Surface Water & Wastewater Heat Exchange

Presented Live at the NY-GEO 2023 Conference Albany, New York on April 27, 2023

Moderator:
Mitchell DeWein / *CHA Consulting*
Panel:
Karl Neubert / *Renewable Resource Recovery*
Aaron Miller / *SHARC Energy*
Cary Smith / *GreyEdge Group*
Brendan Hall / *CHA Consulting*

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Surface Water & Wastewater Heat Exchange

Thursday, April 27 • 10:00–11:00 AM • Salon E

NY-GEO

2023 NY-GEO Conference

Surface Water & Wastewater Heat Exchange

SPEAKERS:

- Karl Neubert – Resource Recovery Corp/@Source-Energy
- Aaron Miller – Eastern Regional Manager, SHARC Energy
- Cary Smith – The GreyEdge Group
- Brendan Hall – Mechanical/Geothermal Lead Engineer, CHA Consulting, Inc.

NY-GEO

2023 NY-GEO Conference

Carbon Neutral – Net Zero Buildings with

Sewer Heat Exchange

Future-proofing of infrastructure and a new source of revenue for municipalities and utilities

Source-Energy

A Renewable Resource Recovery Corp. System

2023 NY-GEO Conference
Surface Waste & Waste Water Heat Exchange

April 27, 2023

Karl Neubert
Directors and VP Marketing

Renewable Resource Recovery Corp.
T 917 970 1028

info@at-source-energy.com
www.at-source-energy.com
2477 Maley Dr, Sudbury, ON P3A 4R7 Canada

Problem / Opportunity

Some jurisdictions want their housing stock to be carbon neutral by 2050

How to profitably heat and cool buildings while meeting climate change targets?

How to pay for new or to replace aging wastewater infrastructure?

Using sewer heat exchange (SHX) for ground heat exchange (GHX) with thermal district energy projects – replacing vertical bores and fields

Value Proposition

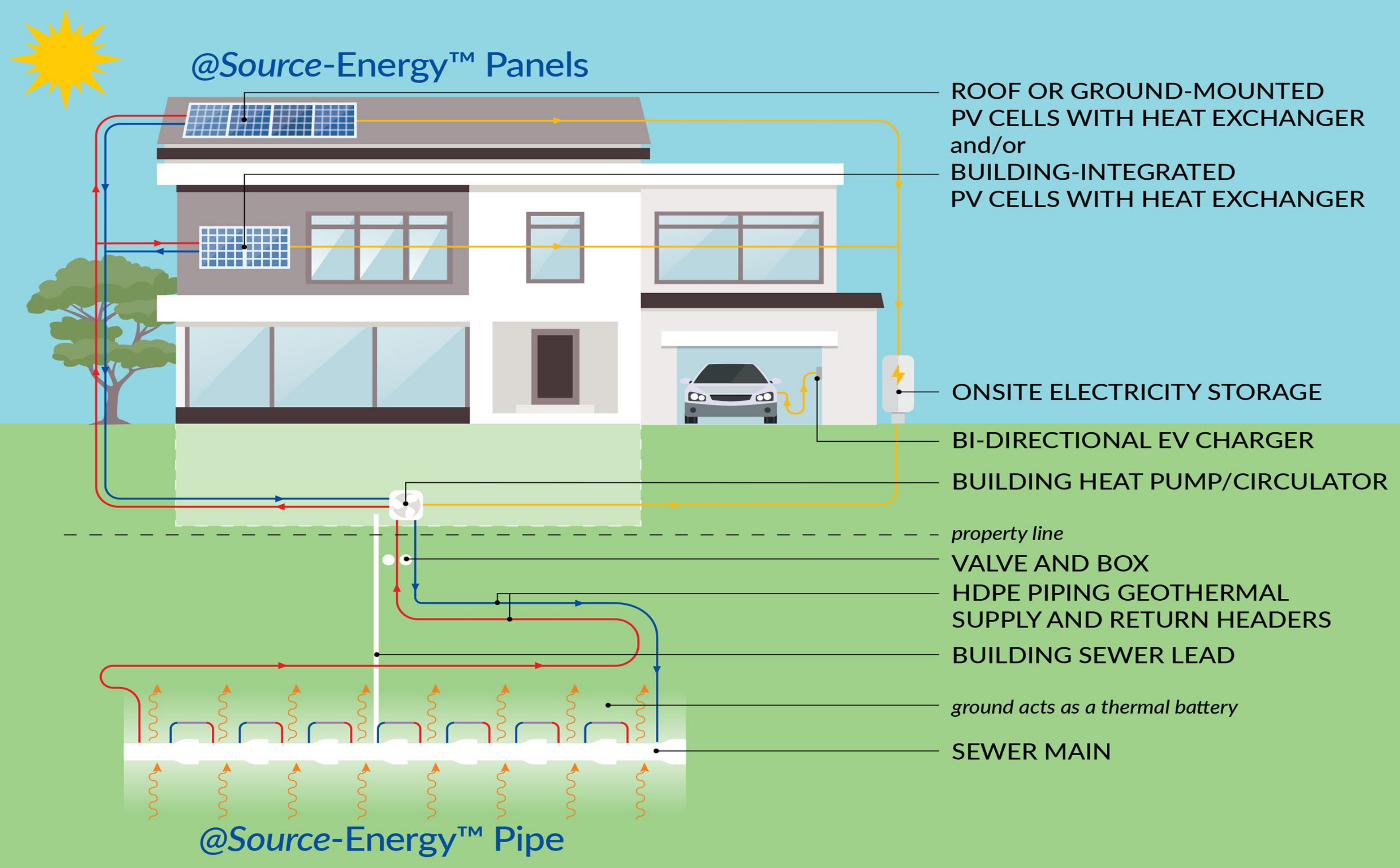
Generating energy savings while eliminating fossil fuels for heating and cooling and warm water provision of buildings

Integrating proven GHX heat pump technology with storm and wastewater energy recovery

Reducing peak electricity demand in summer and winter

Providing stable energy pricing independent of carbon levies

@Source-Energy™ System



@*Source*-Energy™ System - Installations

@*Source*-Energy™ Pipe and Panel
Gold LEED certified
Cambrian College
Sudbury, Ontario, Canada

@*Source*-Energy™ Pipe and @*Source*-Energy™ Panel
55 Units, 56,000 ft^2
Net Zero Carbon target – under construction
Sheena Sharp - Coolearth Architects Inc.
Sudbury, Ontario Canada

@*Source*-Energy™ Pipe
Subdivision installation
Sudbury, Ontario, Canada

@*Source*-Energy™ Pipe

Encased HDPE heat exchanger in the wall of a reinforced concrete sewer pipe

Heat exchanger does not come in contact with nor handles sewage

@Source-Energy Pipe and ground around it become a thermal battery

No operating costs and maintenance free over the life of the pipe > 50 years

Same installation as ordinary sewage pipes

@Source-Energy™ Pipe

Pipes in series allow for a 5th generation District Style heating and cooling system

Meets ANSI/CSA/IGSHPA C-448 "*Standard for the design of ground-source heat pump systems for commercial and residential buildings*"

Reduces peak electricity demand in summer as it replaces air conditioners

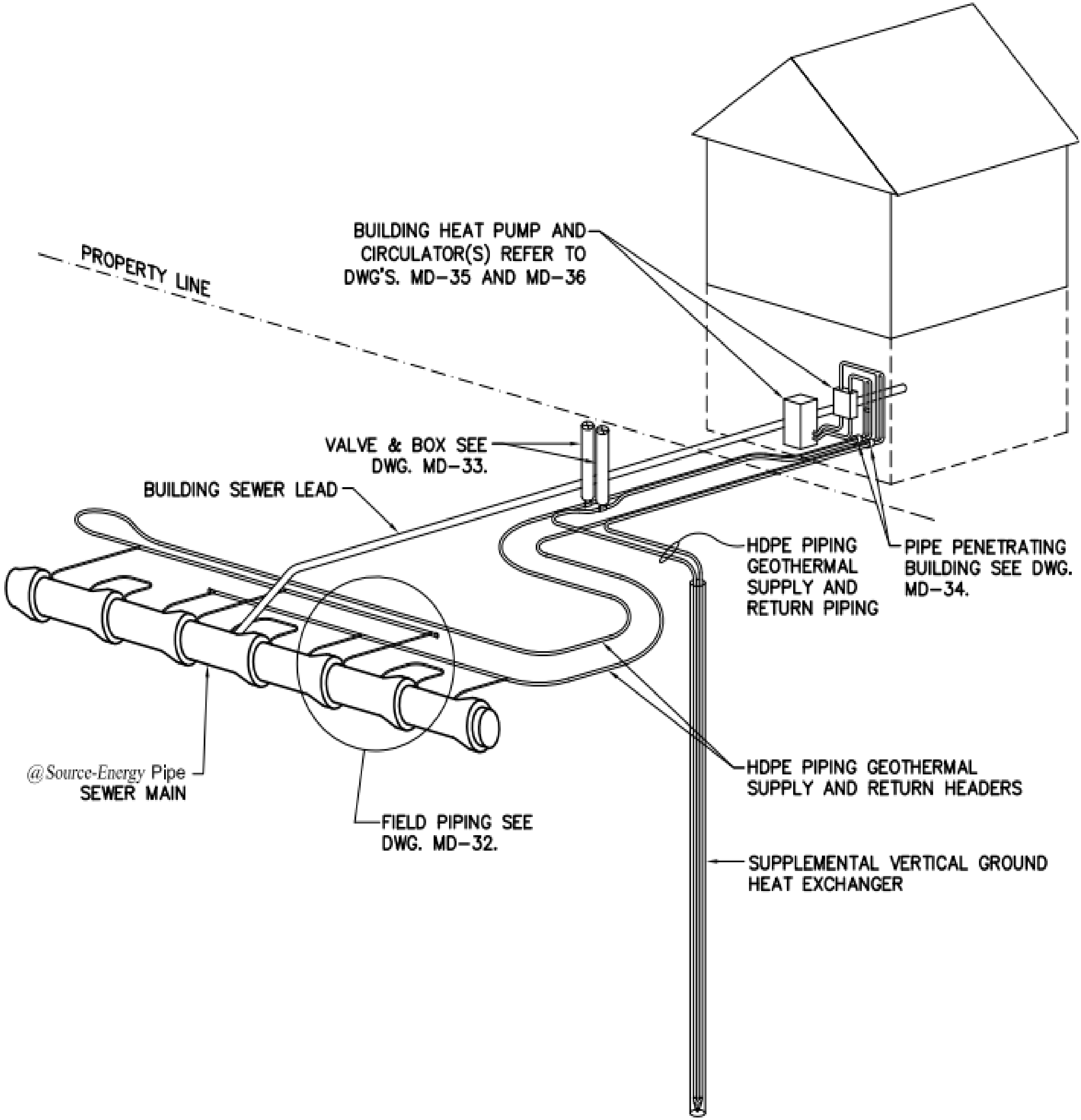
May be combined with vertical bores and hybrid PV panels to supplement GHX

@*Source*-Energy™
Pipe System - Process

- The heat pump in the building pumps a fluid to the @*Source*-Energy Pipes (sewer main in the adjacent diagram);

- Where the fluid absorbs low level heat from the effluent in the sewage pipes and/or the ground surrounding the pipes and

- the fluid is returned to the heat pump and/or boiler where the low level heat is "pumped" to a higher level and



@*Source*-Energy™ Wall / Panel

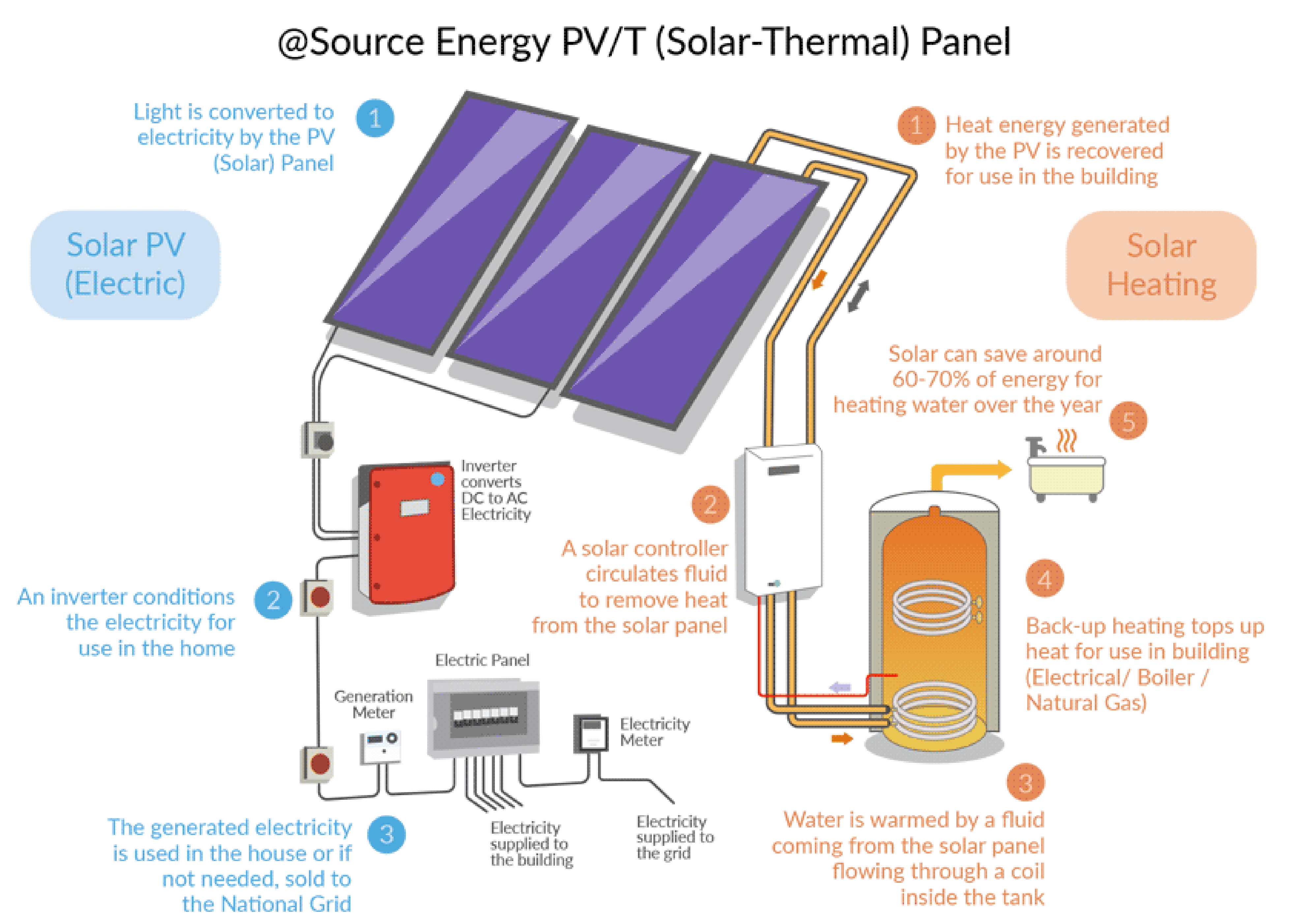
Hybrid photovoltaic / thermal (PV/T) panel

Removes thermal energy from PV panels and stores it in the @*Source*-Energy Pipe

Roof mounted or in walls using skill sets used by PV and solar thermal installers

In warm weather, PV panels are cooled to increase electrical efficiency up to 30%

During winter, PV panels are heated to prevent snow and ice accumulation


@Source Energy PV/T (Solar-Thermal) Panel
Solar PV (Electric)
1 Light is converted to electricity by the PV (Solar) Panel
Inverter converts DC to AC Electricity
2 An inverter conditions the electricity for use in the home
Generation Meter
Electric Panel
Electricity Meter
Electricity supplied to the building
Electricity supplied to the grid
3 The generated electricity is used in the house or if not needed, sold to the National Grid
Solar Heating
1 Heat energy generated by the PV is recovered for use in the building
2 A solar controller circulates fluid to remove heat from the solar panel
3 Water is warmed by a fluid coming from the solar panel flowing through a coil inside the tank
4 Back-up heating tops up heat for use in building (Electrical/ Boiler / Natural Gas)
5 Solar can save around 60-70% of energy for heating water over the year

Business Model

Technology licensing

Fixed fee plus royalties

Energy Service Company / Utility	Fixed license fee for a region plus royalty on energy moved through the *@Source*-Energy System
Pre-cast Concrete Pipe Manufacturer	Fixed license fee for a region plus royalty on @Source-Energy Pipe

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BUILDING PROGRESS FOR PEOPLE AND THE PLANET.

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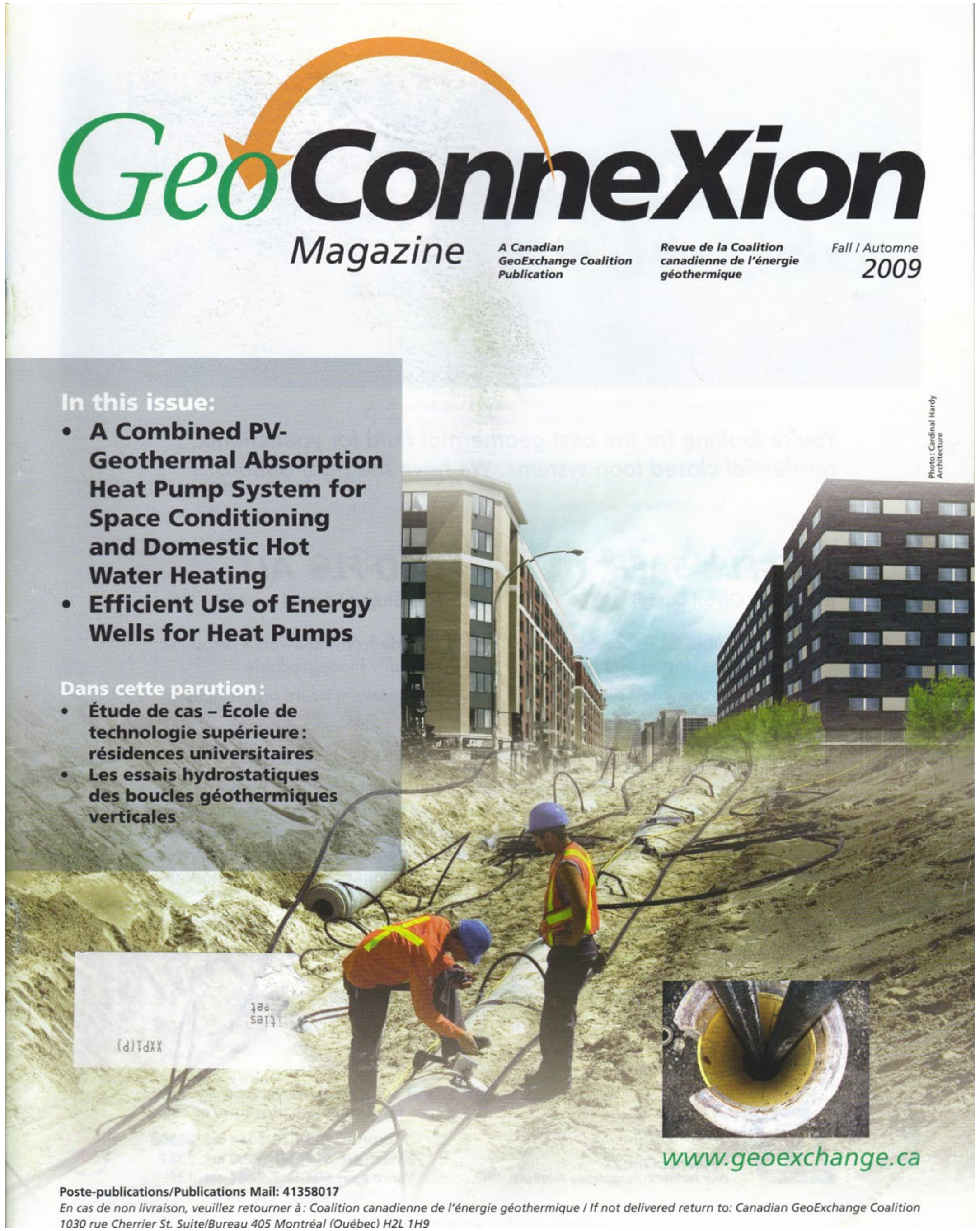
Recognition for the *@Source*-Energy™ System

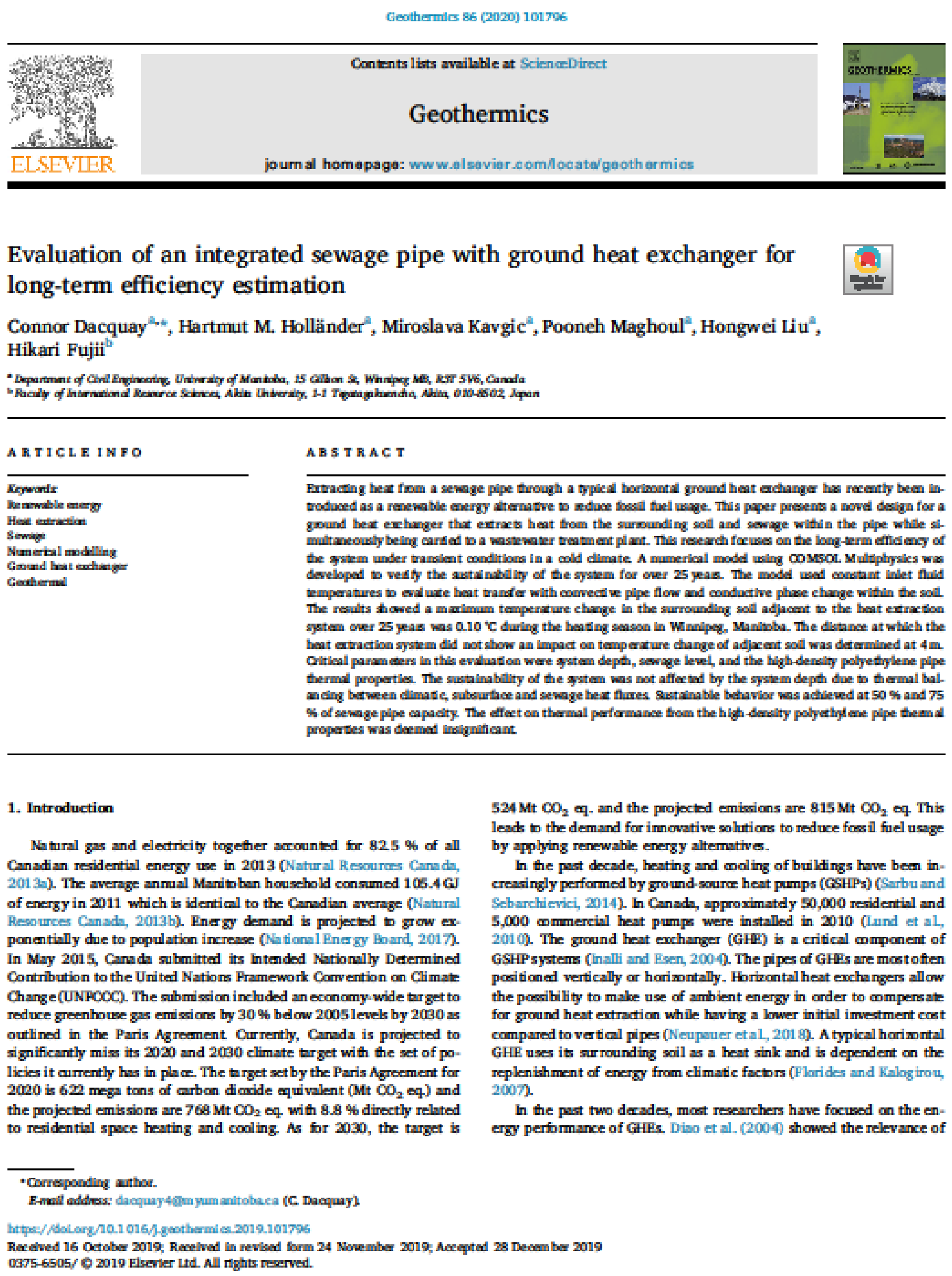
Concrete Canada:

Specialty Concrete Products Award 2009



Research on the *@Source*-Energy™ Pipe

Geothermics 86 (2020) 101796



Geothermics 86 (2020) 101796

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journal homepage: www.elsevier.com/locate/geothermics

Evaluation of an integrated sewage pipe with ground heat exchanger for long-term efficiency estimation

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ARTICLE INFO

Keywords:
Renewable energy
Heat extraction
Sewage
Numerical modelling
Ground heat exchanger
Geothermal

ABSTRACT

Extracting heat from a sewage pipe through a typical horizontal ground heat exchanger has recently been introduced as a renewable energy alternative to reduce fossil fuel usage. This paper presents a novel design for a ground heat exchanger that extracts heat from the surrounding soil and sewage within the pipe while simultaneously being carried to a wastewater treatment plant. This research focuses on the long-term efficiency of the system under transient conditions in a cold climate. A numerical model using COMSOL Multiphysics was developed to verify the sustainability of the system for over 25 years. The model used constant inlet fluid temperatures to evaluate heat transfer with convective pipe flow and conductive phase change within the soil. The results showed a maximum temperature change in the surrounding soil adjacent to the heat extraction system over 25 years was 0.10 °C during the heating season in Winnipeg, Manitoba. The distance at which the heat extraction system did not show an impact on temperature change of adjacent soil was determined at 4 m. Critical parameters in this evaluation were system depth, sewage level, and the high-density polyethylene pipe thermal properties. The sustainability of the system was not affected by the system depth due to thermal balancing between climatic, subsurface and sewage heat fluxes. Sustainable behavior was achieved at 50 % and 75 % of sewage pipe capacity. The effect on thermal performance from the high-density polyethylene pipe thermal properties was deemed insignificant.

1. Introduction

Natural gas and electricity together accounted for 82.5 % of all Canadian residential energy use in 2013 (Natural Resources Canada, 2013a). The average annual Manitoban household consumed 105.4 GJ of energy in 2011 which is identical to the Canadian average (Natural Resources Canada, 2013b). Energy demand is projected to grow exponentially due to population increase (National Energy Board, 2017). In May 2015, Canada submitted its Intended Nationally Determined Contribution to the United Nations Framework Convention on Climate Change (UNFCCC). The submission included an economy-wide target to reduce greenhouse gas emissions by 30 % below 2005 levels by 2030 as outlined in the Paris Agreement. Currently, Canada is projected to significantly miss its 2020 and 2030 climate target with the set of policies it currently has in place. The target set by the Paris Agreement for 2020 is 622 mega tons of carbon dioxide equivalent (Mt CO_2 eq.) and the projected emissions are 768 Mt CO_2 eq. with 8.8 % directly related to residential space heating and cooling. As for 2030, the target is 524 Mt CO_2 eq. and the projected emissions are 815 Mt CO_2 eq. This leads to the demand for innovative solutions to reduce fossil fuel usage by applying renewable energy alternatives.

In the past decade, heating and cooling of buildings have been increasingly performed by ground-source heat pumps (GSHPs) (Sarbu and Sebarchievici, 2014). In Canada, approximately 50,000 residential and 5,000 commercial heat pumps were installed in 2010 (Lund et al., 2010). The ground heat exchanger (GHE) is a critical component of GSHP systems (Inalli and Esen, 2004). The pipes of GHEs are most often positioned vertically or horizontally. Horizontal heat exchangers allow the possibility to make use of ambient energy in order to compensate for ground heat extraction while having a lower initial investment cost compared to vertical pipes (Neupauer et al., 2018). A typical horizontal GHE uses its surrounding soil as a heat sink and is dependent on the replenishment of energy from climatic factors (Florides and Kalogirou, 2007).

In the past two decades, most researchers have focused on the energy performance of GHEs. Diao et al. (2004) showed the relevance of

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E-mail address: dacquay4@myumanitoba.ca (C. Dacquay).

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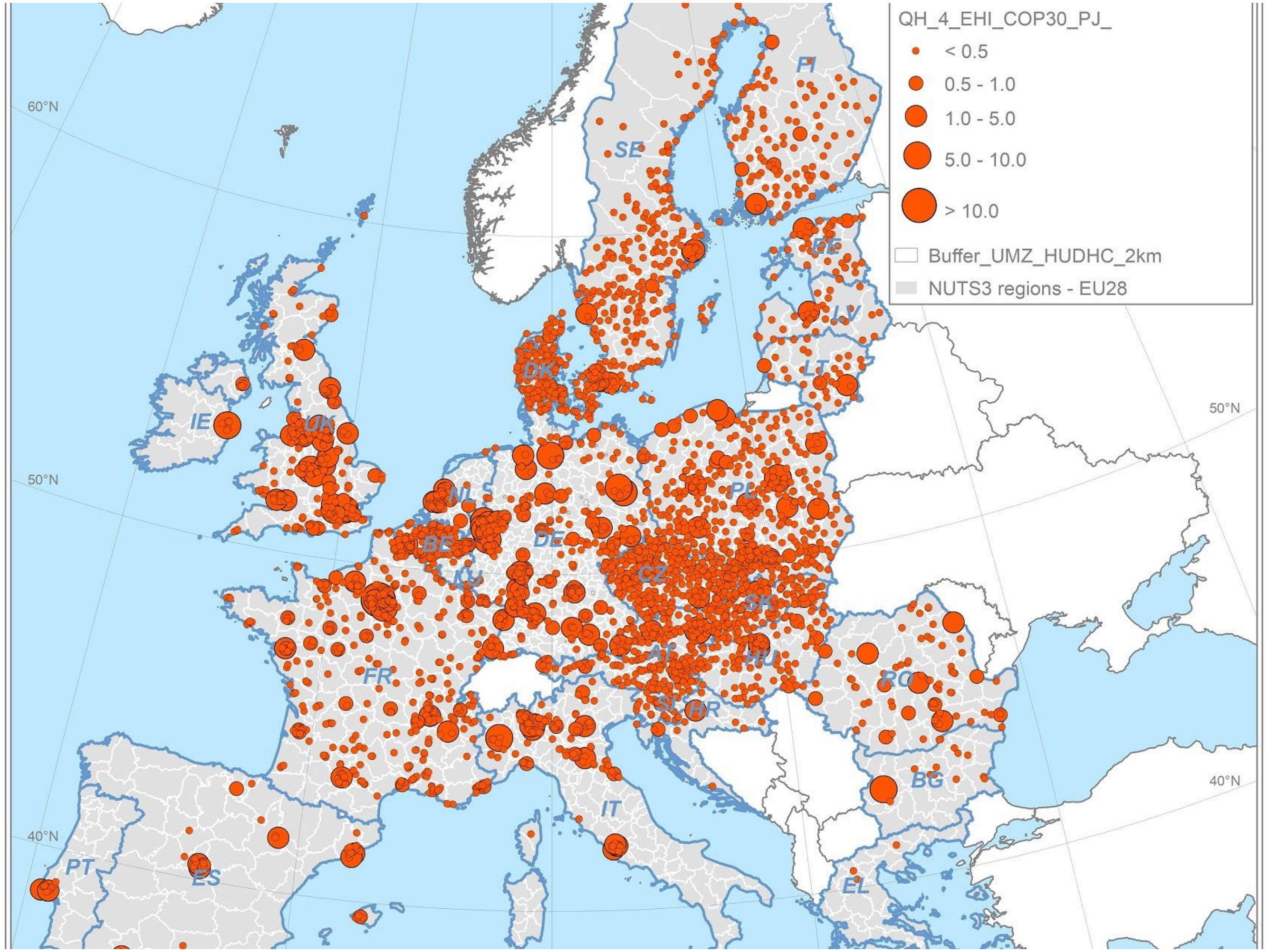
EU’s Urban Waste Heat Potential

Approximately 1.2 EJ (or 340 TWh ~6 billion bbl of oil) per year are possible to recover from data centres, metro stations, service sector buildings, and waste water treatment plants. This corresponds to more than 10 percent of the EU’s total energy demand for heat and hot water, which is approximately 10.7 EJ (or 2,980 TWh)

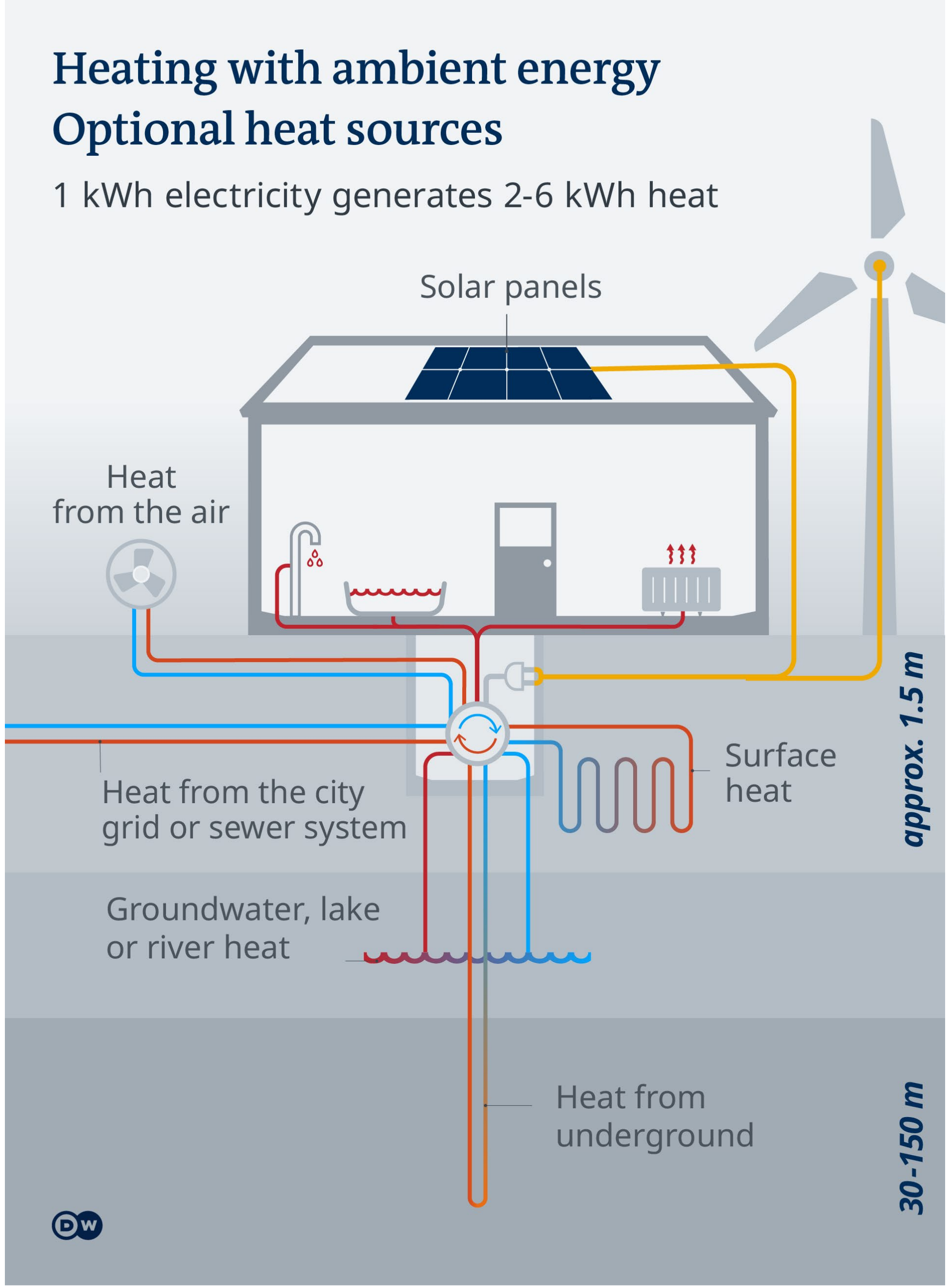


U, Averfalk H. Accessible urban waste heat.

of Urban Excess Heat. 2018

How Germany plans to phase out oil and gas heating

German Federal Government – Energy Transition



Thank You

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SHARC ENERGY

We Turn Wastewater Into Opportunity

Aaron Miller

Eastern Regional Manager

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646-303-1204

Why Wastewater + Geo?

- Reduces project costs & footprint
- Same load coverage with ~50% less boreholes
- Optimizes loop operating temperature & performance
- Turns sewer into "Urban Geo Field"
- Qualifies for Investment Tax Credit (IRA)

PIRANHA.sharcenergy.com

PIRANHA SERIES

- Wastewater-source heat pump
- Active energy recovery
- No filtering needed
- **Small footprint**
- **No odor**

Wastewater

Residential

- Multi-unit housing, 50–500 units
- Student Housing
- Senior Living
- Community Housing

Commercial

- Hospitals
- Micro-Breweries
- Hospitality
- Commercial Laundry & Car Wash

Industrial

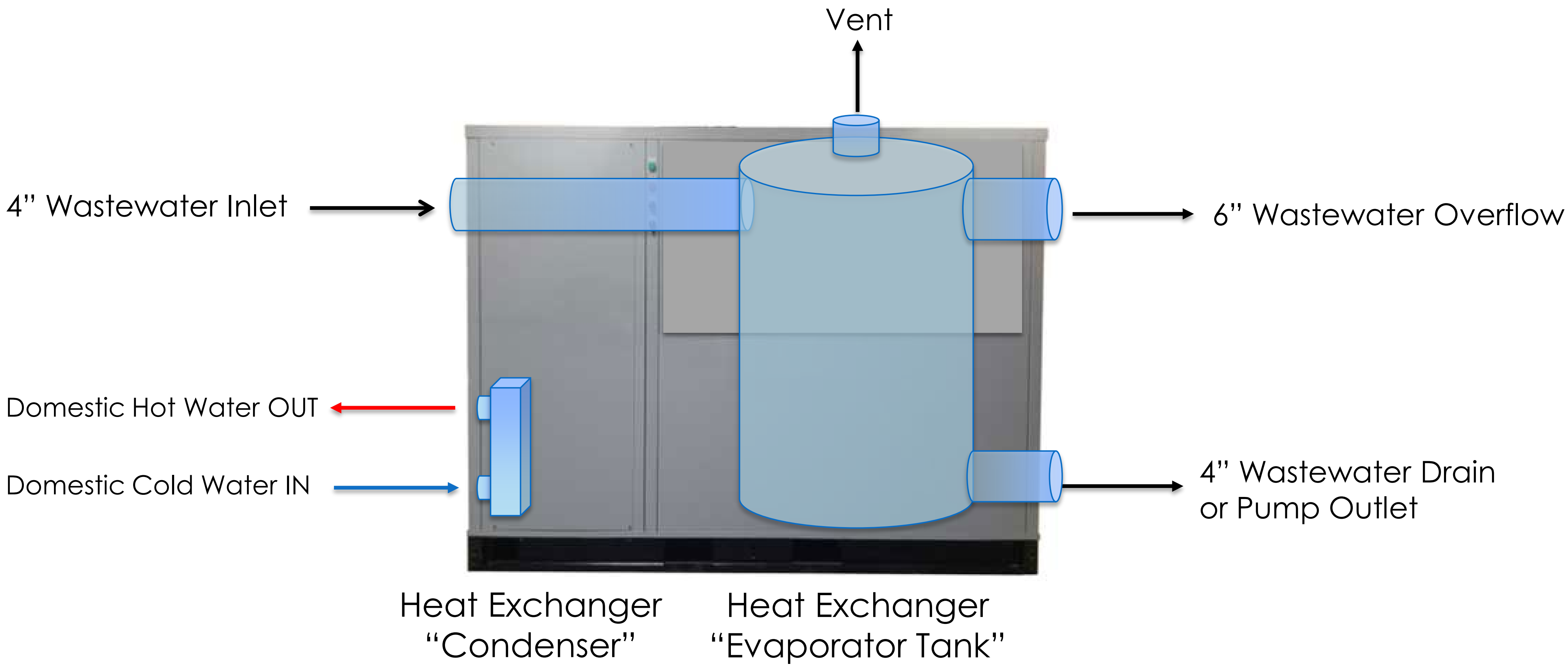
- Commercial Food Production
- Pulp and Paper
- Textiles
- **District Energy**

SHARC.sharcenergy.com

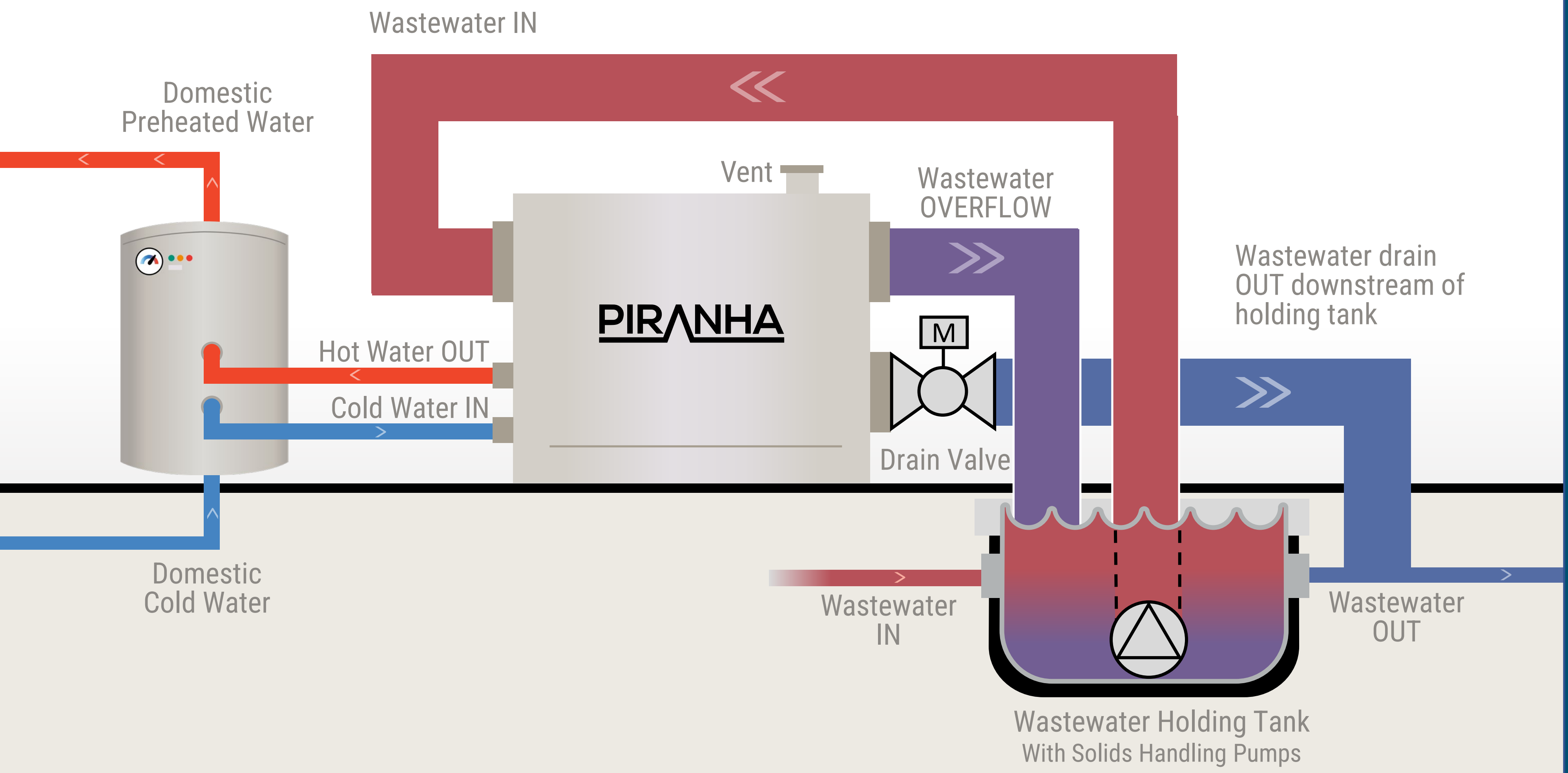
SHARC SERIES

- High capacity
- High volume filtration
- Uses custom heat exchanger
- **Small footprint**
- **No odor**

PIRANHA


Vent
4" Wastewater Inlet
6" Wastewater Overflow
Domestic Hot Water OUT
Domestic Cold Water IN
4" Wastewater Drain or Pump Outlet
Heat Exchanger "Condenser"
Heat Exchanger "Evaporator Tank"

Single Building – PIRANHA



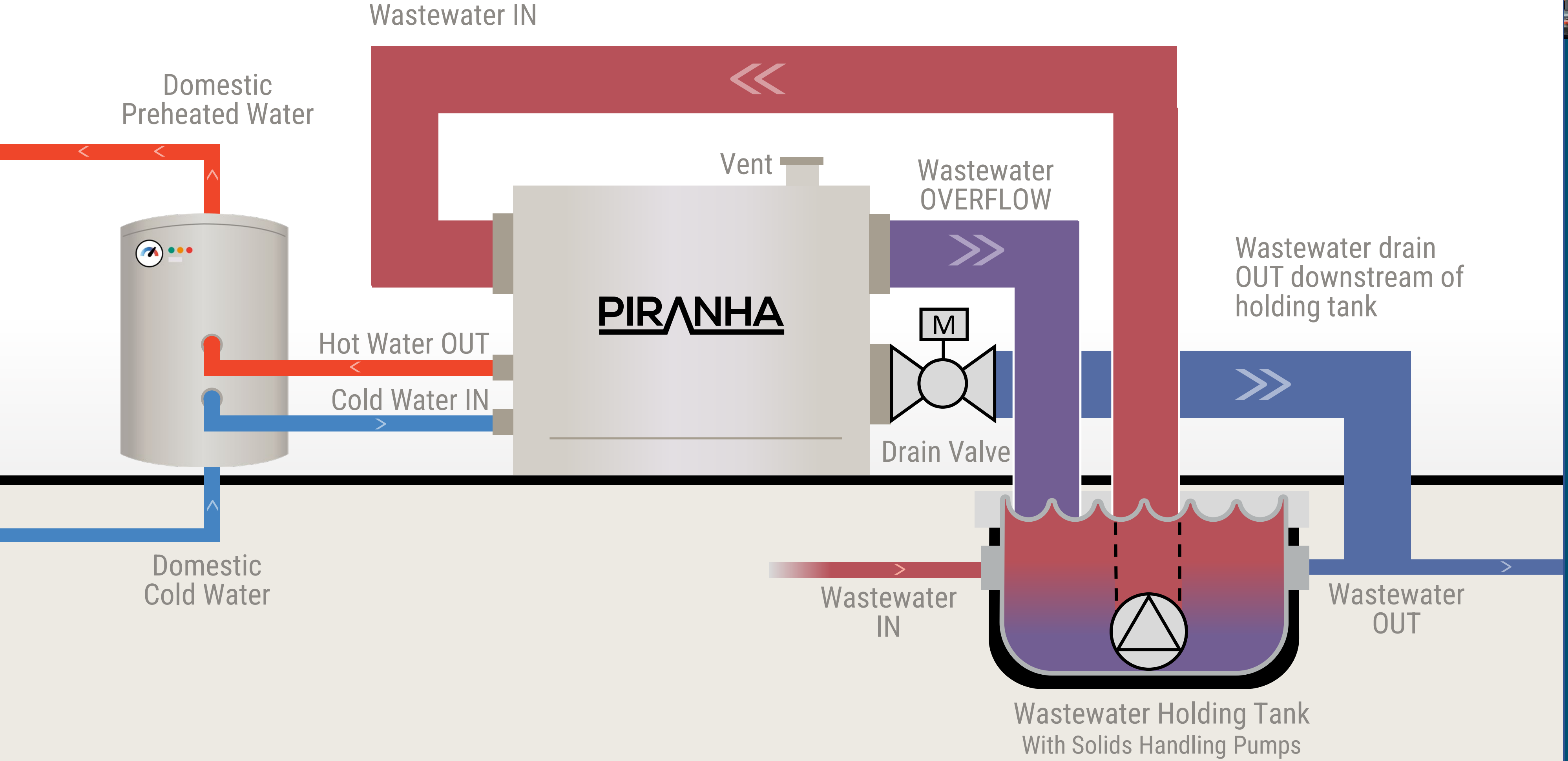
PIRANHA project highlight

Lake Louise

- PIRANHA T10 recovering heat from 4 commercial laundry washing machines
- Main fuel source: Propane
- 60% Reduction in fuel costs
- 5.25 COP

CUSTOMERS.sharcenergy.com

Single Building – PIRANHA



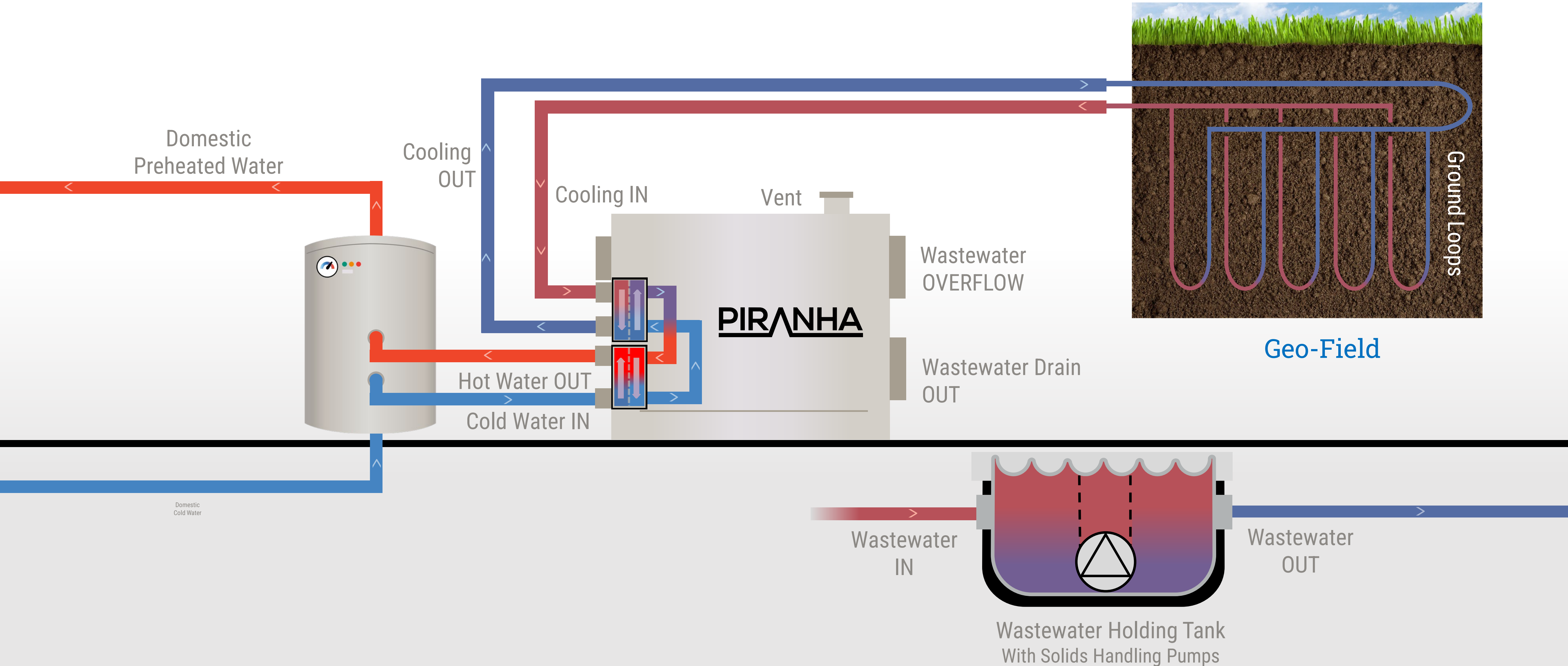
PIRANHA project highlight

3200 Bluff

- PIRANHA T5
- Providing DHW to 37 residential units
- Main fuel source: Propane
- 3.25 COP
- 44% energy reduction vs baseline (~54 metric t CO_2e/year)

PIRANHA HC

Paired with Geo-Exchange



SHARC SYSTEM

- SHARC Filter Unit
- Support Frames/Skids
- Control Panel
- Macerator/Grinder
- Piping/Valve Assembly
- Plate & Frame Heat Exchanger
  - Wide Gap

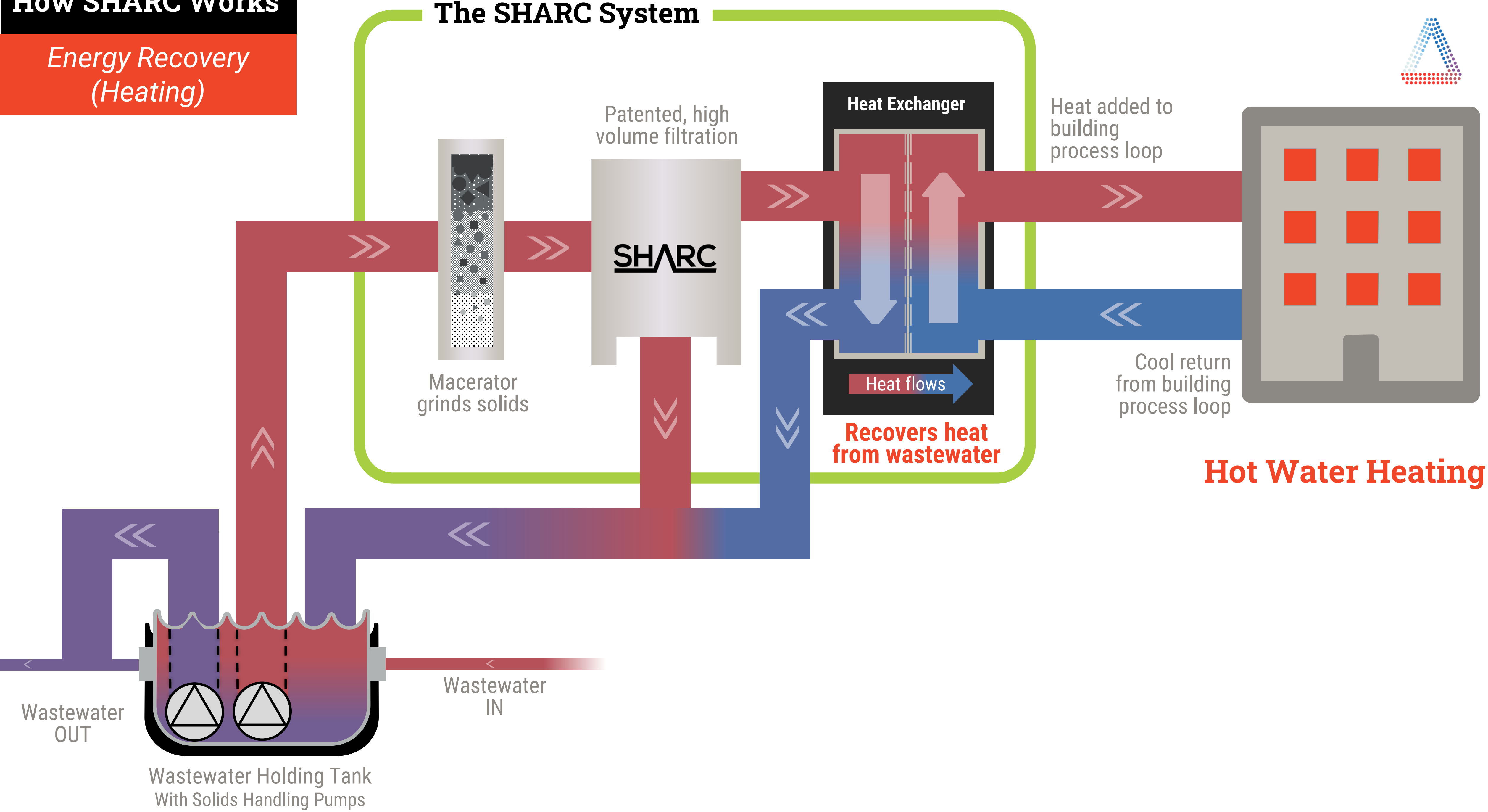
- Wastewater Holding Tank & Solids Handling Lift Pumps

  Existing Tank can be used
- Heat Pump
  - May not be needed in ambient/low temp systems

*Sourced Separately

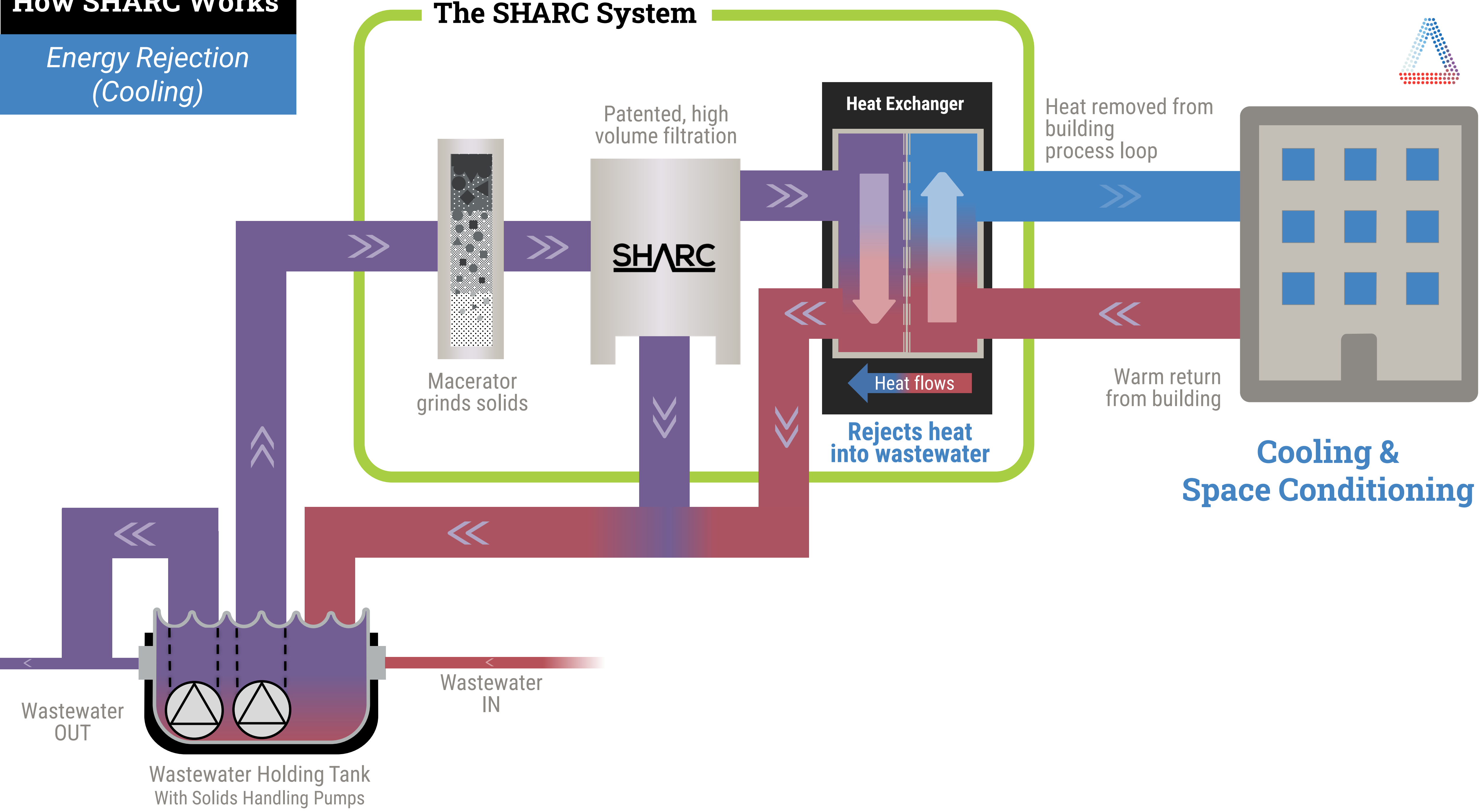
How SHARC Works

Energy Recovery (Heating)

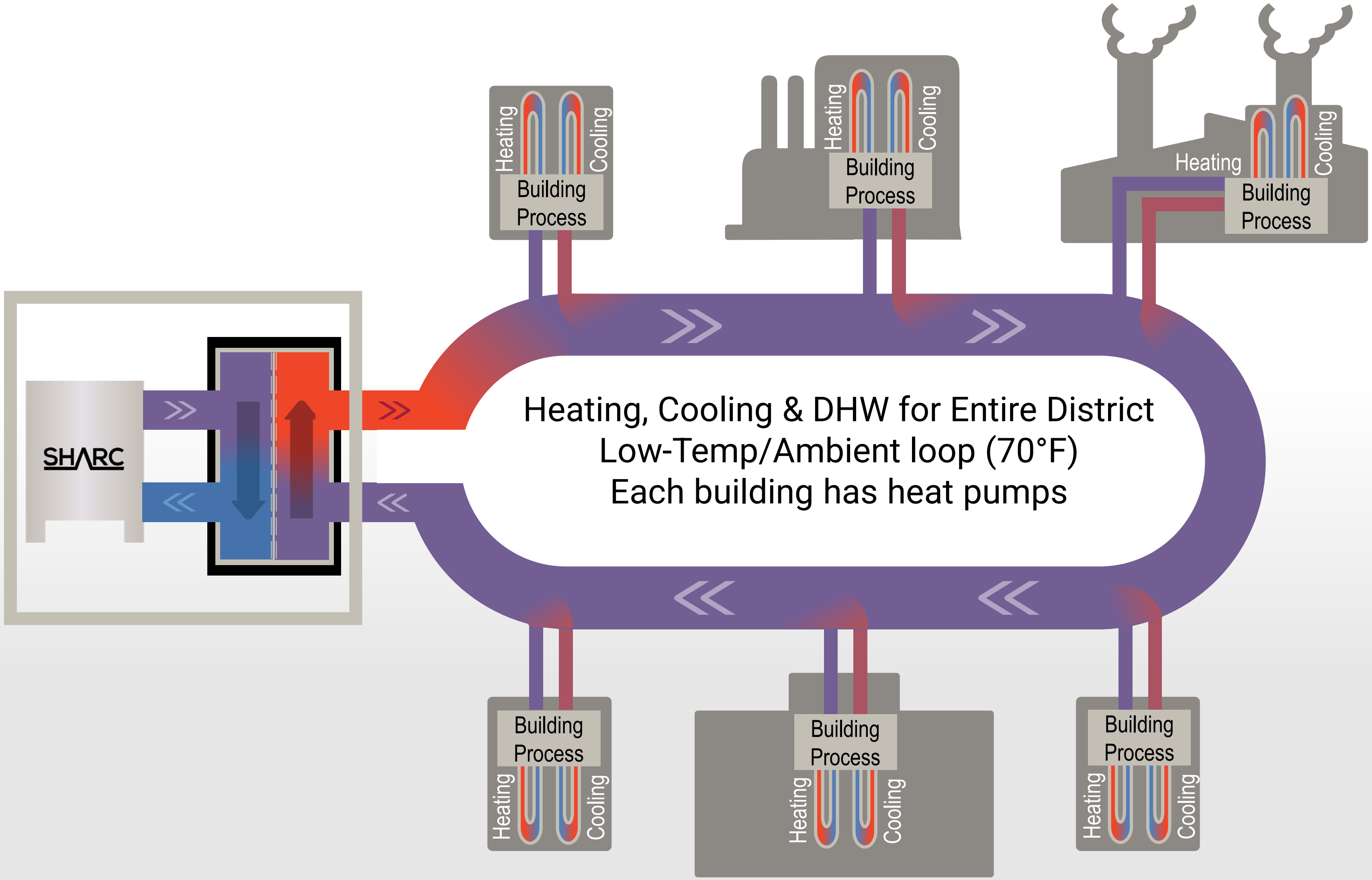


How SHARC Works

Energy Rejection (Cooling)



District Energy – SHARC



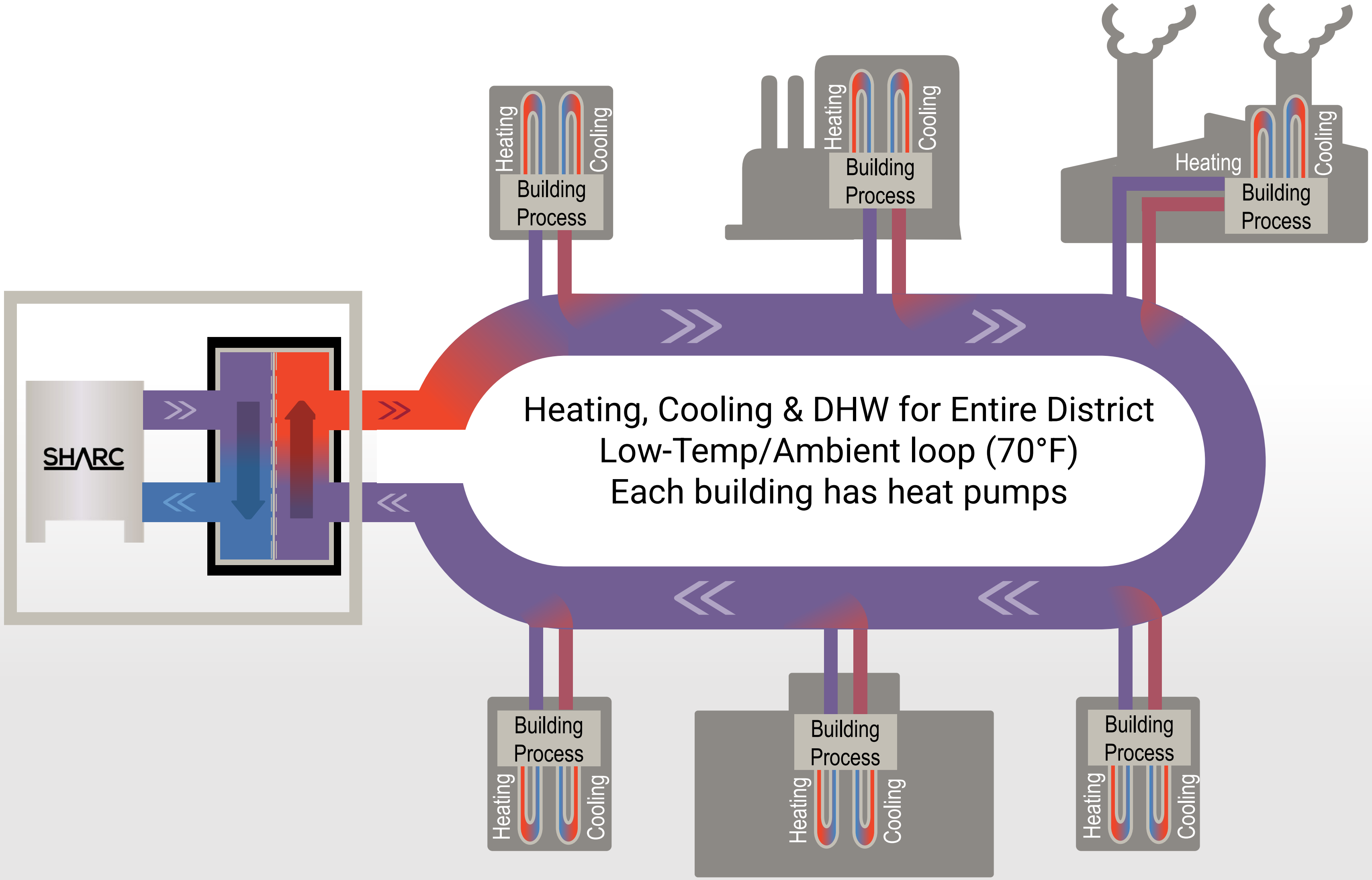
SHARC project highlight

National Western Center

- (2) SHARC 880 provide 3.8MW of thermal transfer
- 90% of total heating & cooling load for 1M sq ft of indoor space
- ~2600 mt CO_2e/yr offset
- Plans to expand plant to 10MW

CUSTOMERS.sharcenergy.com

District Energy – SHARC



SHARC project highlight

ləlǝm' living

- 22-acre mixed-use
- 1.3M sq ft indoor space
- 30,000 sq ft retail, including grocery
- 1,300 residences
- 15,000 sq ft community center

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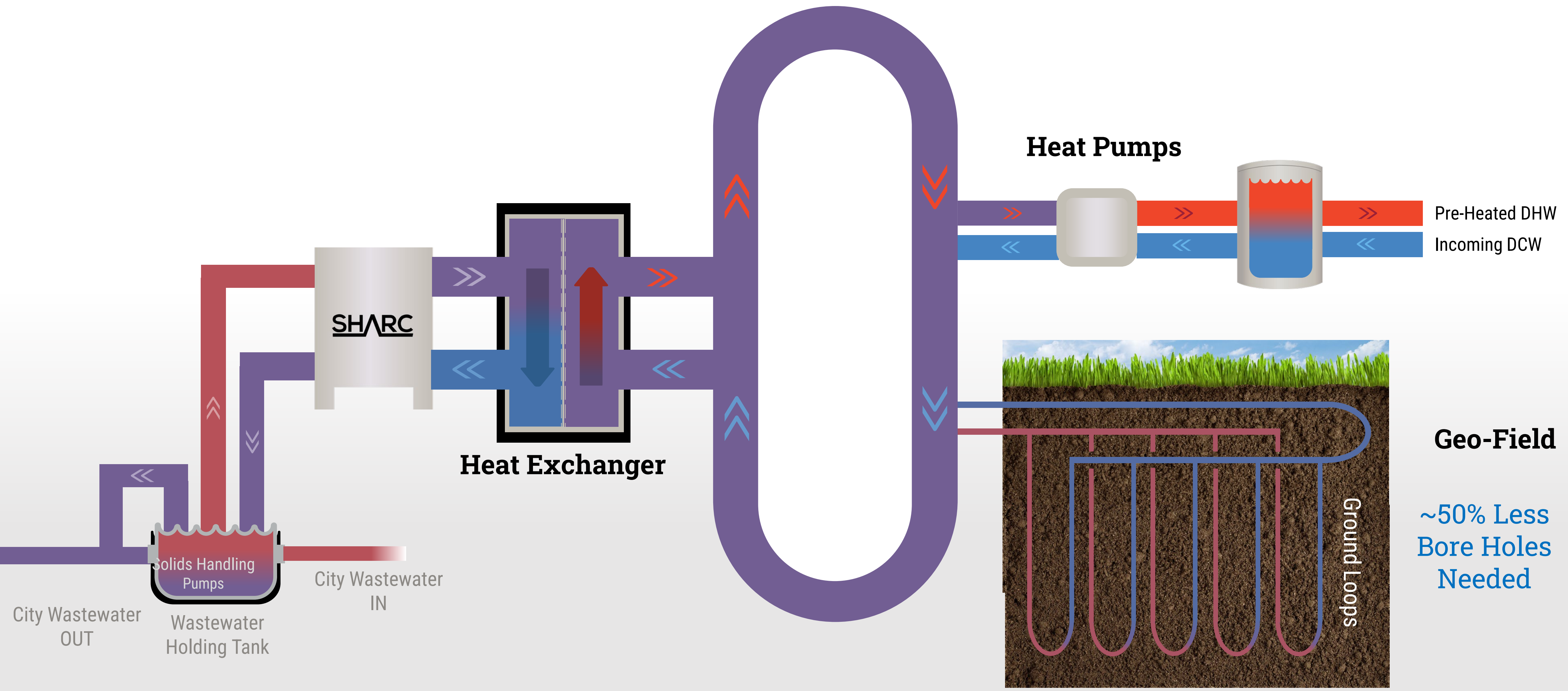
SHARC

Paired with Geo-Exchange & Sewer



SHARC ENERGY

We Turn Wastewater Into Opportunity

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Eastern Regional Manager

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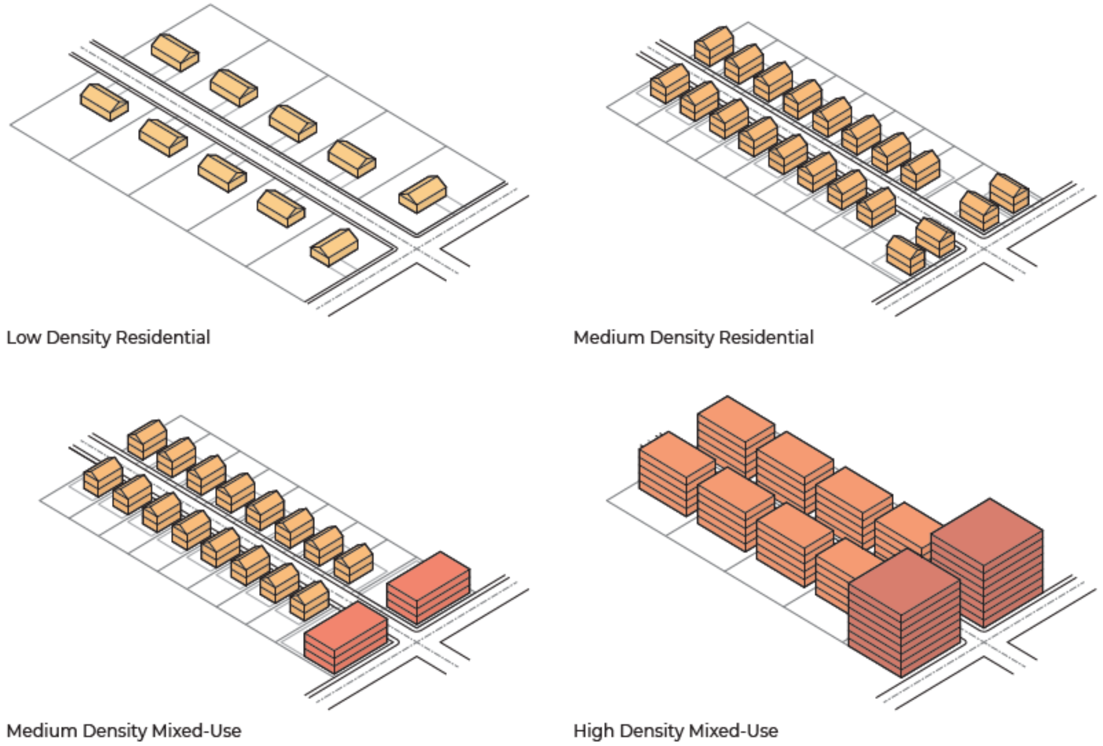
Surface Water, Waste and Grey Water

Energy harvested, *moved*, and *reused*



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The Grey Edge Group
and
Sound Geothermal Corporation
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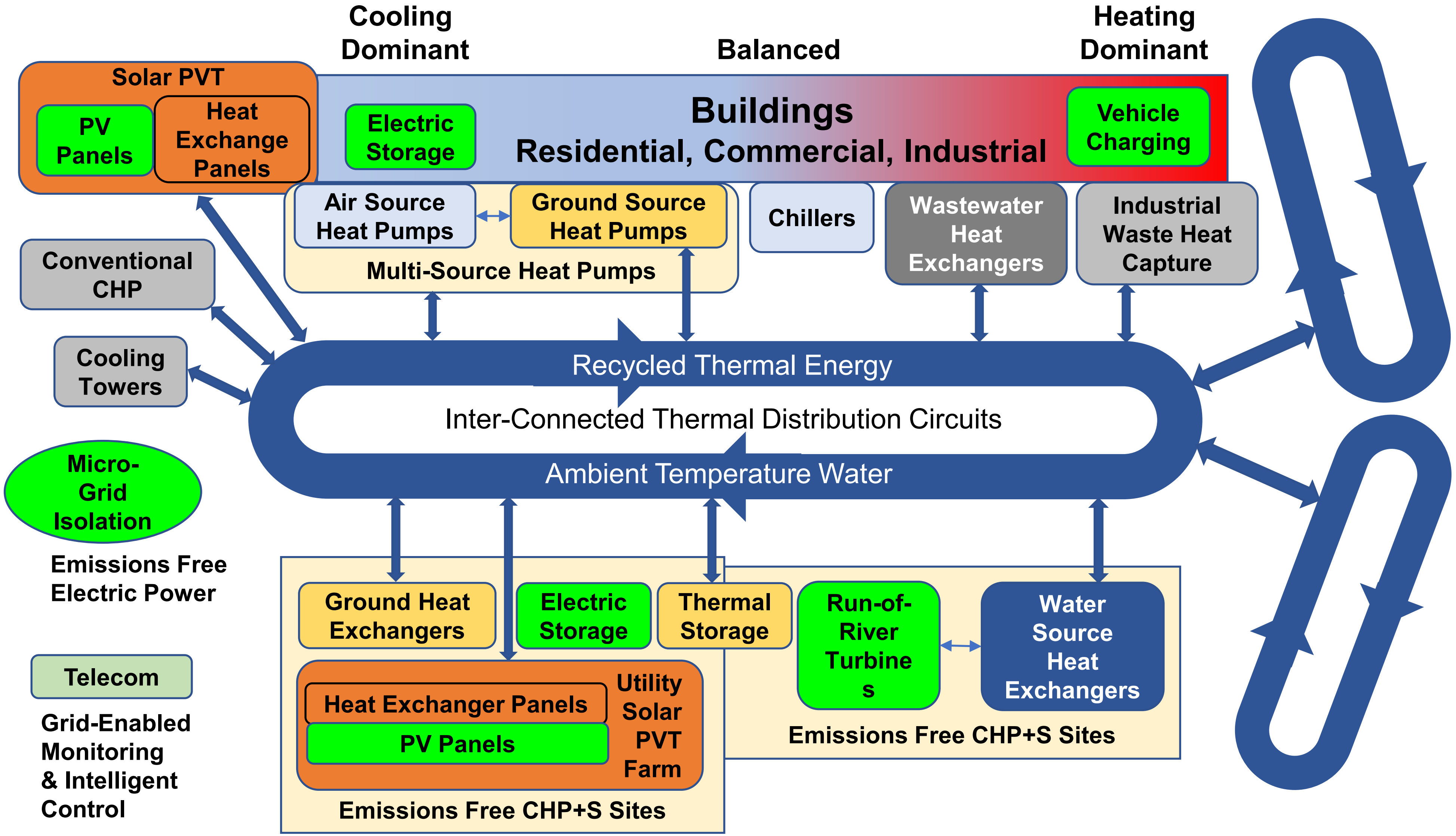
Sound Geothermal Corporation

the GreyEdge group

District-Level Applications

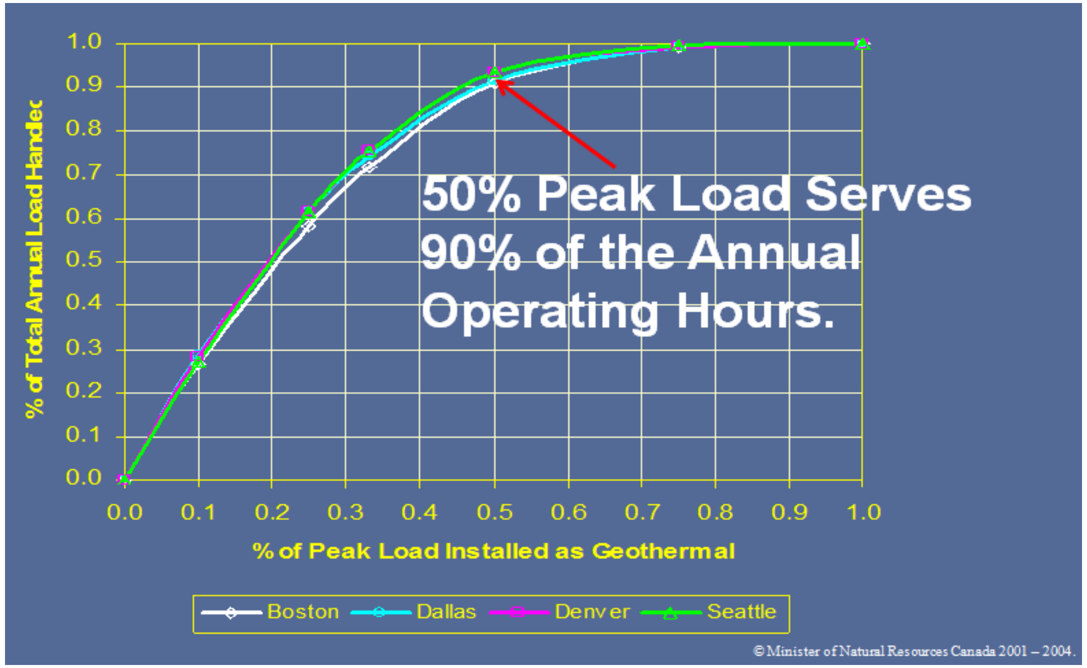
Clean Energy Applied at a Thermal District Scale

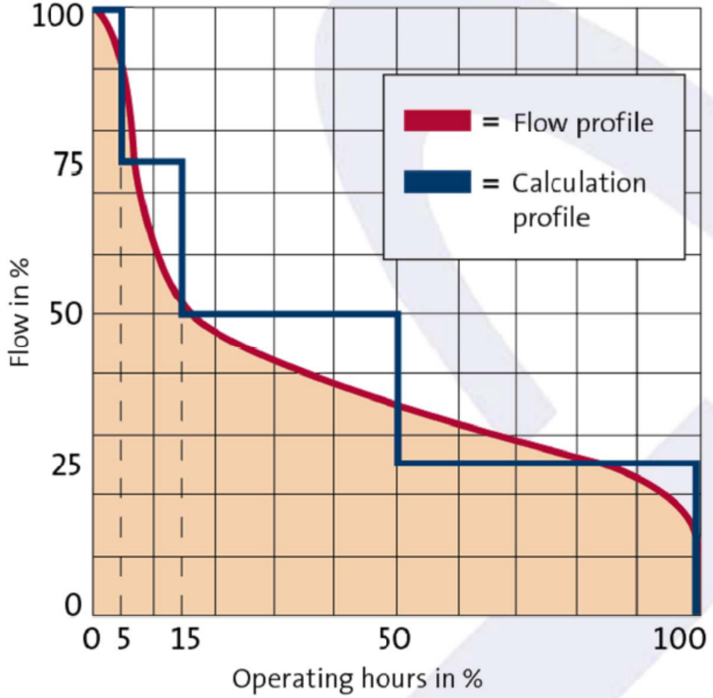
Integrated Plug and Play
Electric / Thermal Energy Systems



Part Load Analysis, The core of DESIGN of an ATL

% of Peak Load vs. % of Annual Hours

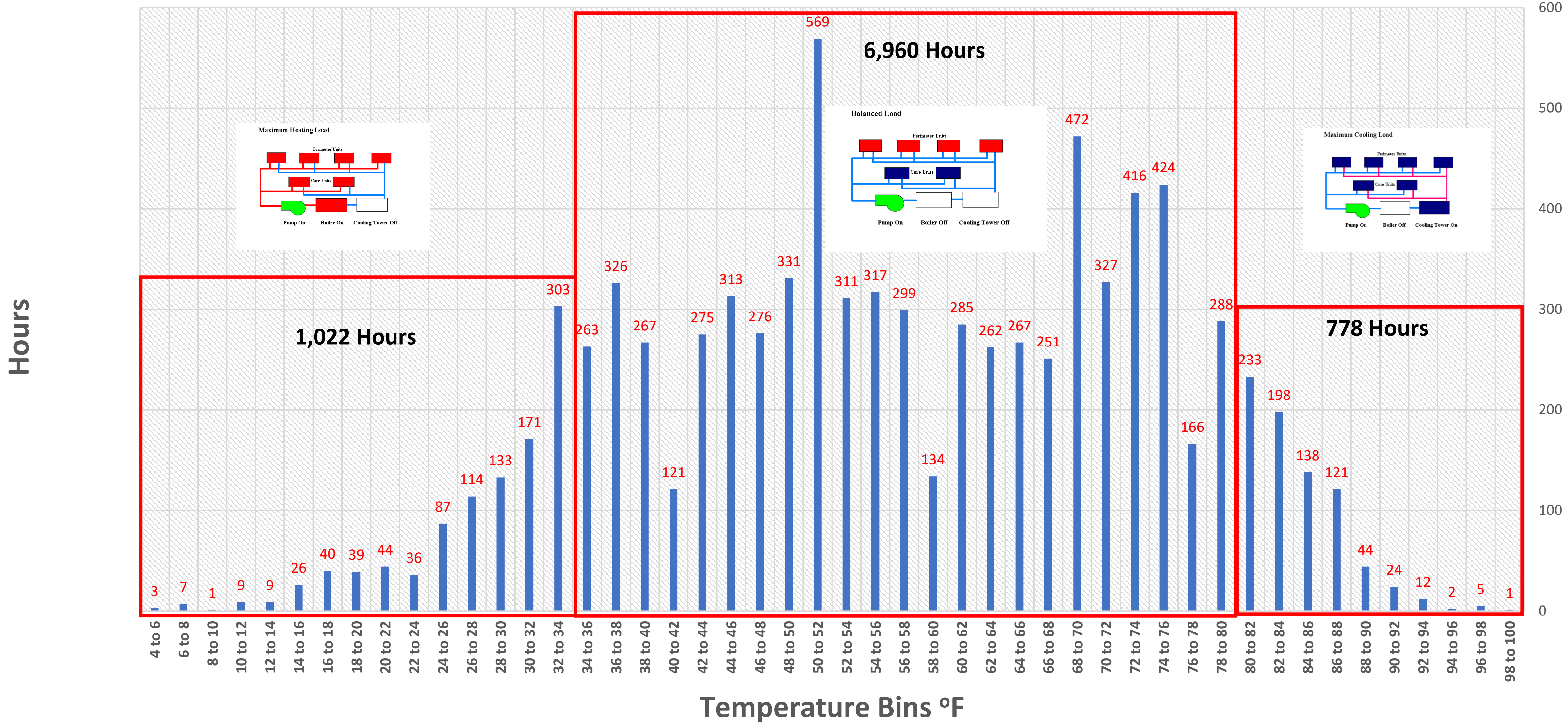




Flow in %	Hours in %
100	6
75	15
50	35
25	44

This profile is also applicable to the building load.

Conventional Bins for NEW YORK LAGUARDIA ARPT - Hours: 8760



Some see a POND…

We See a <u>Fuel Free, Emission Free, Power Plant</u> created through demand reduction when used in conjunction with geo-exchange heat pumps.

Pond Loop

Forks Market, Winnipeg Canada

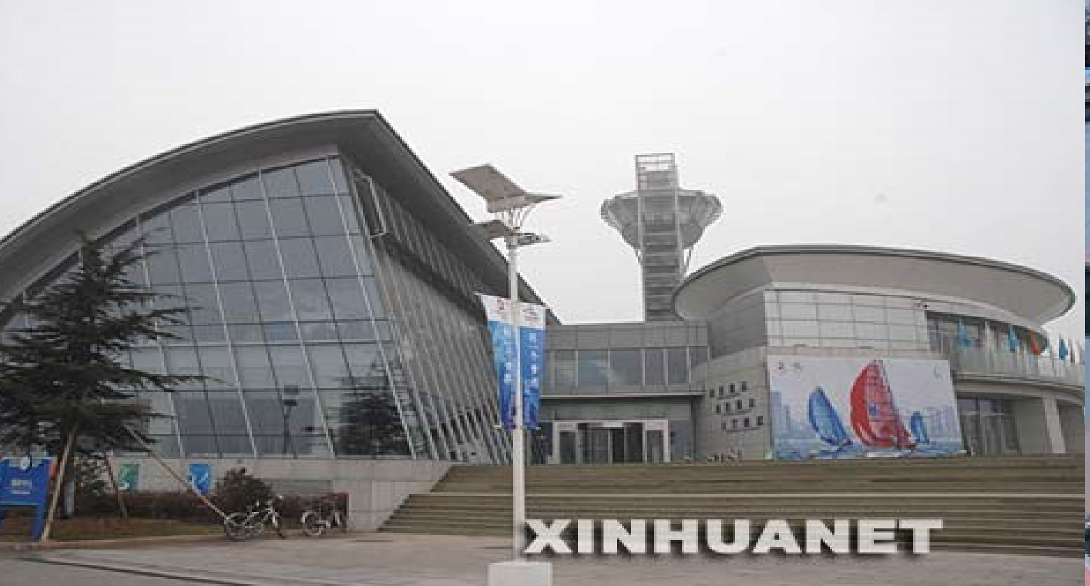
400 Ton Capacity

2008 Olympic Media Center, Qingdao, China

600 Refrigeration Tons

Geothermal Heat Pumps

Source: Seawater – Titanium Heat Exchanger



Nashville International Airport

3600 Ton Capacity

3600 Tons (HR) – Converted from cooling towers to closed loop geothermal system.

Conserving over 30 Million Gallons of Potable Water Annually!

Reducing Utility Cost over $430,000.00 Annually!

LARGEST Lake Loop System in North America

Replaced (3) - 1200 Ton Cooling Towers reducing

- Emissions
- Energy Usage
- Water Consumption

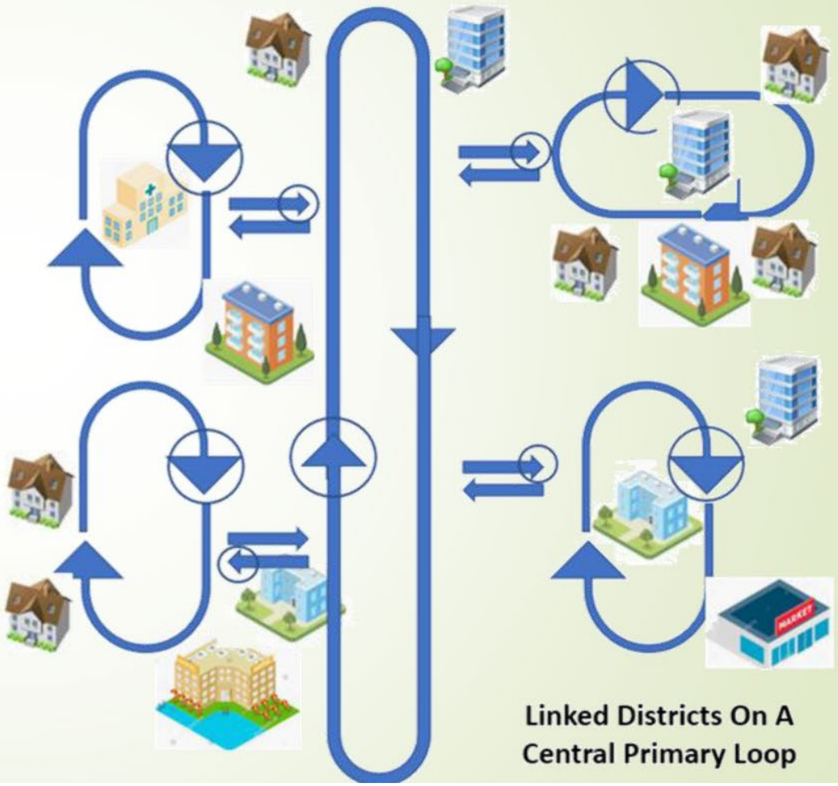
Sydney Harbor, Sydney Australia

850 Ton Capacity (Titanium)

LARGEST Lake Loop System in Australia

Wastewater as a *Thermal* ***Source/Sink***

- Municipal wastewater is typically 65-75°F <u>*all year*</u>
- Wastewater systems are connected to EVERY building
- The thermal energy contained within is FREE and RENEWABLE
- We can use this technology to both ***heat*** and ***cool*** the *Thermal Highway*©



The Average Person Uses **24 Gallons** of **Hot Water** per Day at 140°F/60°C*

- Average Residential Wastewater Temperature is 70°F/ 20°C
- Commercial & Industrial Wastewater Temperature can reach 140°F/60°C or Higher

Wastewater sources:

- Black and Grey Water Within Buildings
- Sanitary Sewers
- Lift Stations/Treatment Centres

**estimated 60 gallons/day of wastewater*

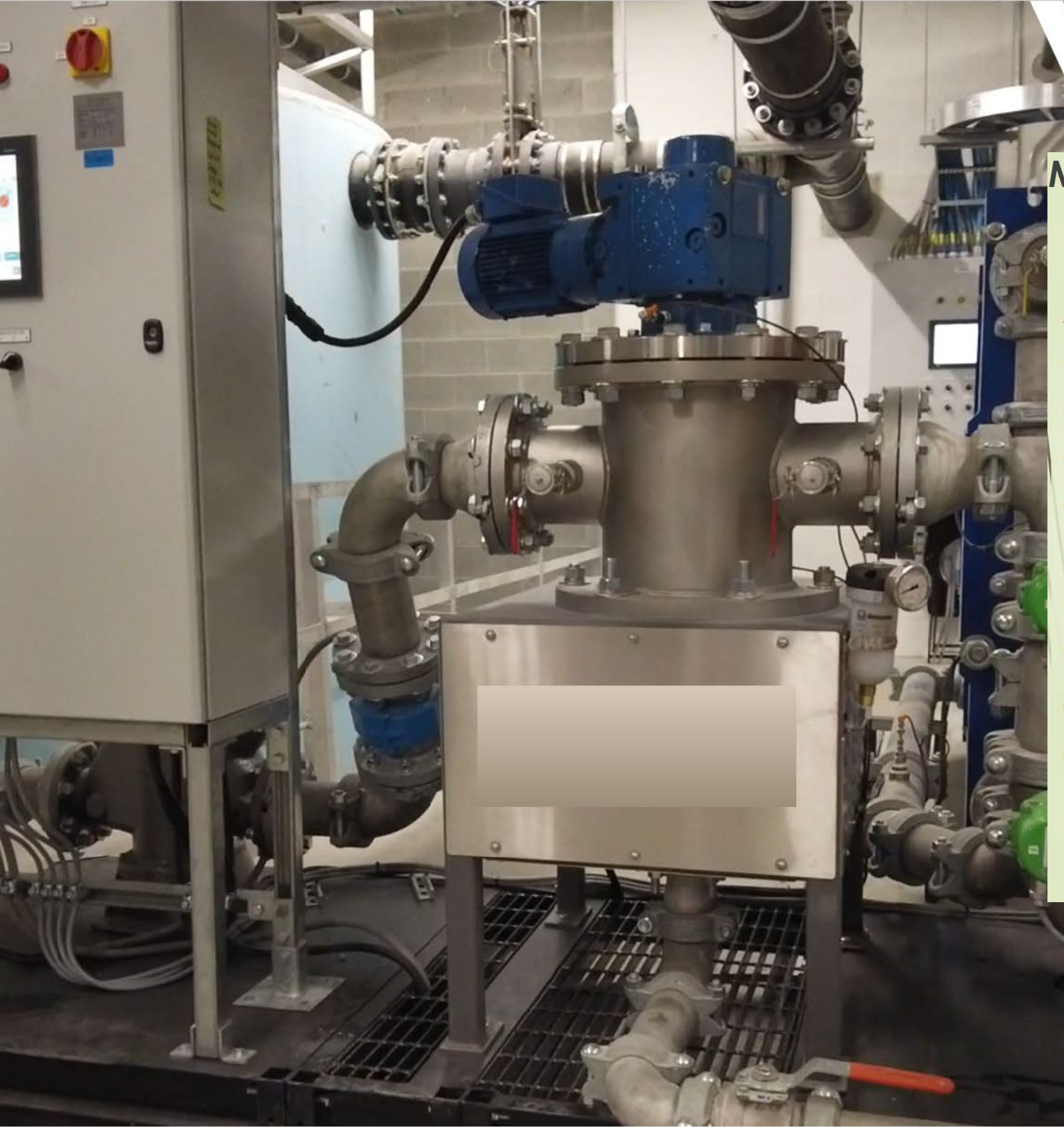
40% of Load – See 50/90 Rule

Cooling Tower

- No water consumption
- No wastewater generation from blowdown
- No chemical costs
- No carry-over to stain cars or surfaces
- No noise, vibration or unsightly equipment
- No chance of Legionella
- Less maintenance
- LOWER energy consumption and overall cost

Boiler

- No fossil fuels with associated hazards:
  - Fuel leaks or spills
  - Fumes
  - Explosions
- No on-site CO_2 generation
- No Certified Boiler Operator
- No annual burner adjustments
- No Boiler Room – less space
- No combustion air intakes or ducts
- No chimney or boiler stacks through roof (leaks)
- No gas meter!



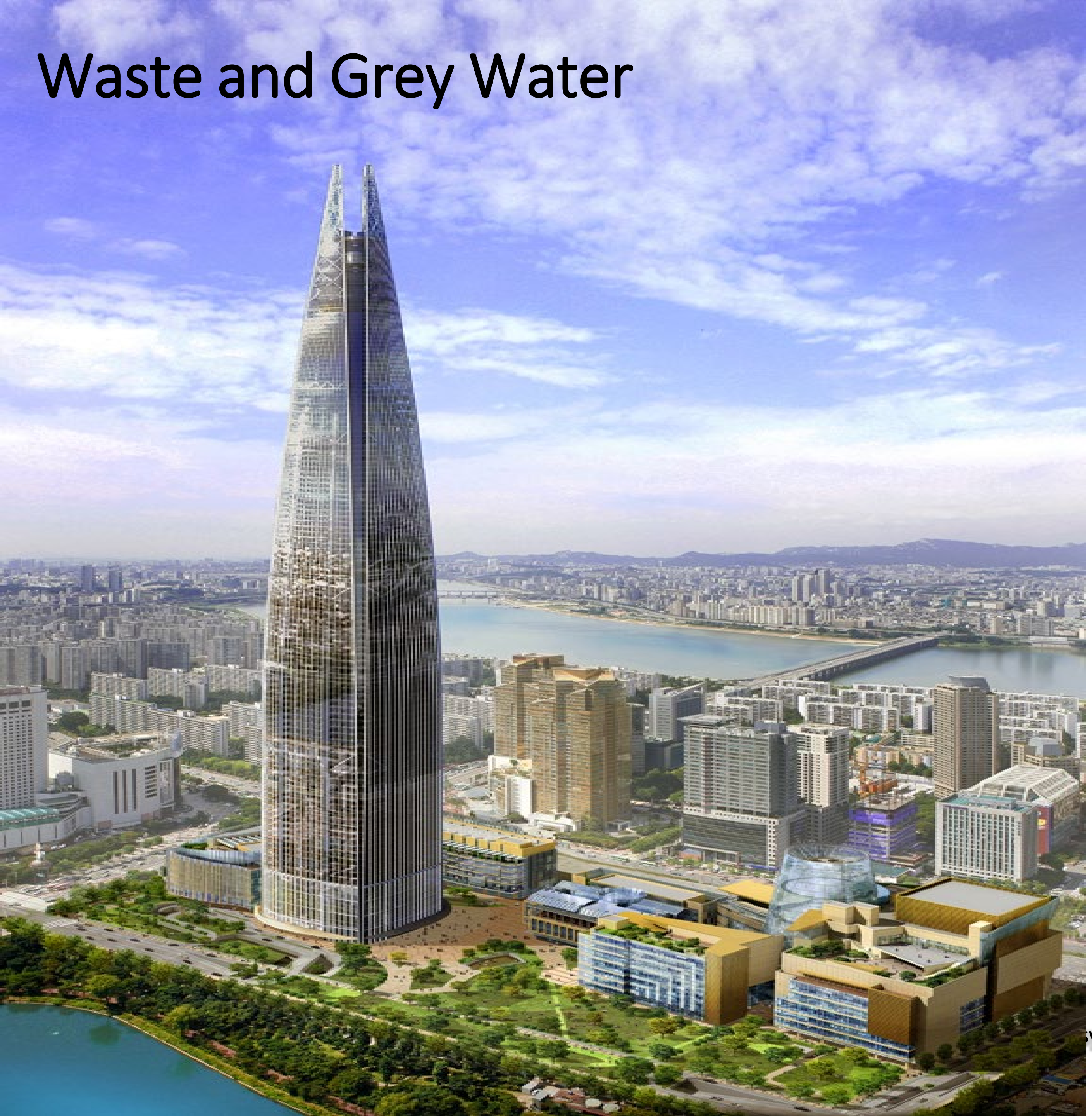
MAINTENANCE?

APPLICATION:

- Project Location: Vancouver, Canada
- Size: 1,000 tons / 3.5 MW
- Average COP of 4.5 to 5.0
- Flow: 2,000 GPM (126 l/s) of Raw Sewage (> 0.5 ***Billion*** Gallons!)
- Pressure drop is < 2 PSIG (14 kpa)
- Duration: 6 months of operation, 24/7

With proper application and equipment, these systems can reliably operate with minimal need to open them up!

Waste and Grey Water



Lotte tower, jamsil, seoul, korea

- 555 meter height (1830 feet)
- 123 story mixed use building
- Offices, apartments, retail, fitness centers, restaurants, night clubs
- 1100 vertical bores 200 meter depth
- Geothermal 8000 rt from 3 sources
- 3500 rt closed loop vertical, 3500 rt municipal water, 1000 rt waste water
- Geothermal system is appx. 30% of total building load and supplies over 70% of total heating, cooling annual hours
- All geothermal boreholes were drilled under footprint of building

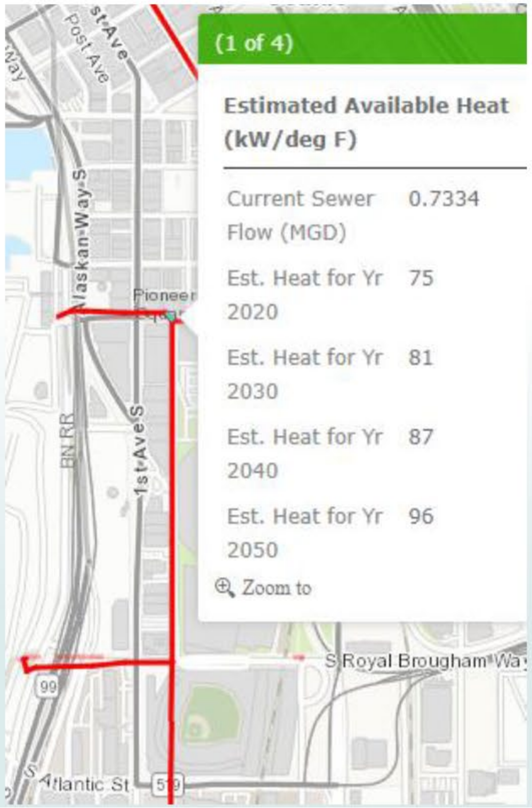
y of The GreyEdge

WASTEWATER AUTHORITY HEADQUARTERS

- Project Type: New construction of offices for municipal water and wastewater authority
- Project Location: Eastern USA
- Project Size: 167,000 FT^2/ 14,800 M^2
- Project Completion: 2018

Sewer Heat Recovery Lookup Application

Warm and hot wastewater flushed from homes and businesses is a significant source of energy. The US Department of Energy estimates that 350 billion kilowatt-hours of heat energy are flushed down the drains in the United States every year—roughly enough to power 30 million homes.



Challenges and Roadblocks

Is the juice worth the squeeze?

Brendan Hall, PE

CHA

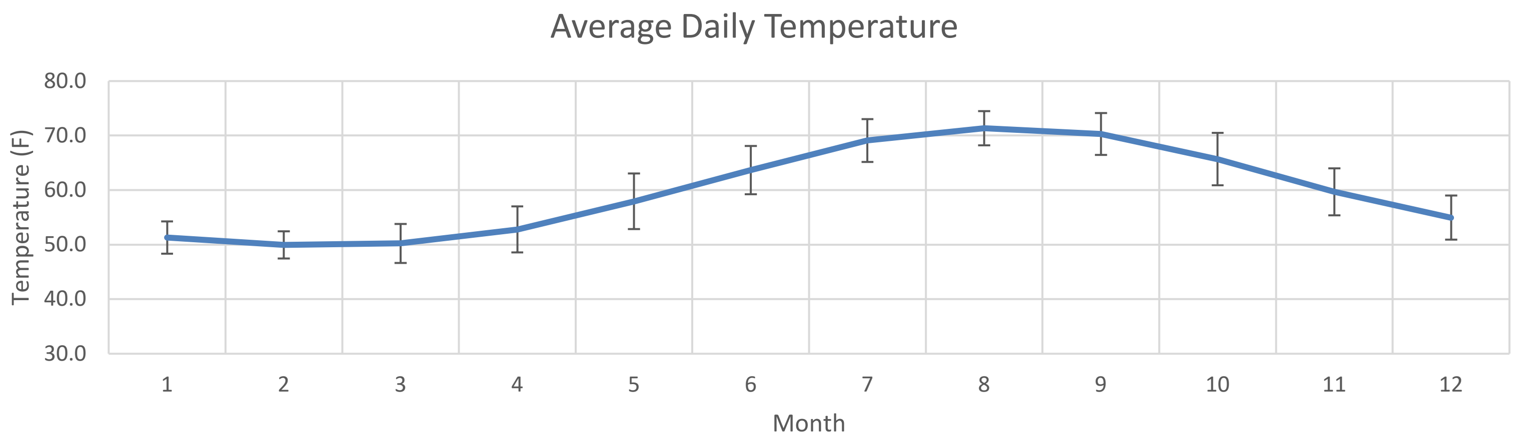
Why bother?

- Flows are generally warmer in the winter and more consistent than vertical boreholes.
- Usable flows are generally found in areas with higher density that don’t work as well for borefields.
- Once the infrastructure is in place, its “free” heat.
- The amount of available heat can be substantial.
  - Ex. 40 MGD WWTP plant -> 28,000 gpm -> assuming 50% of the flow is used, could support 98,000 MBH in HP heating.

Wastewater Streams

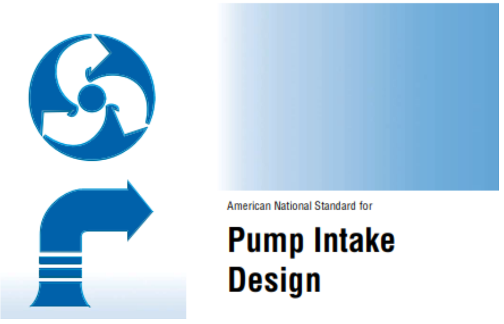
- Graywater
- WWTP Outfall
- Minimal to no filtering

- Blackwater
- Sewer Lines
- Specialized material handling



Accessing Flows

- Converting a gravity flow to a pressurized flow (force main)
- Screening and material handling for dirty flows.
- Wet well Construction
  – Hydraulic Institute Guidelines



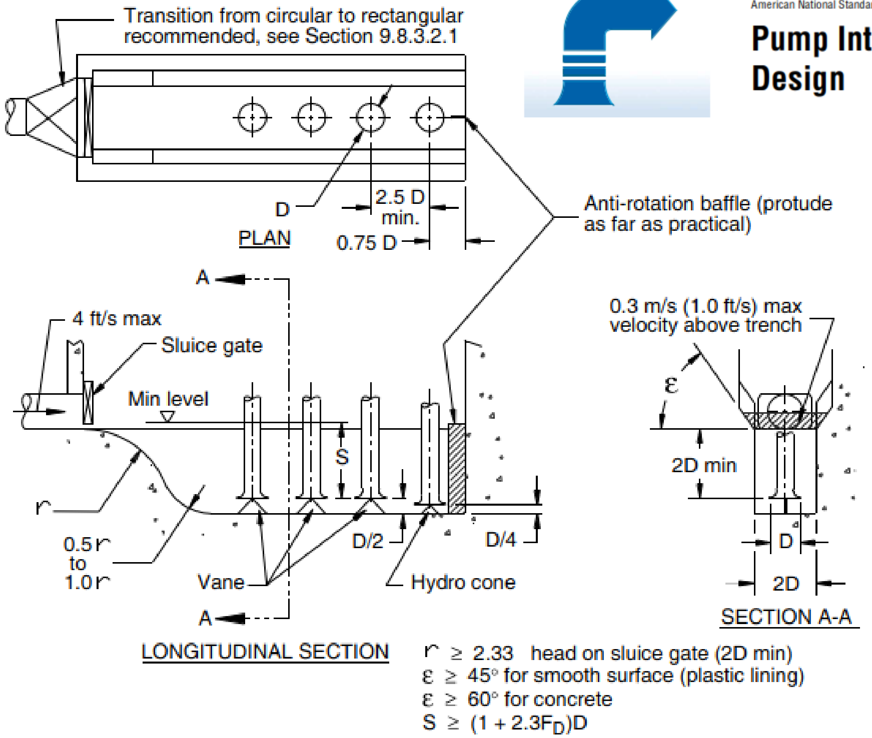


Figure 9.8.13 — Open trench-type wet well

Sewer Main Connection Challenges

- Depth to existing sewer mains
- Sewer Material
  - In older NE cities, can often be brick, clay and prestressed concrete pipe. All of which present challenges to access.
- Siting
  - Where to site above ground infrastructure
  - Land ownership
  - Zoning
  - Proximity to loads

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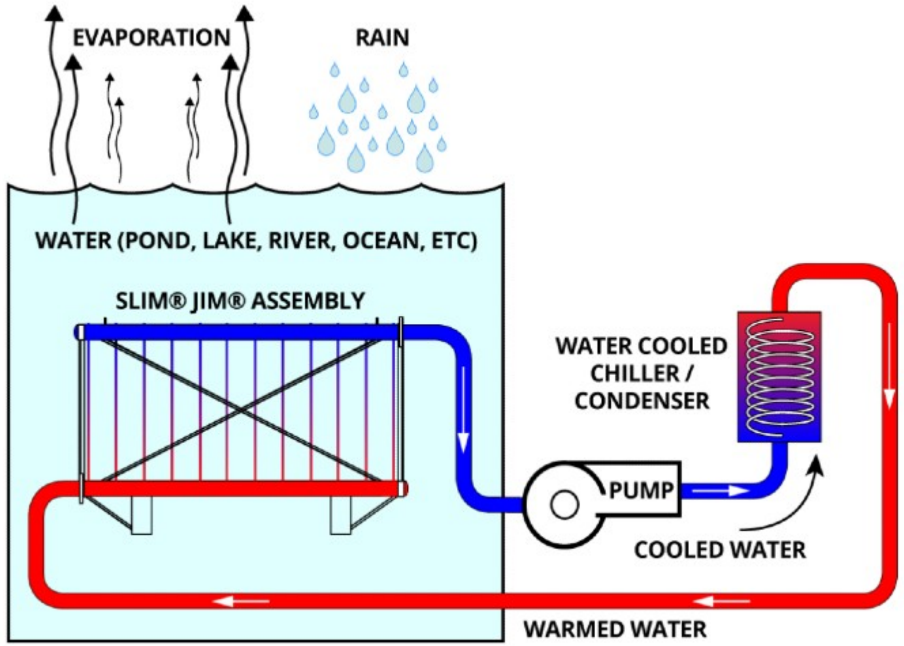
River Water

- In-flow heat Exchanger
  - Better performance than pond/lake.
  - Potential for glycol leakage.
  - Low approach temperatures.
- Direct heat exchange
  - Intake/Return Structure
  - Velocity limits
  - Wildlife impacts
  - Thermal environmental impacts.
  - Federal and/or State permitting process.



Customer Obligations

- Plan for intermittency
  - – Firm, dispatchable backup heating sources.
  - – Thermal Storage
  - – Backup power requirements
- Utility obligation to provide heat.

Questions

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