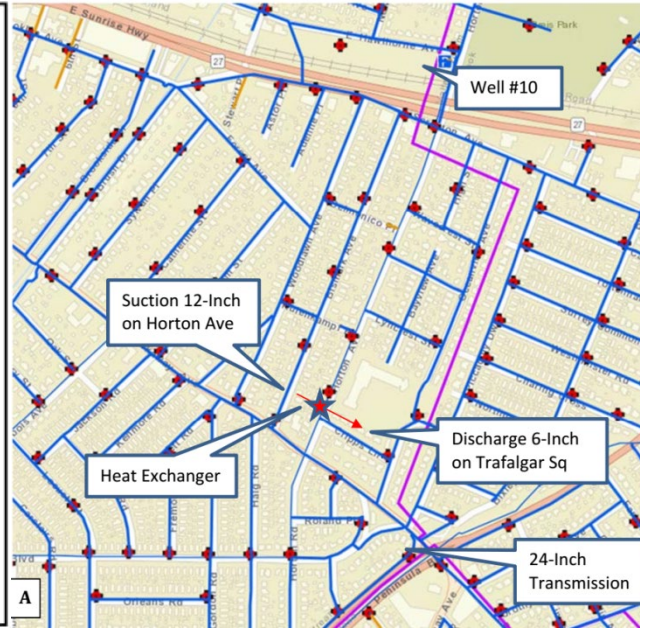
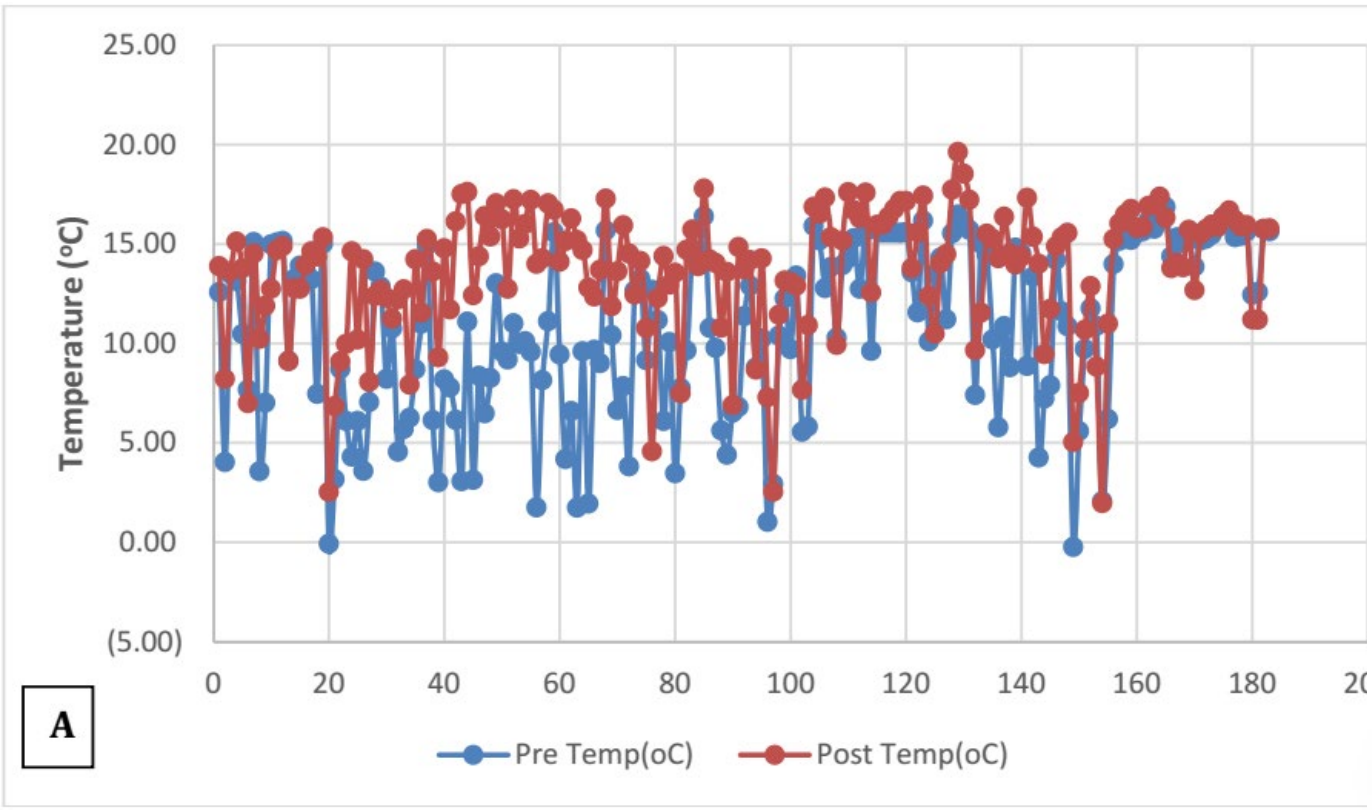


Figure 2. Typical coupon-derived biofilm suspension used for ATP determination.





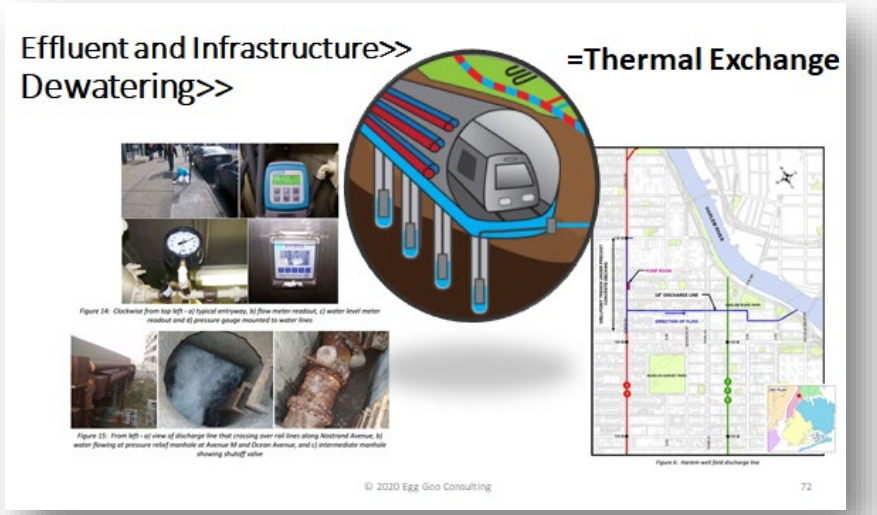
Ellen D. Smith
Xiaobing Liu

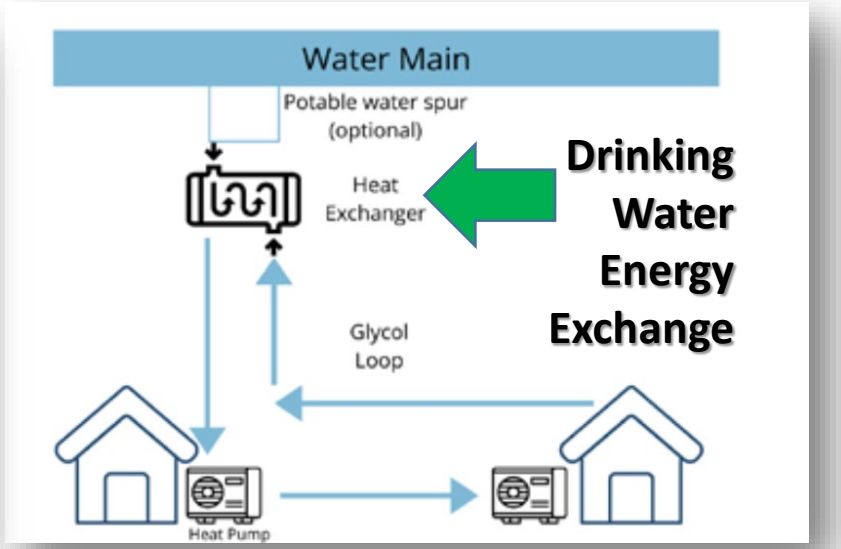
June 30, 2018

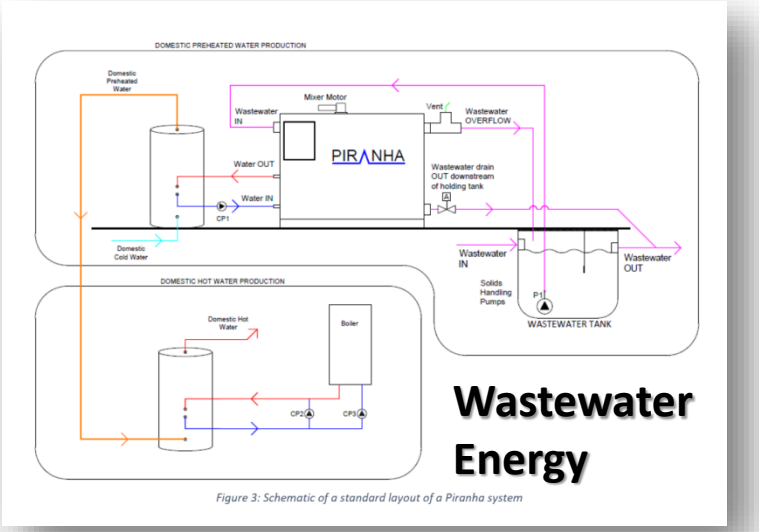
egg geo

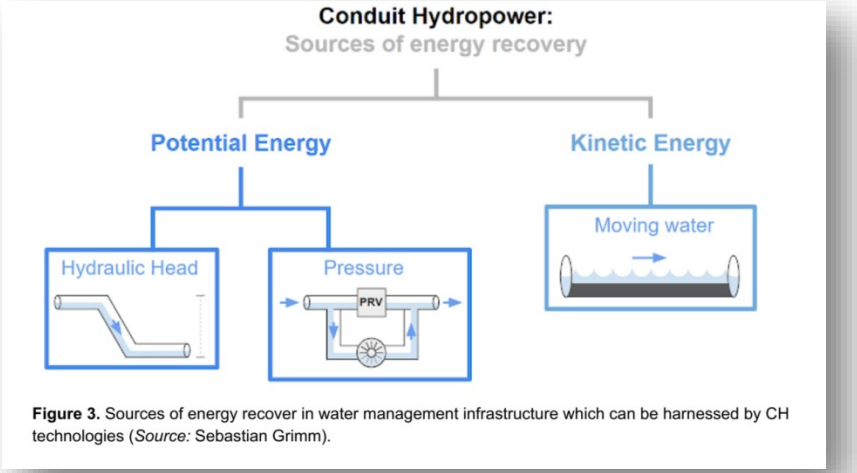
6 Ways to use Existing Water for Energy

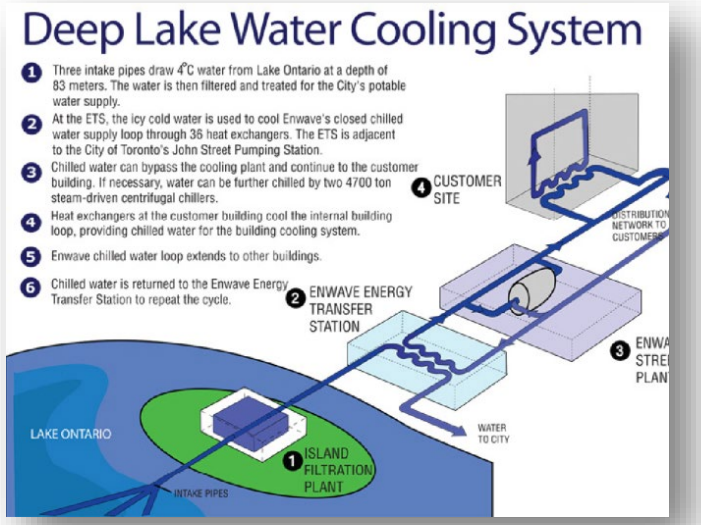
Sharing Knowledge Engineering and Education

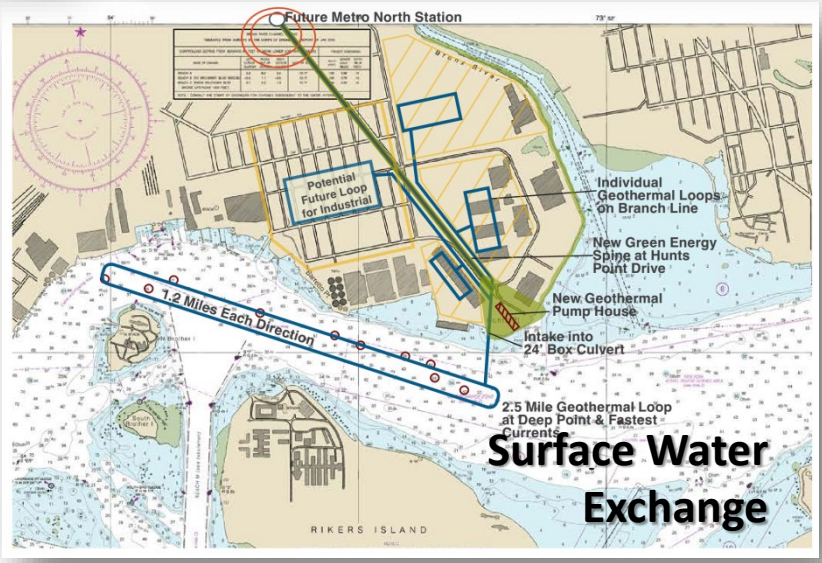






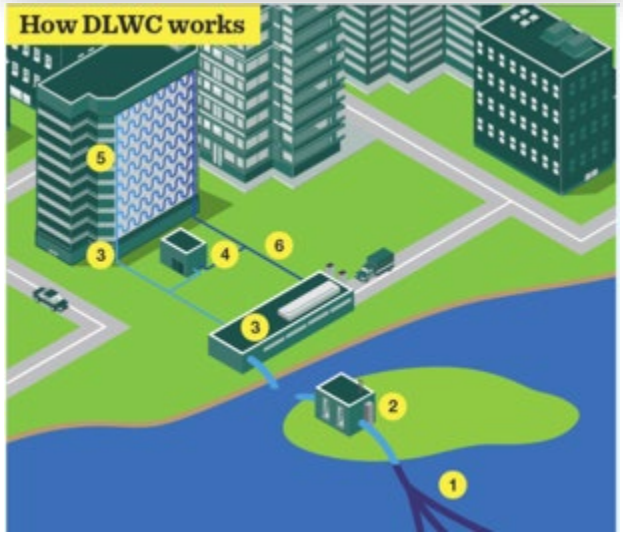




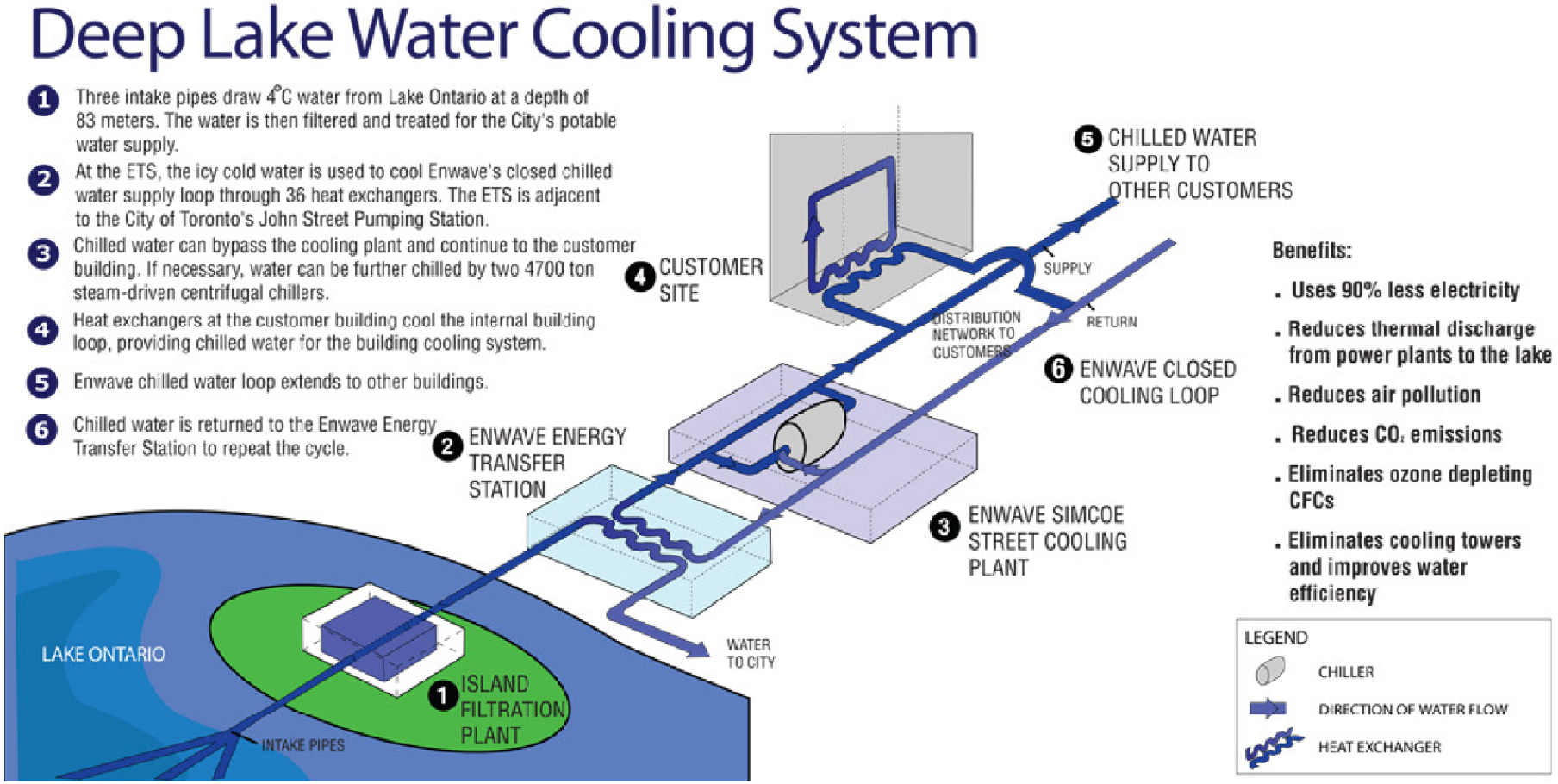


Hydroelectric facilities should also provide Thermal Exchange and take care of the Heating and Cooling needs of nearby communities

Toronto’s Drinking Water Energy System



The Drinking water Exchange Design for the Toronto Deep Lake Cooling System



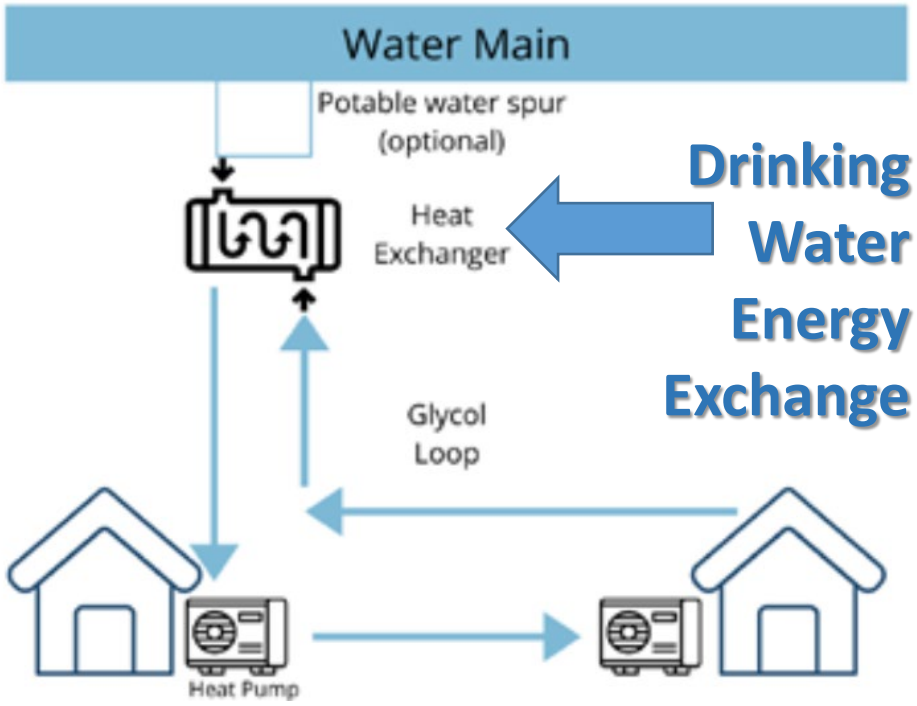
Drinking Water Exchange with Refrigeration Systems

Dedicated Potable Water Cooler

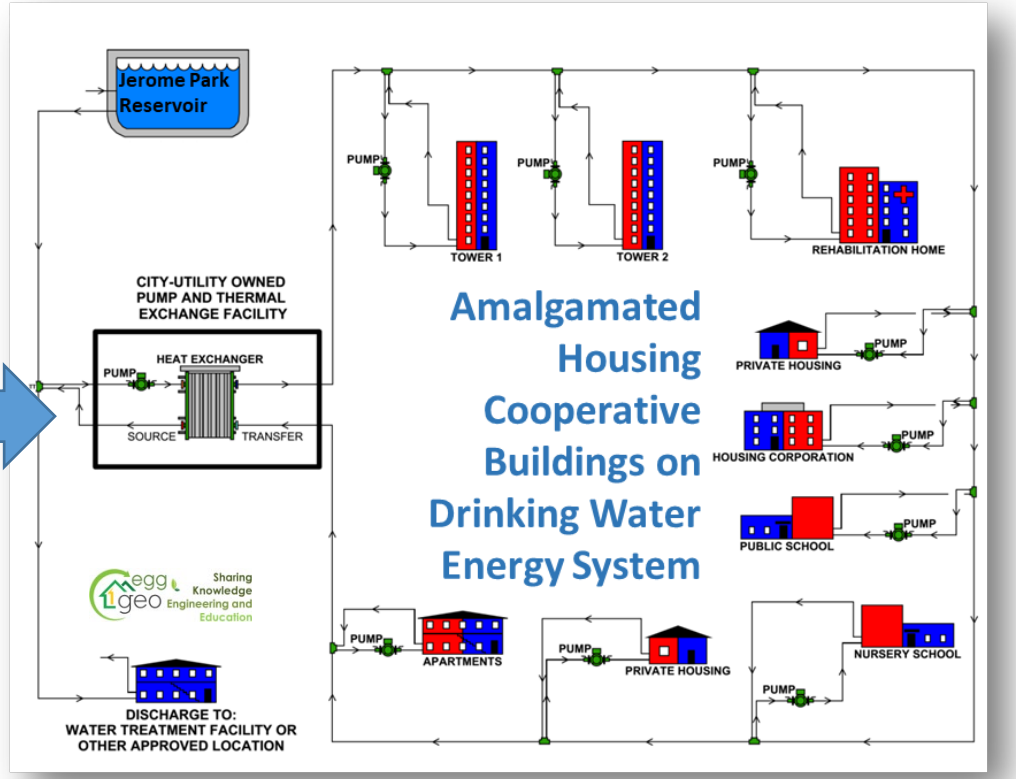
Dedicated and passive Domestic Hot Water Generators

Dedicated Hot Water GHP (water-to-water GHP)

One Drinking Water Energy Exchange Facility can provide comfort heating, cooling, and domestic hot water

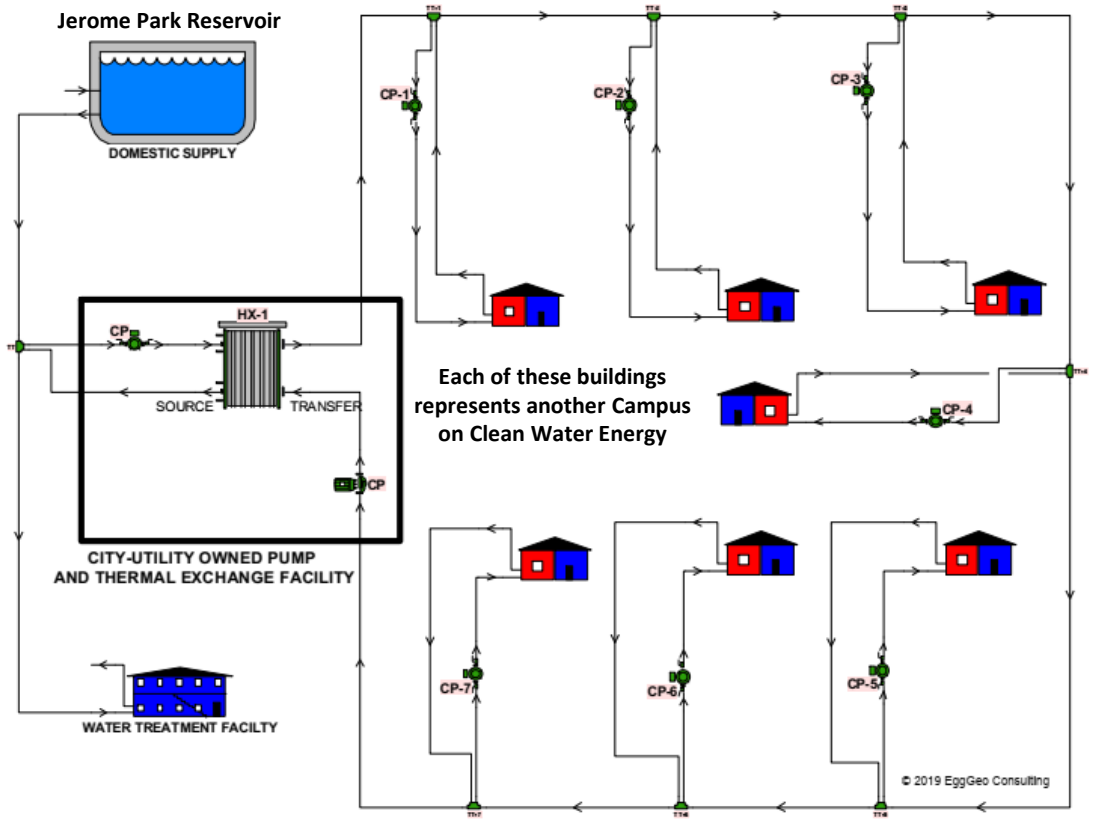


Drinking Water Energy Exchange



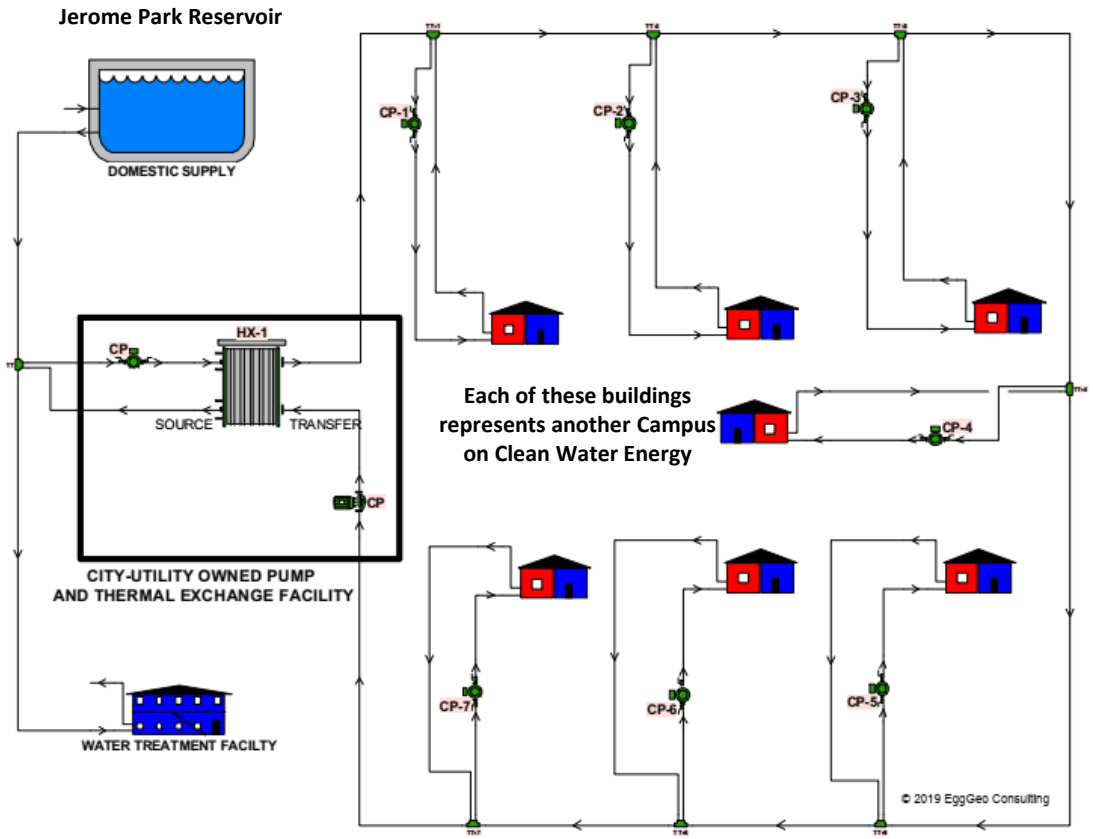
Drinking Water Energy Exchange

Drinking Water Energy Exchange will have significant benefit to the Campuses around Jerome Park Reservoir.



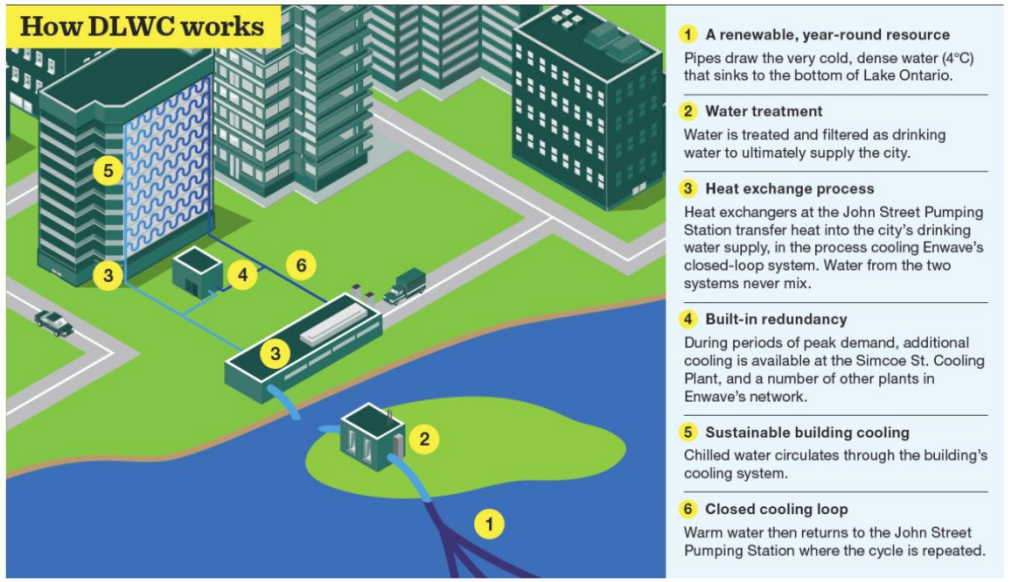
Two Ways Rochester may use Drinking Water for Energy

Drinking Water Thermal Exchange Rochester



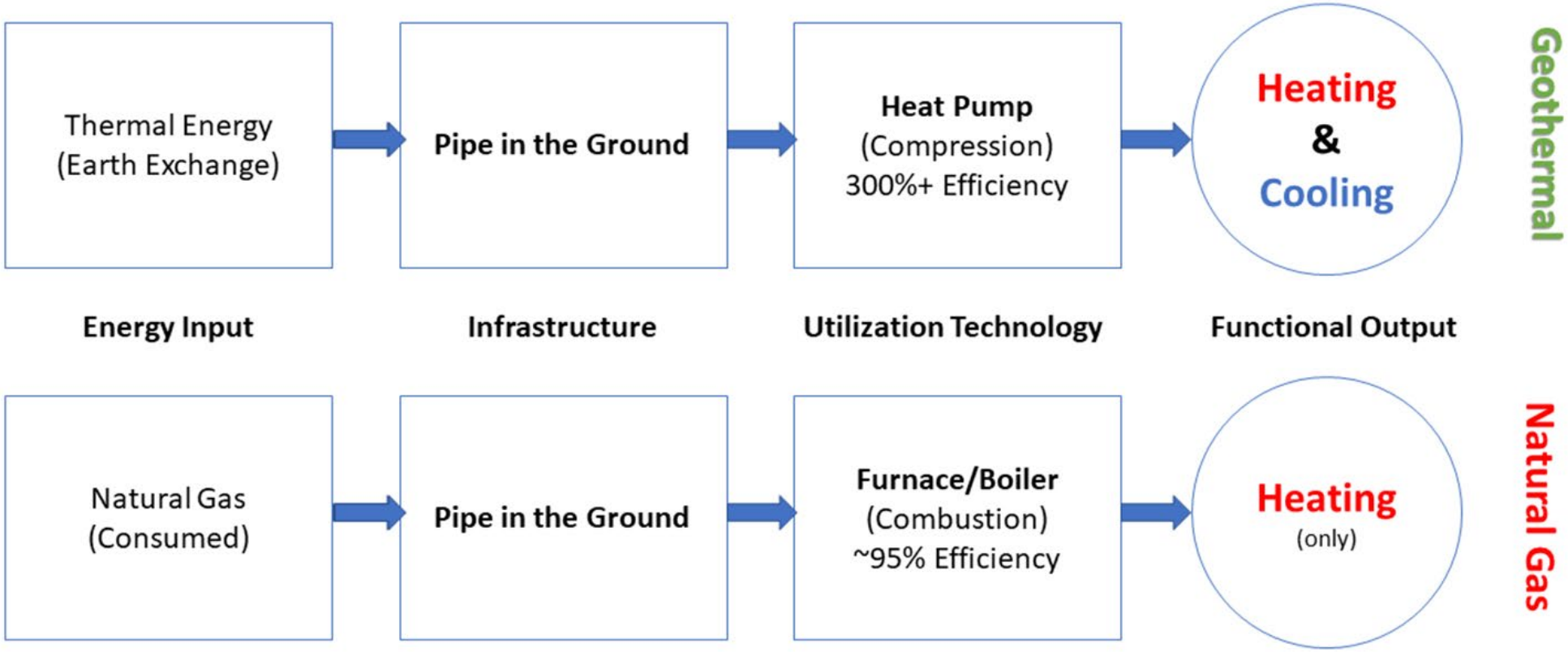
Drinking Water Thermal Exchange in Toronto

Figure 1: DLWC Process (Source: Toronto Hydro)



The Next Evolution for DLWC

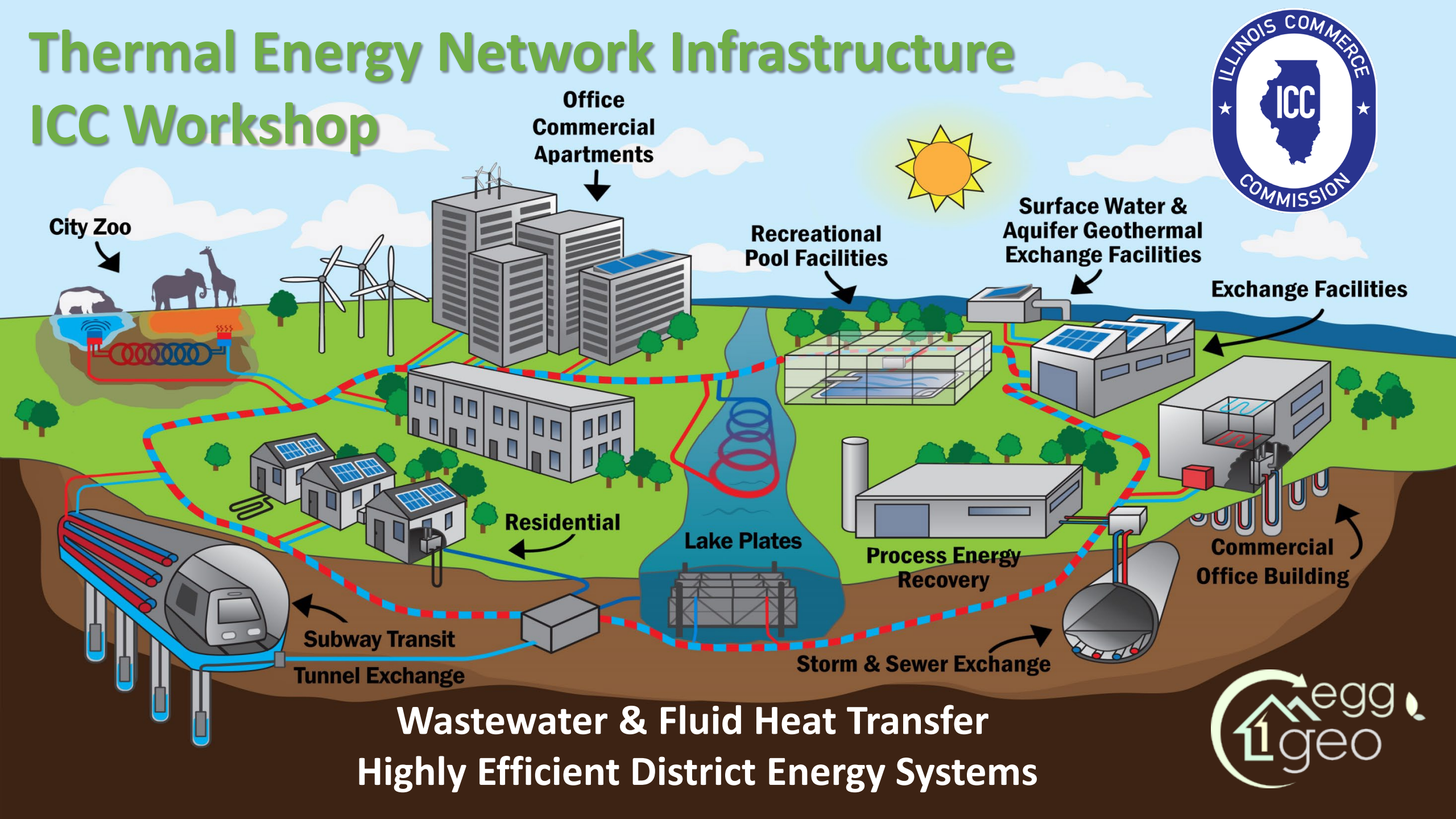
Simplified Schematic View of Thermal Energy vs. Natural Gas for Heating and Cooling Systems



2

The Water Energy Nexus: https://bit.ly/SESI_TEN_Stanford

Thermal Energy Network Infrastructure
ICC Workshop



Wastewater & Fluid Heat Transfer
Highly Efficient District Energy Systems