NYSERDA
Heat Recovery
Roundtable

Syracuse University Center of Excellence

April 9, 2024

Heat Recovery Roundtable Agenda

Q&A Session after each Manufacturer Presentation

Help us get to know the audience:

// Welcome Networking + Coffee/Pastries 9:00 AM - 9:30 AM //

- ***National Grid & NYSEG + RG&E*** Utility Offerings
- Manufacturer #1: Wastewater Heat Recovery by ***SHARC Energy***
- Manufacturer #2: High-Efficiency ERV+DOAS by ***Oxygen 8***
- Manufacturer #3: Condenser Heat Recovery by ***Trane Technologies***
- ***NYSERDA*** Incentive Programs [FlexTech / Clean Schools / Heat Recovery]

// NYSERDA Closing + Final Networking 11:30 AM - 12:00 PM //

Heat Pump Energy Recovery

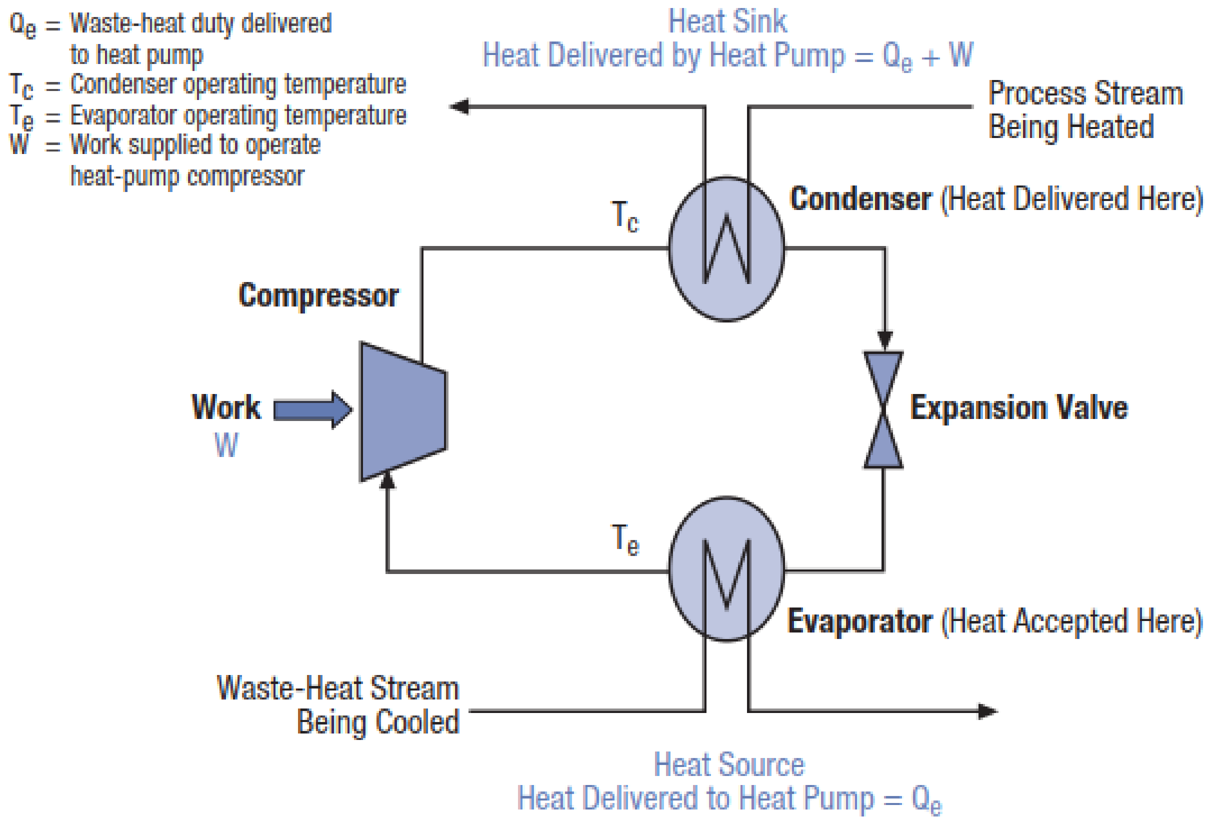
April 9, 2024

nationalgrid

Agenda

- What is a Heat Pump
- Heat Pump vs Heat Recovery Chillers
- NYS Clean Heat Eligibility
- Marketing
- Q & A

Heat Pump Schematic



1. Waste-heat stream evaporates heat-pump working fluid at low temperature and pressure
2. Compressor increases pressure of heat-pump working fluid
3. Heat-pump working fluid condenses at high temperature and pressure in the condenser, providing useful heat to a process stream
4. Condensed working fluid is expanded back to the evaporator

Heat Pump Chillers vs Heat Recovery Chillers

Heat recovery chillers ("HRC") and heat pump chillers ("HPC") are systems that provide space and water heating to a building by recovering heat from a low temperature source.

These systems can also provide chilled water for cooling.

ASHRAE 90.1 Notes that:

- HP Chillers provide <u>either</u> heating (HW) or cooling (CHW)
- HR Chillers provide <u>simultaneous</u> heating and cooling

Manufacturers call these products "chillers" because they were typically derived from legacy chiller products (analog: ASHPs derived from ACs)

Appropriate Standards are AHRI 550/590 for large or ISO 13256-2 for some small

NYS Clean Heat Eligibility

To be eligible for Clean Heat incentives, HRC/HPCs must be electrically operated and meet or exceed the minimum efficiency requirements at operating conditions set forth in ASHRAE Standard 90.1-2022, Table 6.8.1-16, when tested in accordance with AHRI 550/590.

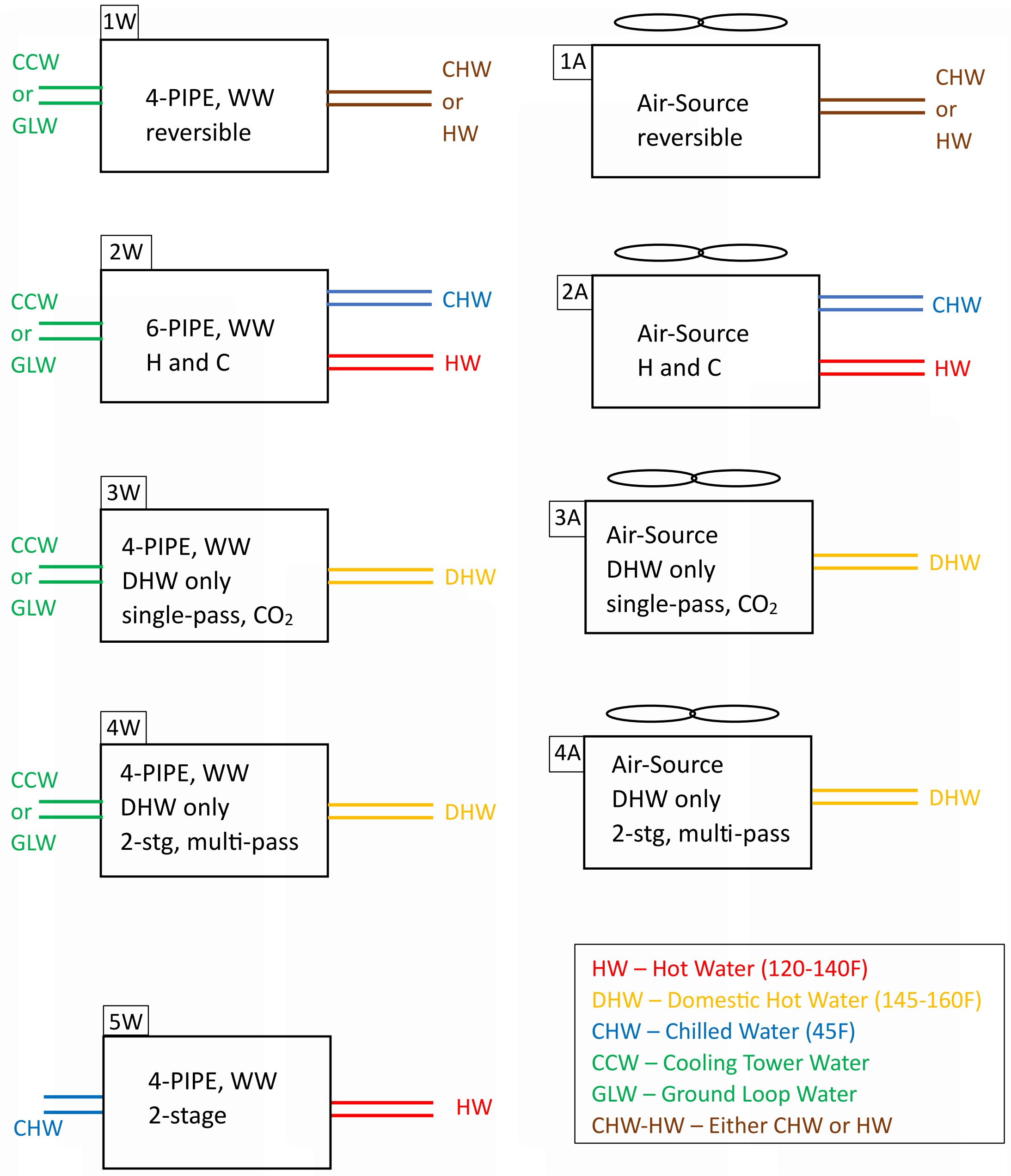
HRCs are exempt from minimum annual baseline heating consumption displacement thresholds for Category 4 partial load eligibility.

A Product Classification Scheme

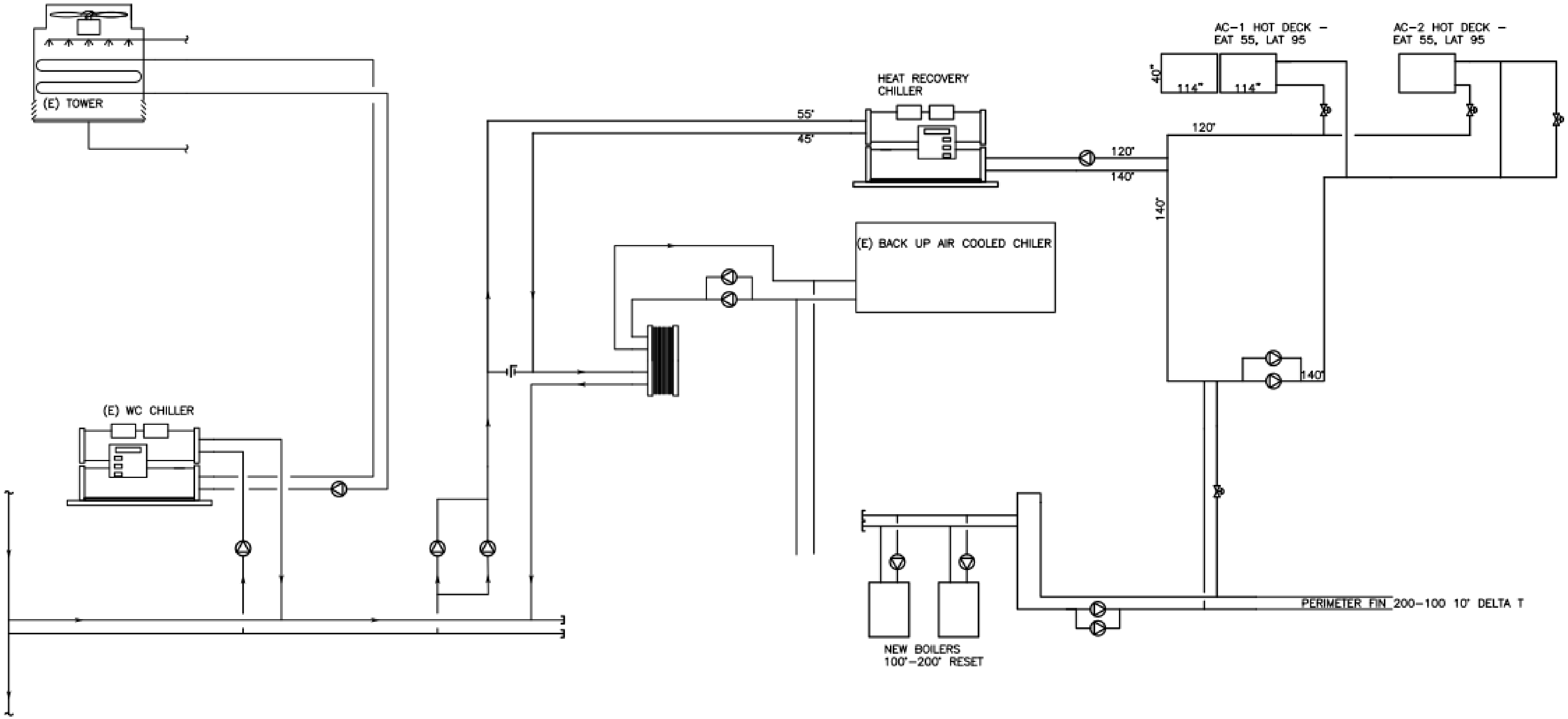
Types 1 to 5, with (W) for water-to-water and (A) for air-source

Types 1,3 and 4 are HP chillers
Types 2 and 5 are HR chillers

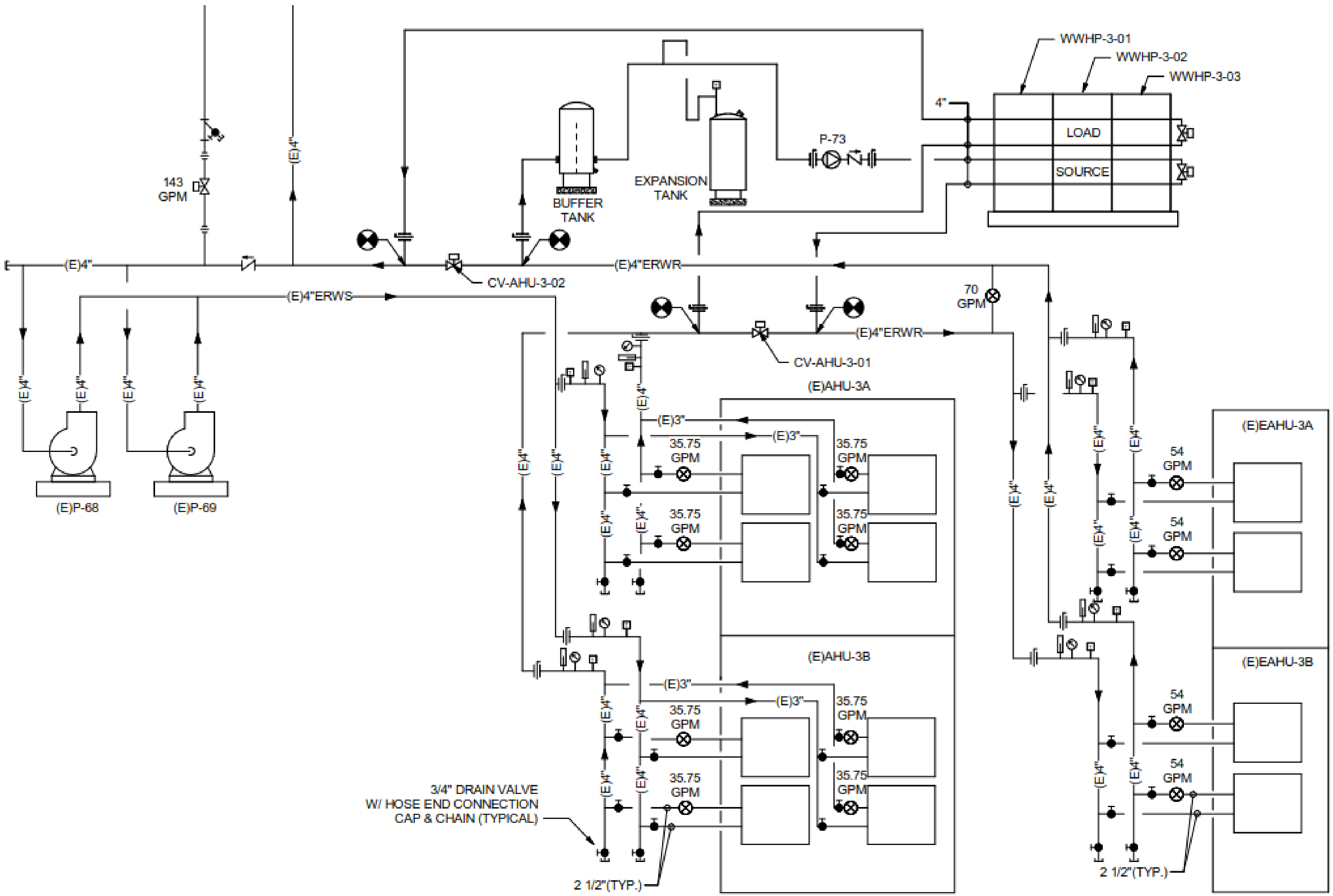
Low temperature heat source for heating can be: CCW, GLW, CHW or another other source (e.g., WWTP)



Syracuse University Skytop Data Center – HRC System



Syracuse University Life Science Center – HPC System



NYS Clean Heat Resources

For customers

- https://ngrid.com/cleanheat
- https://ngrid.com/nys-cleanheat
- https://cleanheat.ny.gov/

For contractors

- https://cleanheat.ny.gov/contractors/
- https://cleanheatconnect.ny.gov/

Heat Recovery Incentives

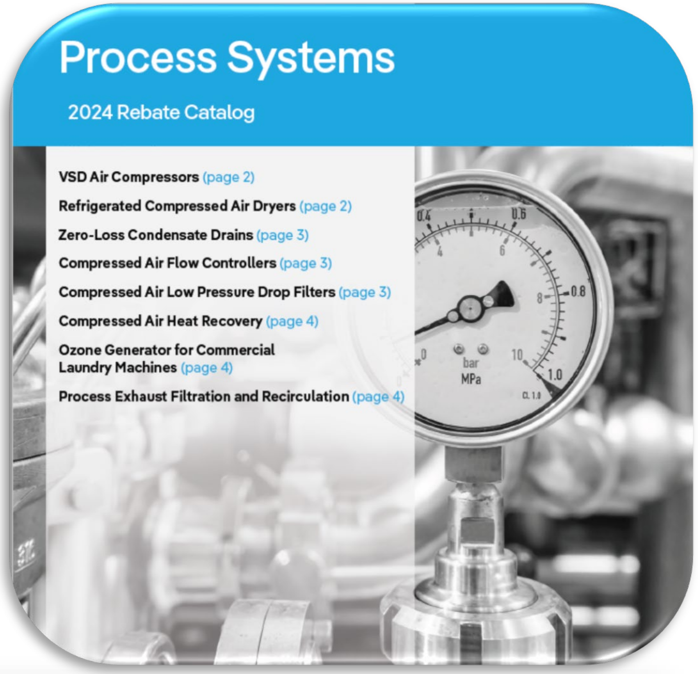
Tiffany Sheffield

04.09.2024

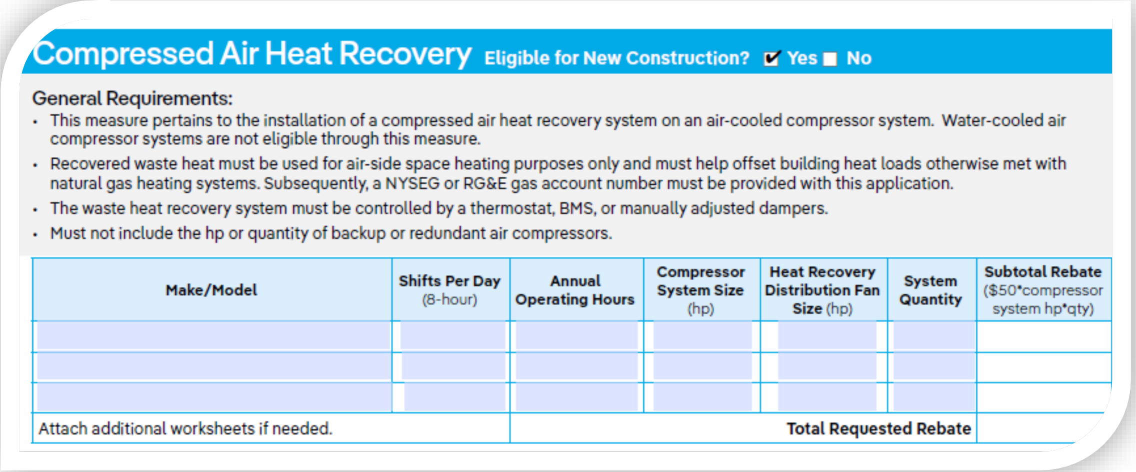
NYSEG RG&E
Part of the AVANGRID Family

NYSEG and RG&E Clean Heat and Heat Recovery Offerings

Prescriptive Rebate	Custom Rebate	Clean Heat Heat Pump
• Predetermined incentives • All found in the catalogs on our website • Preapproval not required, but encouraged	• Performance based incentives • Preappoval required • Pay up to 50% of your project	• Prescriptive Category <300,000 btu/h Incentive based on HP capacity at 5 degrees • Custom Category >300,000 btu/h Incentives based on MMBTU saved • Eligible Equipment ASHP, GSHP, HPWH, AWHP, HPC, ERV's, VRF's, HRV's



Commercial Projects can be capped. Projects cannot exceed 50% of the project cost.



Compressed Air Heat Recovery Eligible for New Construction? ☑ Yes ☐ No

General Requirements:
- This measure pertains to the installation of a compressed air heat recovery system on an air-cooled compressor system. Water-cooled air compressor systems are not eligible through this measure.
- Recovered waste heat must be used for air-side space heating purposes only and must help offset building heat loads otherwise met with natural gas heating systems. Subsequently, a NYSEG or RG&E gas account number must be provided with this application.
- The waste heat recovery system must be controlled by a thermostat, BMS, or manually adjusted dampers.
- Must not include the hp or quantity of backup or redundant air compressors.

Make/Model	Shifts Per Day (8-hour)	Annual Operating Hours	Compressor System Size (hp)	Heat Recovery Distribution Fan Size (hp)	System Quantity	Subtotal Rebate ($50*compressor system hp*qty)
Attach additional worksheets if needed.					Total Requested Rebate	

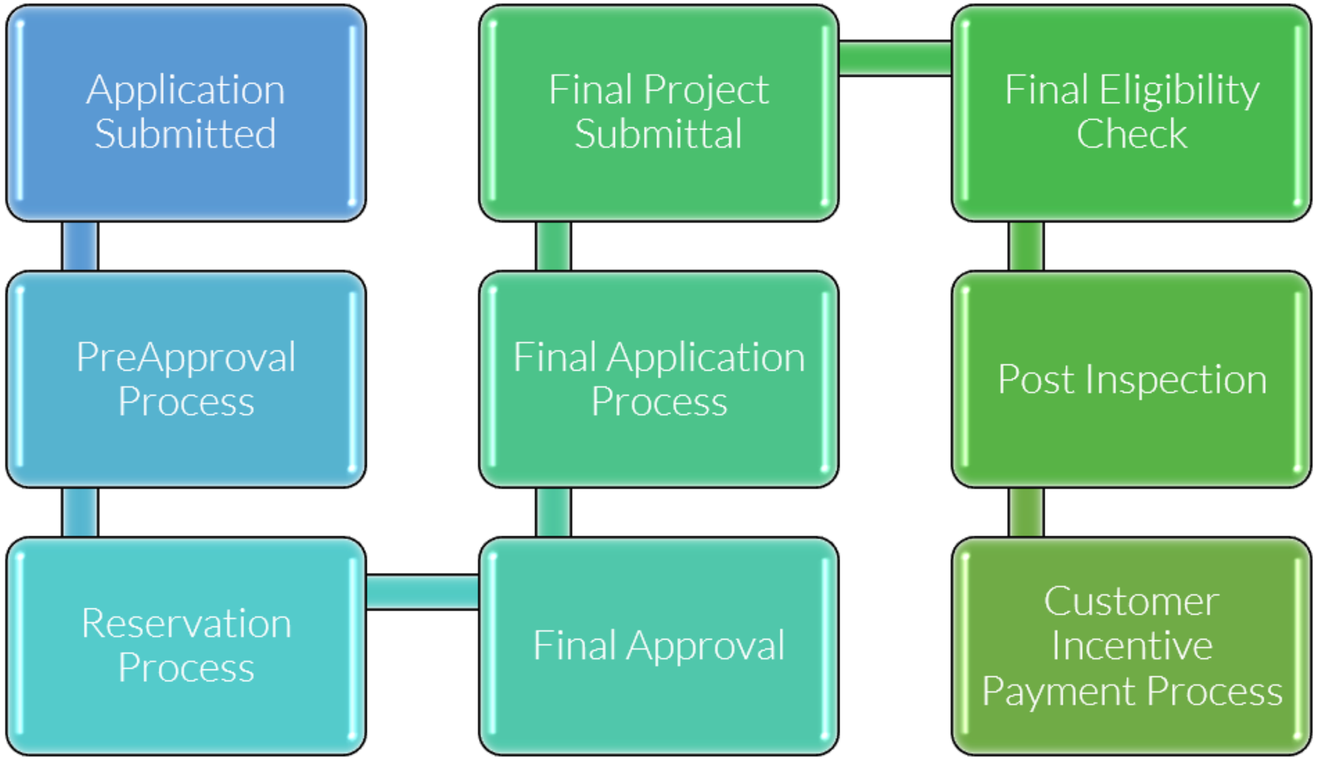
C&I Program Manager – Tiffany Sheffield – Tiffany_Sheffield@rge.com
Clean Heat Program Manager – Nicole Williams – Nicole.Williams@NYSEG.com

Project Process Flow

1. Application Submitted
2. All project documents submitted w/application
3. Eligibility Check
4. Customer Incentive Payment Process

Prescriptive Project Process – no pre-inspection required

Custom Project Process



Project Example – 1 Business 2 sites

Project Cost	Therm Savings	MMBTU Savings	Customer Incentive
$42,544.88	53,494.34	5,359.43	$23,000

<u>Both Projects were Prescriptive</u>

- Compressed Air – Heat Recovery – Rebate of $11,500

Heat Recovery Chiller Project

Project Summary

- One of the first Heat Pump Chillers brought into the Clean Heat program under Category 4
- An approximate 300-ton heat recovery chiller combined with 5 ERV's.
- Eligible for over $500,000 in Clean Heat Incentives. (Subject to M&V)
- In commercial applications, heat pump chillers or heat recovery chillers ("HRC") are heat pumps that provide hydronic or hot water (HW) heating that can be used for space or water heating. The word "chiller" implies the unit is reversible and can also provide cooling (or chilled water, CHW) when needed. The heat source for a HRC can be 1) outdoor air (as in an air-to-water heat pump, AWHP), or 2) a water stream such as condenser water or chilled water.

SHARC ENERGY

Turn Your Wastewater Into Opportunity

COMPANY OVERVIEW

SHARC Energy headquartered in Port Coquitlam, BC, Canada

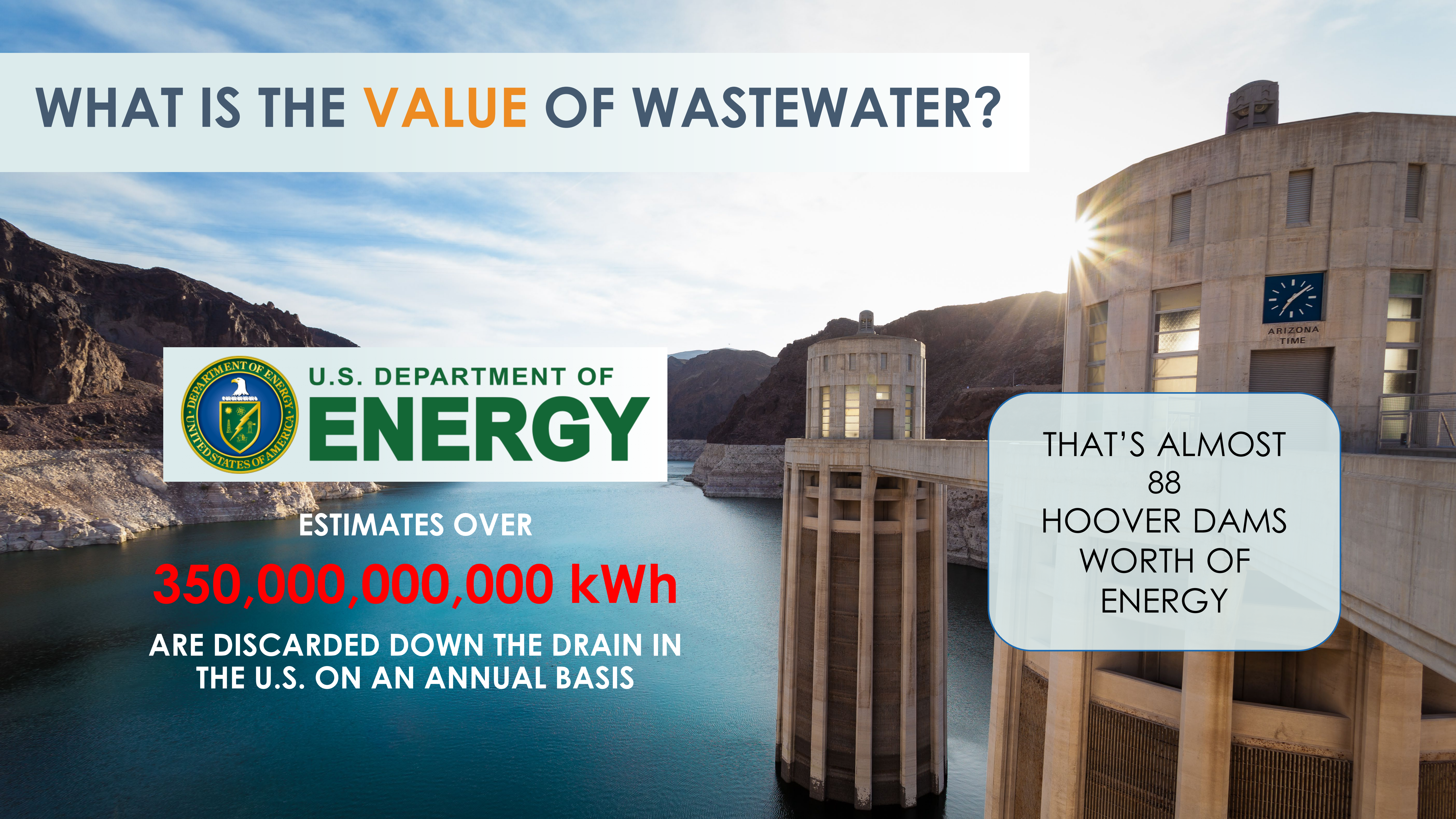
Founded in 2010, by a team of engineering professionals with significant experience in the HVAC & Geo-Exchange and Plumbing industries

Developed its first product: the 'SHARC' in 2011

In 2016, released second product the 'PIRANHA' for smaller scale applications

In 2019, released 'PIRANHA HC'

WHAT IS THE VALUE OF WASTEWATER?



U.S. DEPARTMENT OF ENERGY

ESTIMATES OVER

350,000,000,000 kWh

ARE DISCARDED DOWN THE DRAIN IN THE U.S. ON AN ANNUAL BASIS

THAT'S ALMOST 88 HOOVER DAMS WORTH OF ENERGY

The Average Person Uses **30 Gallons of Hot Water** per Day at **120°F***

- Producing an estimated **60 gallons/day** of wastewater
- Average Residential Wastewater Temperature is **70°F**
- Commercial, Industrial, & Healthcare Wastewater Temperature can reach **140°F** or Higher

Wastewater sources:

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

* Hot-Water Demand and Use Guidelines for Apartment Buildings, Medium Average Daily - Table 7. ASHRAE Heating, Ventilating & Air-Conditioning Applications, Chapter 50 - Service Water Heating

Why Wastewater?

- Limitless Energy Source Material
- Consistent Temperatures Year-Round

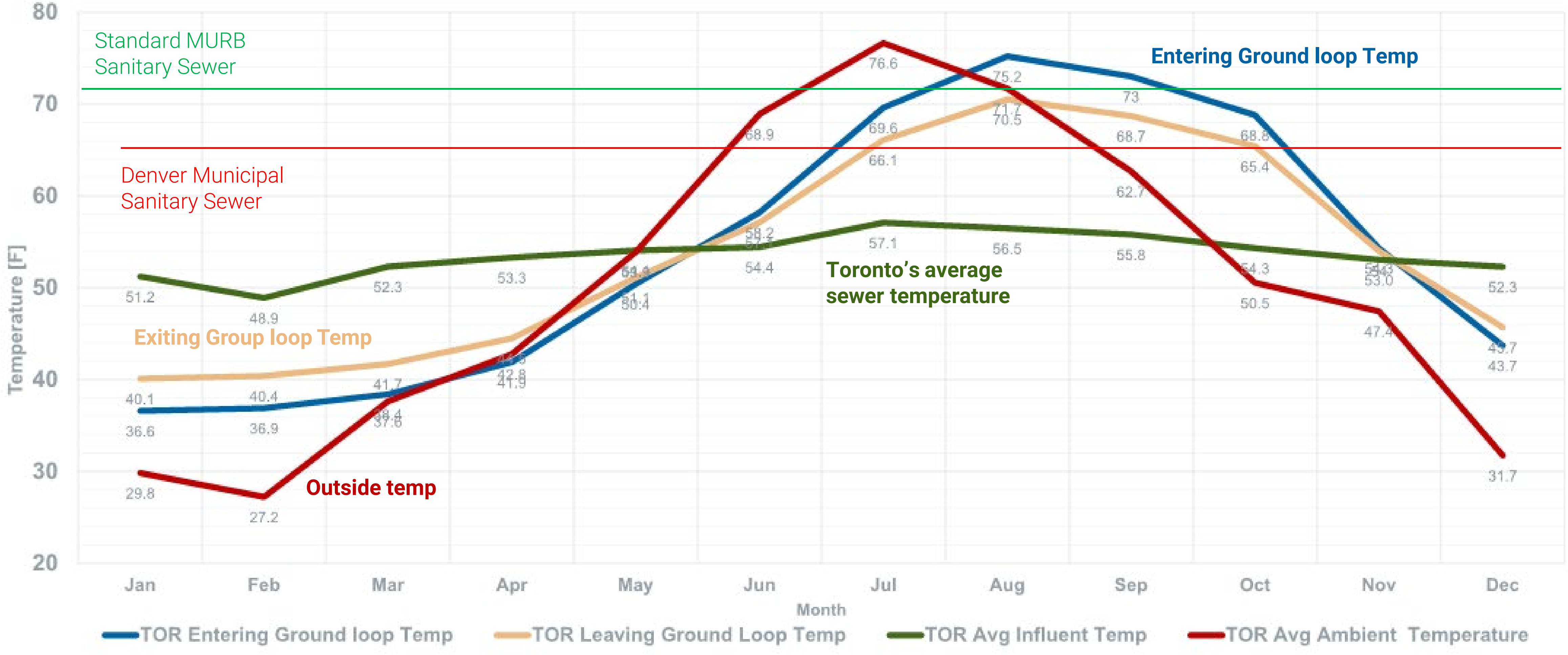
Reduces

- Energy Loss from Buildings
- Energy Use & Operational Costs
- GHG Emissions
  - "Carbon Taxes"

High Efficiency Electrification

- Market Demand
- Utility Heat Pump Incentives
- Qualifies for Investment Tax Credit (IRA)

Wastewater – Geothermal – Ambient Temps



Source: City of Toronto presentation

PIRANHA.sharcenergy.com

PIRANHA SERIES

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

Wastewater Energy Transfer (WET) Market Applications

Residential

- Multi-Family Housing
  - ➢ PIRANHA (35–350 Units)
  - ➢ SHARC (350+ Units)
- Student Housing
- Senior Living
- Community Housing
- Corrections

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**

The PIRANHA Series

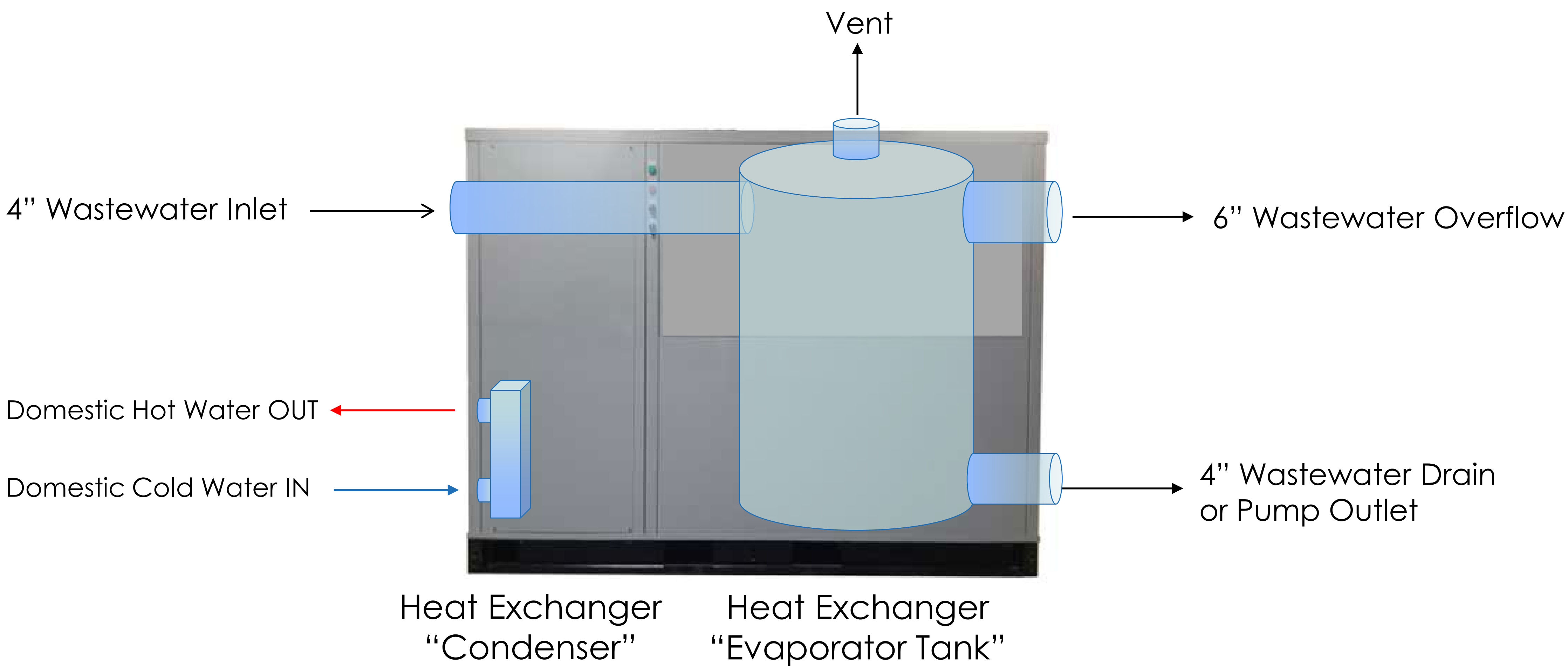
The PIRANHA is a self-contained heat pump that uses a specifically designed direct expansion heat exchanger to recover thermal energy from a building's wastewater for domestic hot water heating

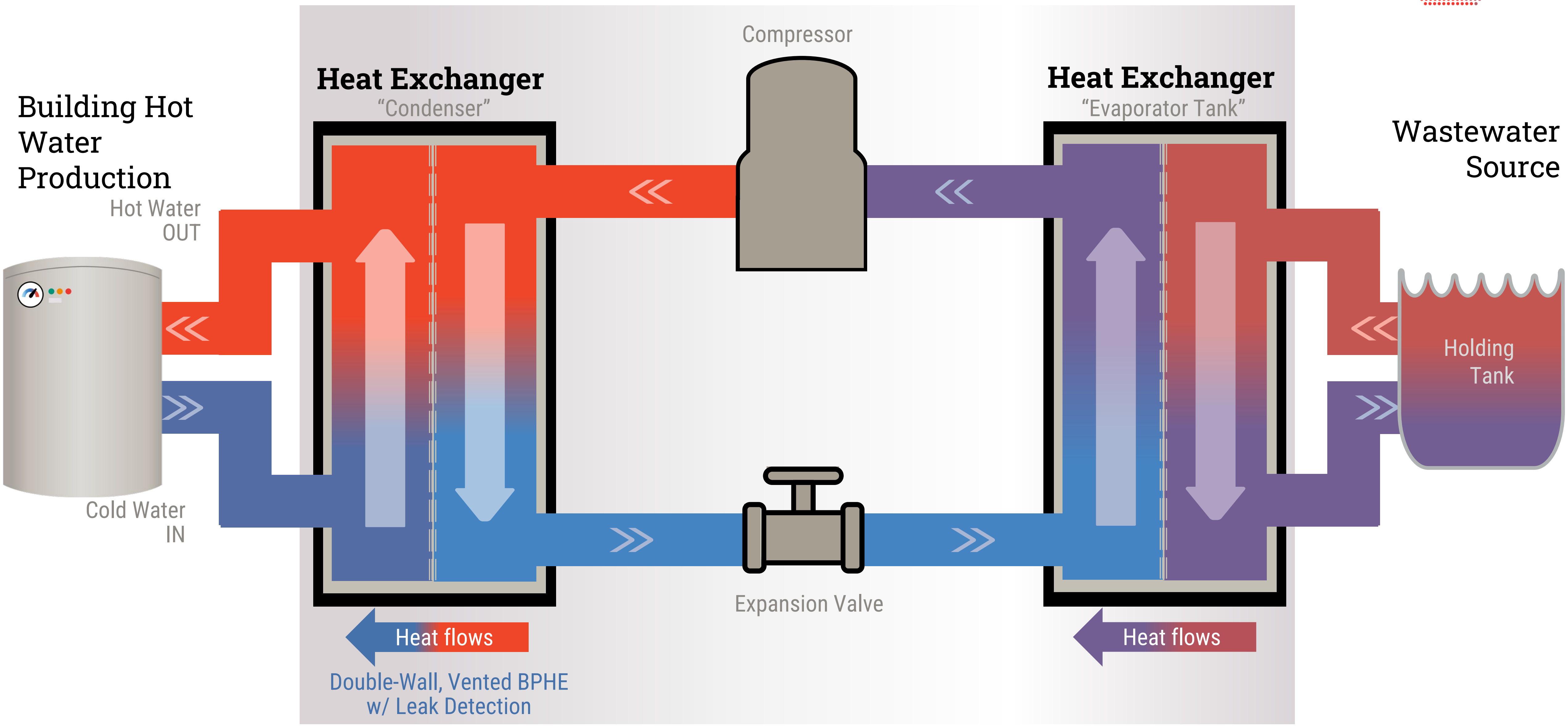
Models: T5 / T10 / T15

- Design heat output
  - **60 / 120 / 180 MBH**
  - Increase output scalable with multiple units
- Designed to fit through standard double door
- Average COP of 3.5*
- **NSF-372 rated BPHE**
  - Double-wall, leak detection
- R-513a
  - 56% Lower GWP than R-134a (573 vs 1,430)
  - Same performance

*Average COP across a range of source temperatures, output temperatures and application types.

PIRANHA

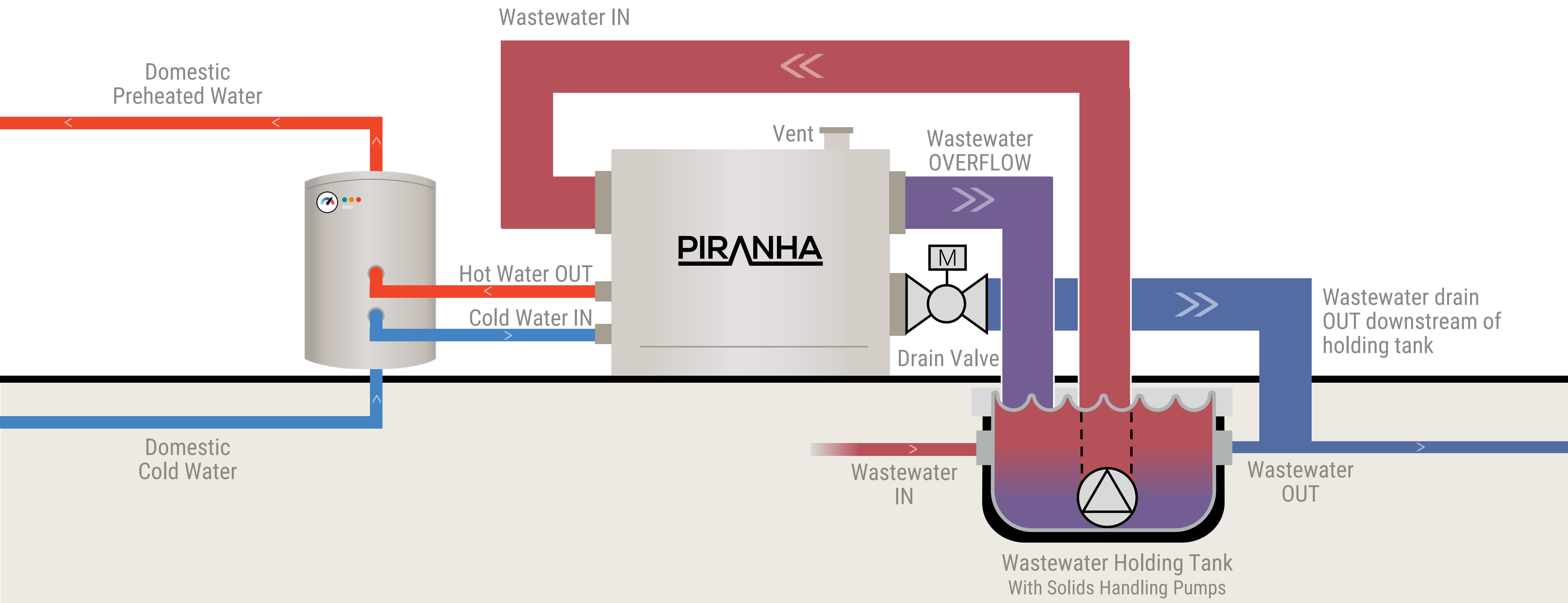

Vent
4" Wastewater Inlet
6" Wastewater Overflow
Domestic Hot Water OUT
Domestic Cold Water IN
4" Wastewater Drain or Pump Outlet
Heat Exchanger "Condenser"
Heat Exchanger "Evaporator Tank"


Building Hot Water Production
Hot Water OUT
Cold Water IN
Heat Exchanger
"Condenser"
Compressor
Heat Exchanger
"Evaporator Tank"
Wastewater Source
Holding Tank
Expansion Valve
Heat flows
Double-Wall, Vented BPHE w/ Leak Detection
Heat flows

How PIRANHA Works

Energy Recovery (Heating)

Typical Above-Grade PIRANHA Installation



PIRANHA HC

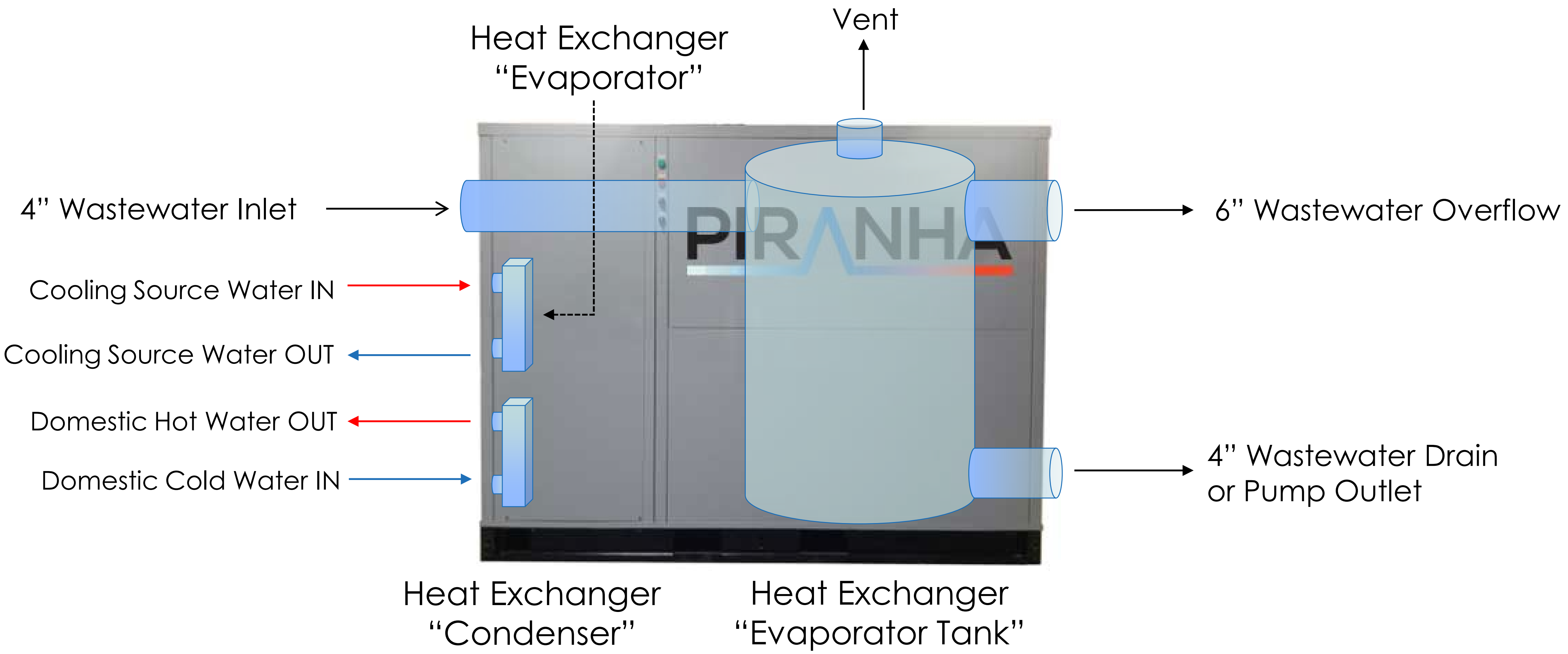
The PIRANHA is a self-contained heat pump that uses a specifically designed direct expansion heat exchanger to recover thermal energy from a building's wastewater for domestic hot water heating

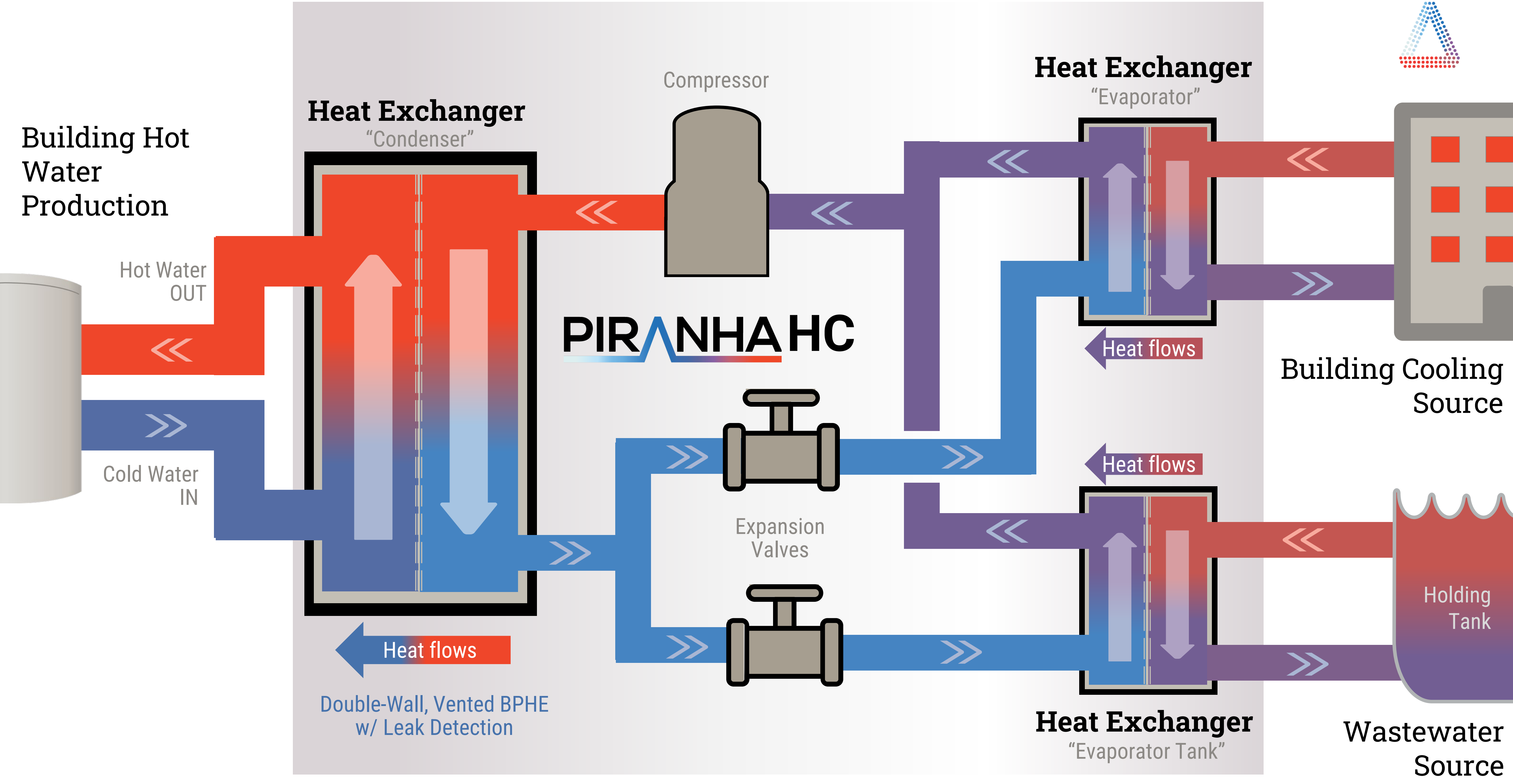
PIRANHA HC Combines Wastewater Energy Recovery with Space Conditioning

- **Models: T5 HC/T10 HC/T15 HC**
  - Design Heat Output
    - **60/120/180 MBH**
  - Design Cooling Capacity
    - **48/96/144 MBH**
    - Increase output scalable with multiple units
  - Designed to fit through standard double door
- Average combined COP up to 7*
- DHW production while Cooling Spaces
- **NSF-372 rated BPHE**
  - Double-wall, leak detection
- R-513a
  - 56% Lower GWP than R-134a (573 vs. 1,430)
  - Same performance

*Average COP across a range of source temperatures, output temperatures and application types.

THE PIRANHA HC

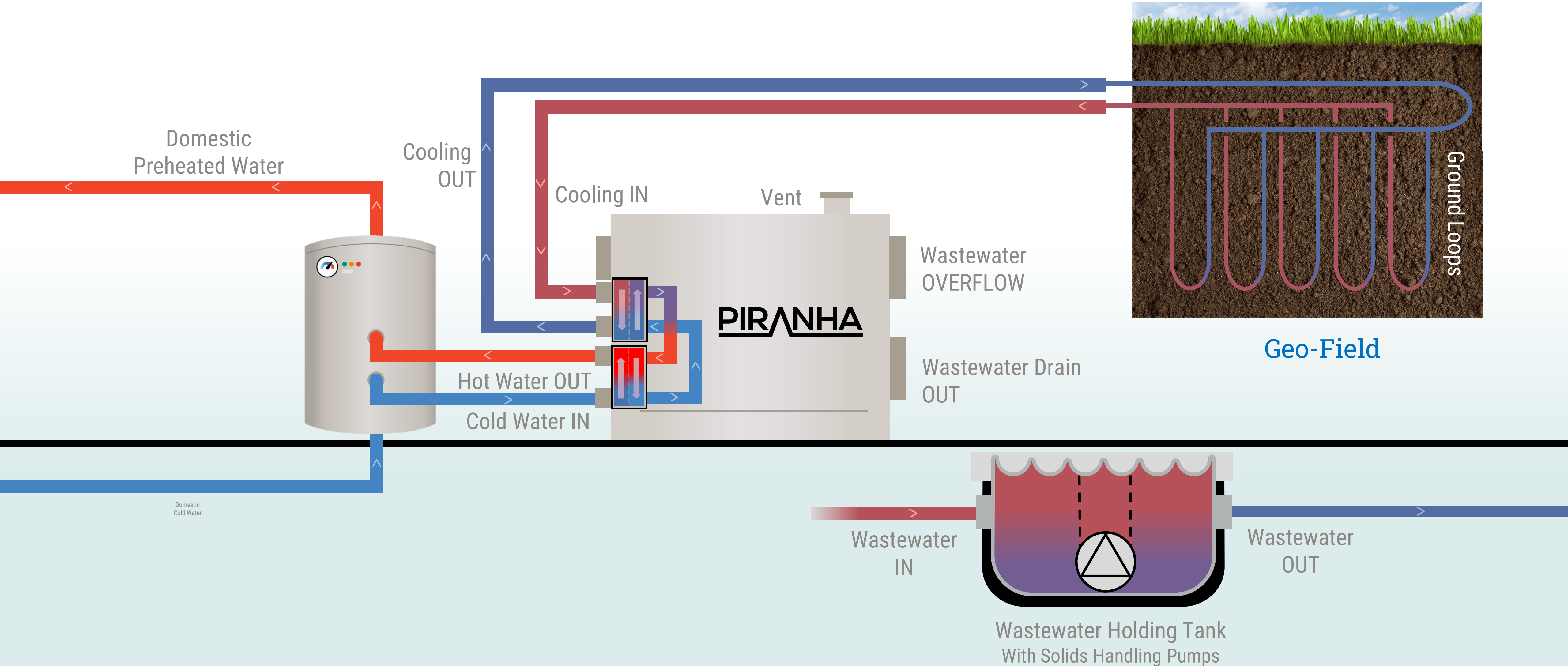




Building Hot Water Production
Hot Water OUT
Cold Water IN
Heat Exchanger
"Condenser"
Heat flows
Double-Wall, Vented BPHE w/ Leak Detection
Compressor
PIRANHA HC
Expansion Valves
Heat Exchanger
"Evaporator"
Heat flows
Heat flows
Heat Exchanger
"Evaporator Tank"
Building Cooling Source
Holding Tank
Wastewater Source

PIRANHA paired with Geothermal

Simultaneous Heating + Cooling



SHARC Series

The SHARC is a wastewater separator/filter that allows access to thermal energy by temporarily removing solids from wastewater.

The filtered wastewater is then passed through a Heat Exchanger where the thermal energy is transferred to/from the building.

SHARC Model	Max Flow	Typical Energy Transfer
660	550 GPM / 34 L/s	2,474 MBH / 0.725 MW
880	1,200 GPM / 75 L/s	5,399 MBH / 1.6 MW
1212 †	2,500 GPM / 157 L/s	11,248 MBH / 3.3 MW

Higher flow rates achieved with parallel modules

† Upcoming Product

SHARC Series

- Designed to allow for high flow rates and ease of service.

- **Variable Use**
  - **DHW (Domestic Hot Water)**
  - **Space Conditioning**
    - Heating (Energy Recovery) or Cooling (Energy Rejection)
  - **Wastewater Cooling**
  - **Geo-Loop conditioning and/or Geo-field offset**

- Exponential efficiency for low-temp loops
  - Up to MW of energy transferred for low kW energy input

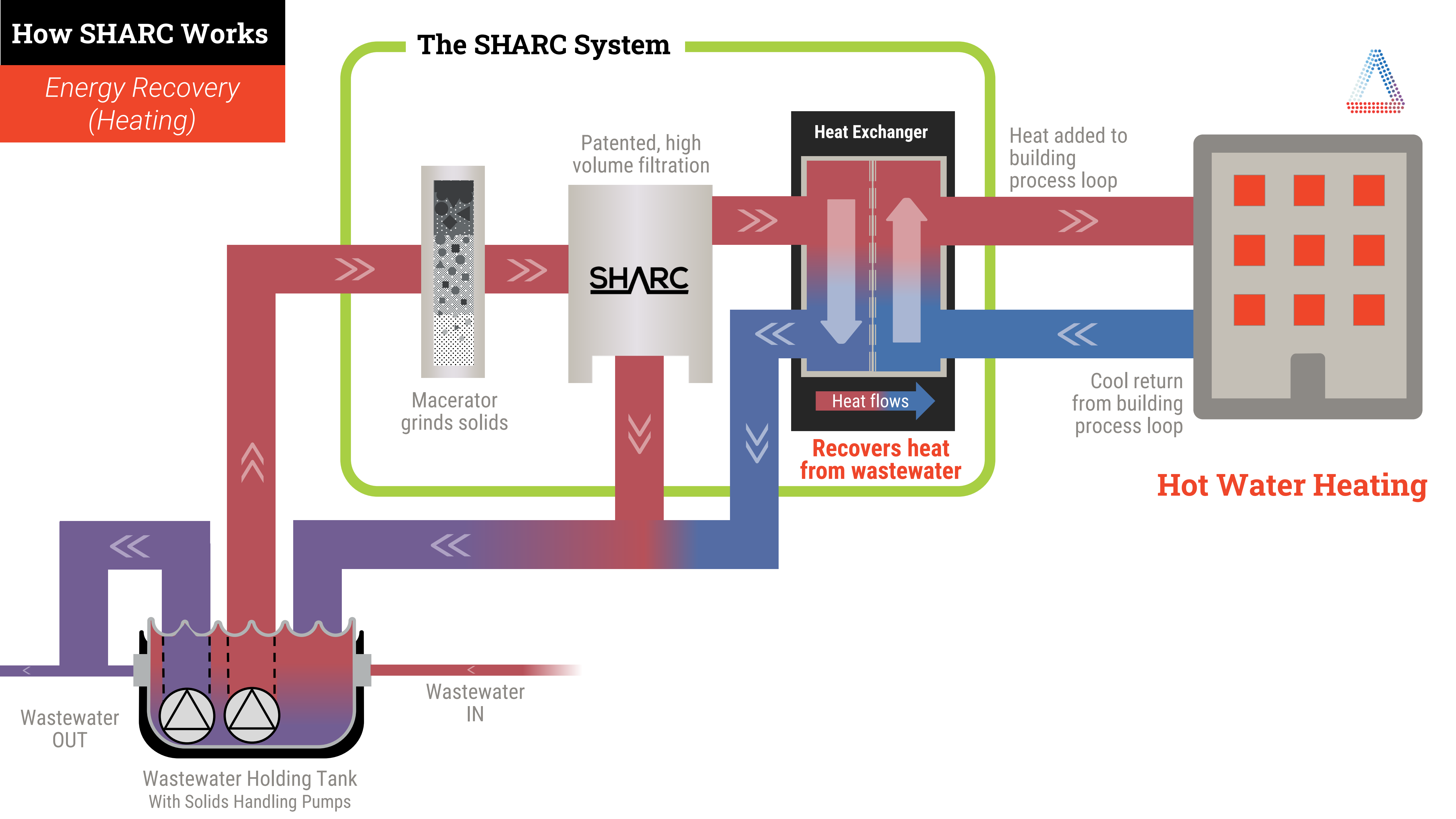
- Completely Sealed at Installation Site – **Odor Free**

SHARC SYSTEM

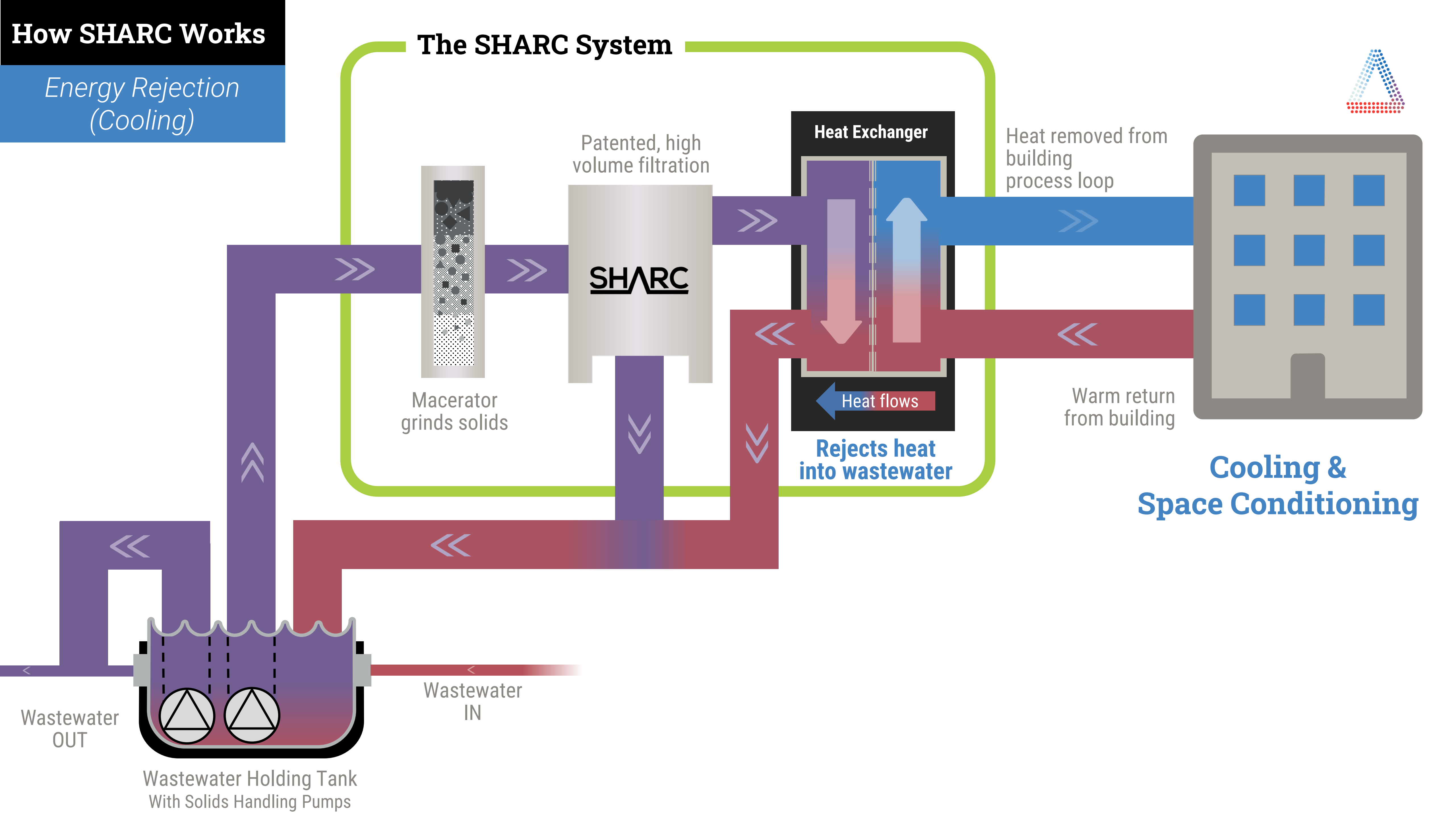
- SHARC Filter Unit
- Support Frames/Skids
- Control Panel
- Macerator/Grinder
- Piping/Valve Assembly
- Plate & Frame Heat Exchanger
  - Wide Gap

- 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

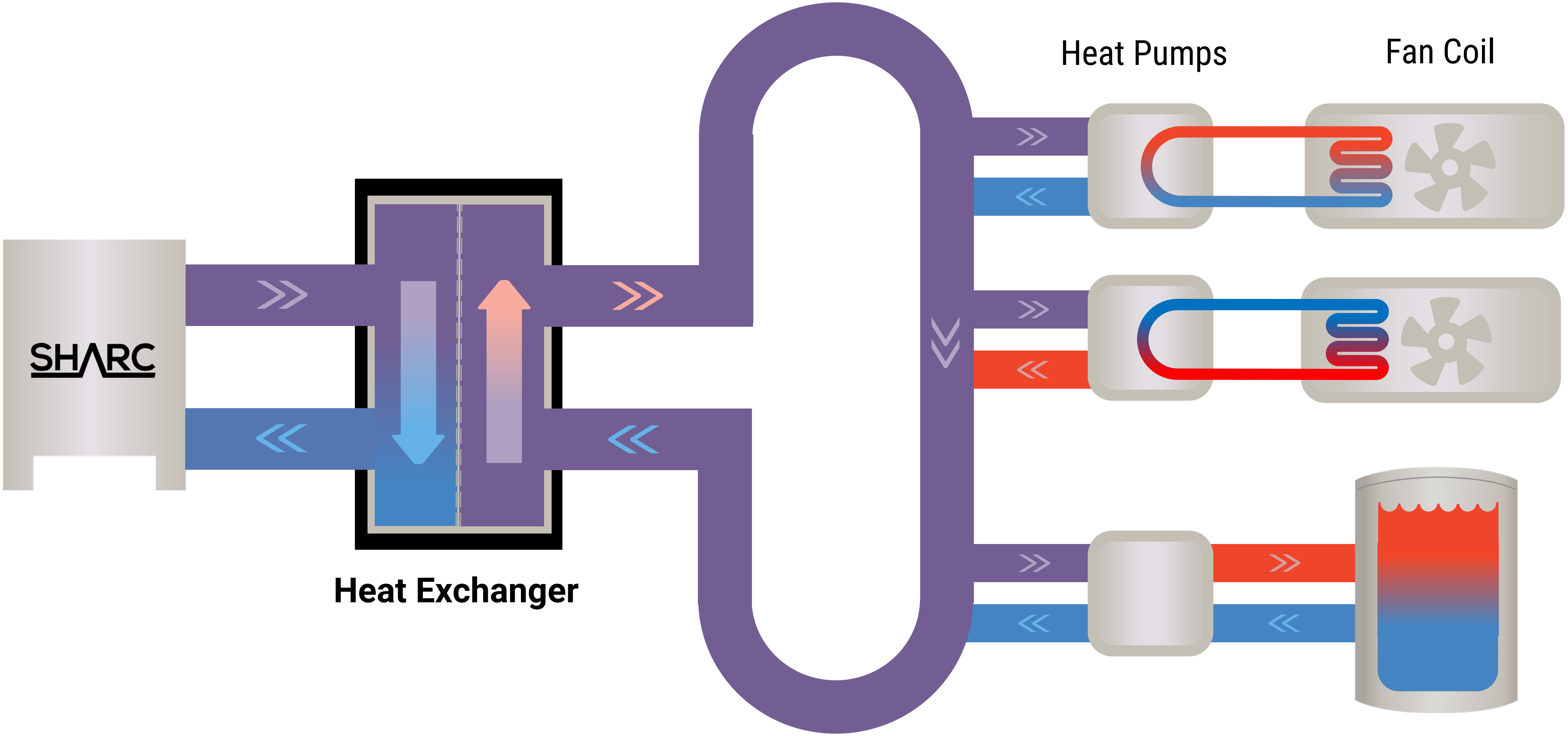


How SHARC Works
Energy Recovery (Heating)
The SHARC System
Patented, high volume filtration
Heat Exchanger
Heat added to building process loop
SHARC
Macerator grinds solids
Heat flows
Recovers heat from wastewater
Cool return from building process loop
Hot Water Heating
Wastewater IN
Wastewater OUT
Wastewater Holding Tank
With Solids Handling Pumps

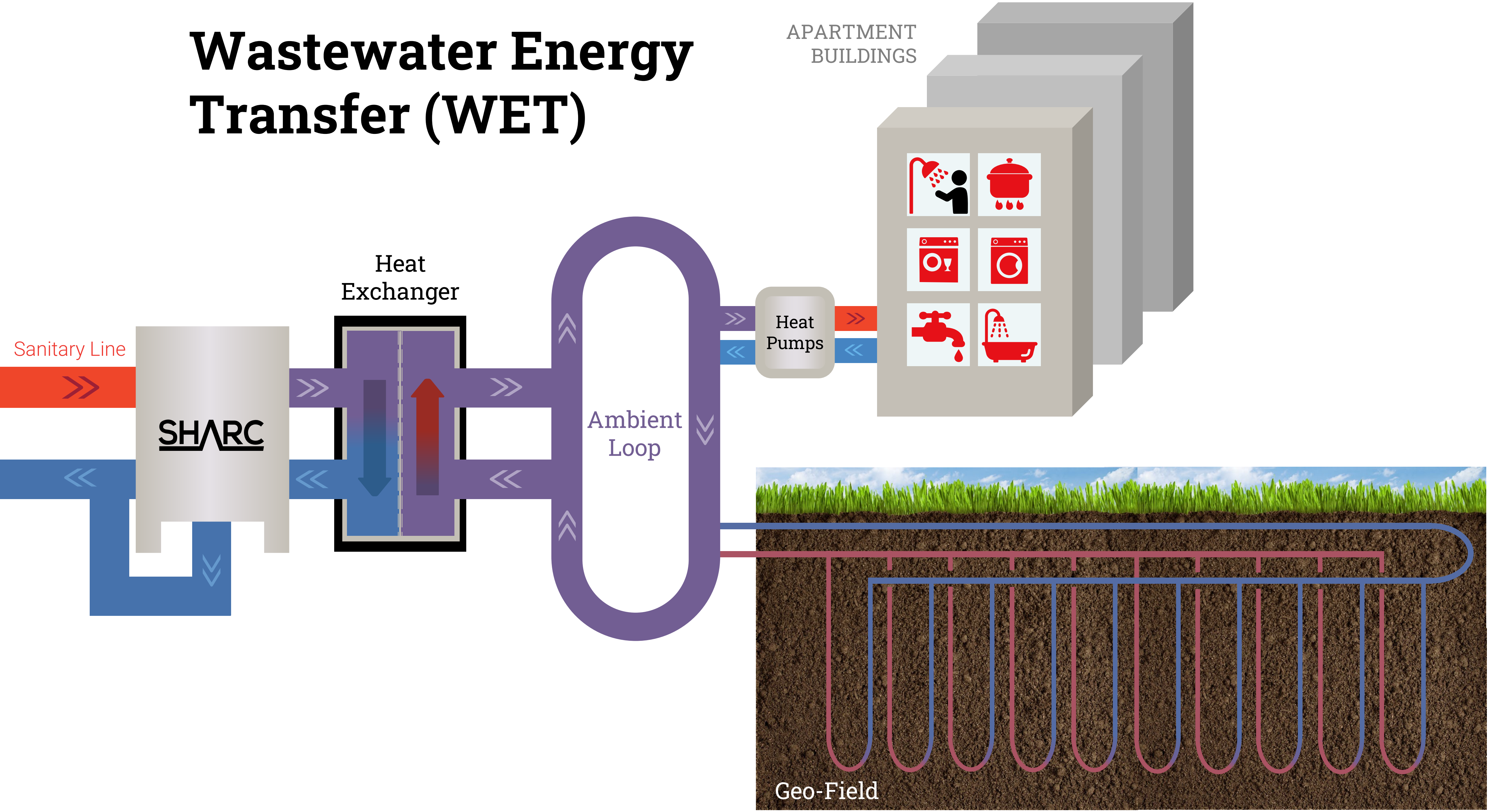

How SHARC Works
Energy Rejection (Cooling)
The SHARC System
Patented, high volume filtration
SHARC
Macerator grinds solids
Heat Exchanger
Heat flows
Rejects heat into wastewater
Heat removed from building process loop
Warm return from building
Cooling & Space Conditioning
Wastewater OUT
Wastewater IN
Wastewater Holding Tank
With Solids Handling Pumps

How SHARC Works

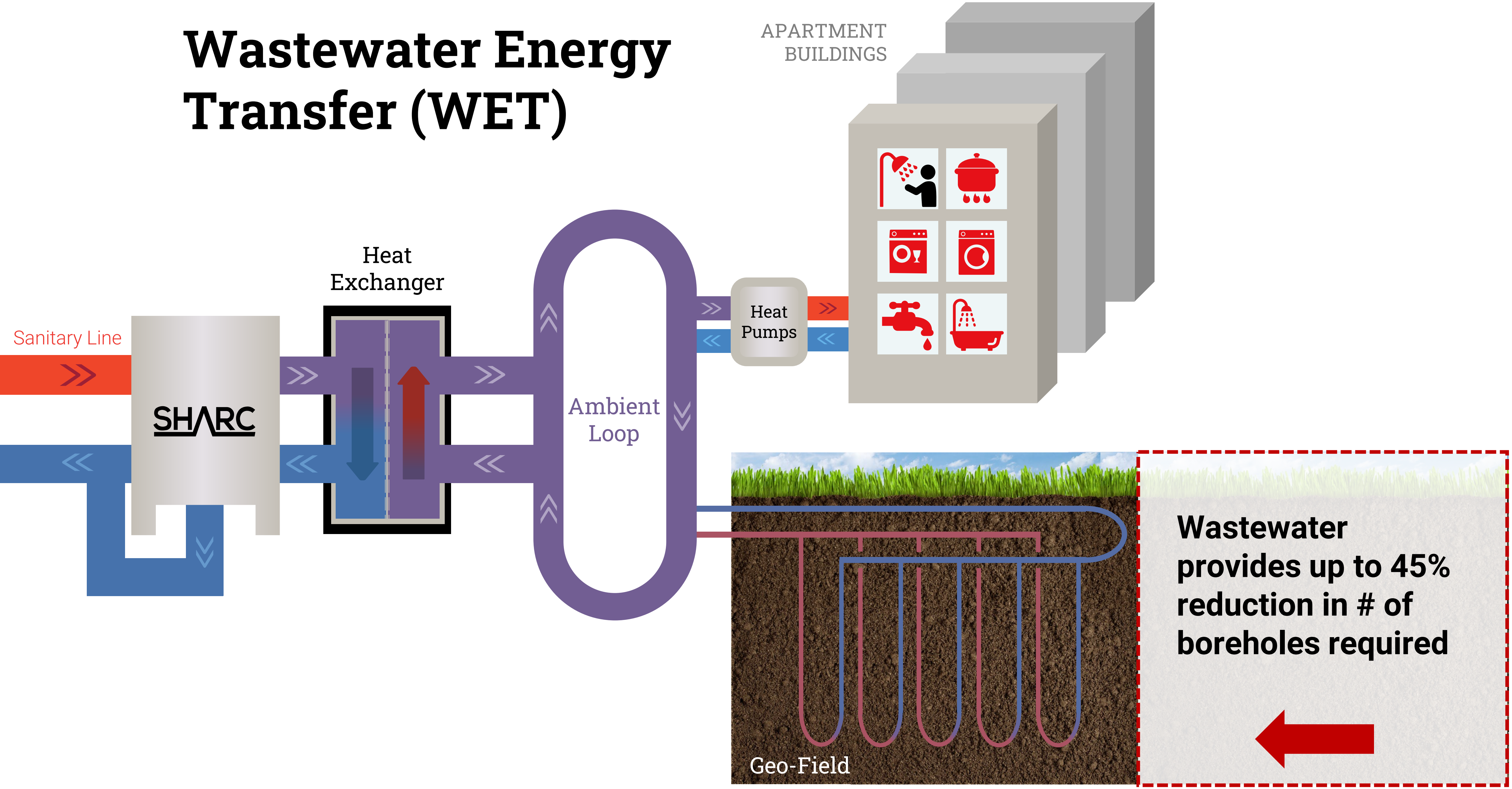
Multi-Use (Heating/Cooling)



Wastewater Energy Transfer (WET)



Wastewater Energy Transfer (WET)



Simple Cleaning & Servicing

SHARC's patented design allows for unparalleled cleaning characteristics.

- Superior continual cleaning of the filter screen ensures high flow rates to meet demand.
- Minimal wear on internal parts for longer lasting components.
- Low pressure drop across the SHARC filter.
- Little or no fresh-water usage.

2x SHARC 880's serviced & back online <5 hours!

*SHARC's filter **after 300 million gallons of sewage in 5 months, 24x7 operation!***

National Western Center, Denver CO

Controls & Integration

Standard For All SHARC Energy Equipment

- SHARC developed Controls program
- Touch screen interface
  - Default Settings / User Configurable
- Remote Monitoring capabilities
  - Emailed warnings & alarms
  - Data Trending
- DDC & BMS integration through BACnet or Modbus
- BTU Meter / Power Meter Options
- Factory Support

New York WET Projects

- ✓ Domestic Hot Water
- ✓ Heating & Cooling
- ✓ Geothermal Field Offset
- ✓ Thermal Energy Networks

Empire Building Challenge
PARTNER
Reimagining Low-carbon Buildings

NEW YORK STATE OF OPPORTUNITY. | NYSERDA

Alafia
Brooklyn, NY

SHARC

CASE STUDY

Vital Brooklyn Initiative

- $373M project will bring 2,400 affordable apartments to the neighborhood
- Phase One includes:
  - **(1) SHARC 660 serving 2 buildings**
  - **(2) PIRANHA T15HC serving 1 building**
- Closed loop geothermal system supports water-source heat pumps (WSHP) to provide heating, cooling and domestic hot water.
- Designed to Enterprise Green Communities and Passive House Standards.

Whitney Young Manor

Yonkers, NY

SHARC

CASE STUDY

A radical transformation for Yonkers' affordable housing

This $12 million decarbonization retrofit incorporates a **SHARC 660** wastewater heat recovery system, air-source heat pumps (ASHP) and water-source heat pumps (WSHP)

- 195 affordable apartments in two towers (230,000 SqFt)
- New hydronic distribution piping enables integration of different heating sources & heat sharing between end-uses

2019 baseline	Expected by 2035
96 kBtu/SF/yr	**48** kBtu/SF/yr **Reduction of 50%**
54% Natural Gas + **46%** Electricity	**25%** Natural Gas + **75%** Electricity
1,456 tCO2e/yr	**273** tCO2e/yr **Reduction of 81%**

Curtis + Ginsberg Architects

BRIGHT POWER

Omni New York LLC

Empire Building Challenge PARTNER Reimagining Low-carbon Buildings

The Towers by Amalgamated Housing Cooperative

Bronx, NY

SHARC

CASE STUDY

Low Carbon Retrofit

AMALGAMATED HOUSING COOPERATIVE

New centralized hydronic distribution piping for two 20-story towers. Using geothermal and wastewater heat recovery that captures heat from domestic water sources, allows Amalgamated to decommission its cooling towers.

- **(2x) PIRANHA T15** helps provide heating, cooling and domestic hot water for 316 affordable apartments
- Wastewater Heat Recovery allows for a reduction in the number of geothermal boreholes required

Current baseline	Expected by 2035
111.6 kBtu/SF/yr	**32.5** kBtu/SF/yr **Reduction of 71%**
84% Natural Gas + **14%** Electricity + **2%** Oil	**100%** Electricity
2,771 tCO2e/yr	**202** tCO2e/yr **Reduction of 93%**

EN-POWER GROUP

egg geo

Empire Building Challenge PARTNER Reimagining Low-carbon Buildings

Seven35

North Vancouver, BC

CASE STUDY

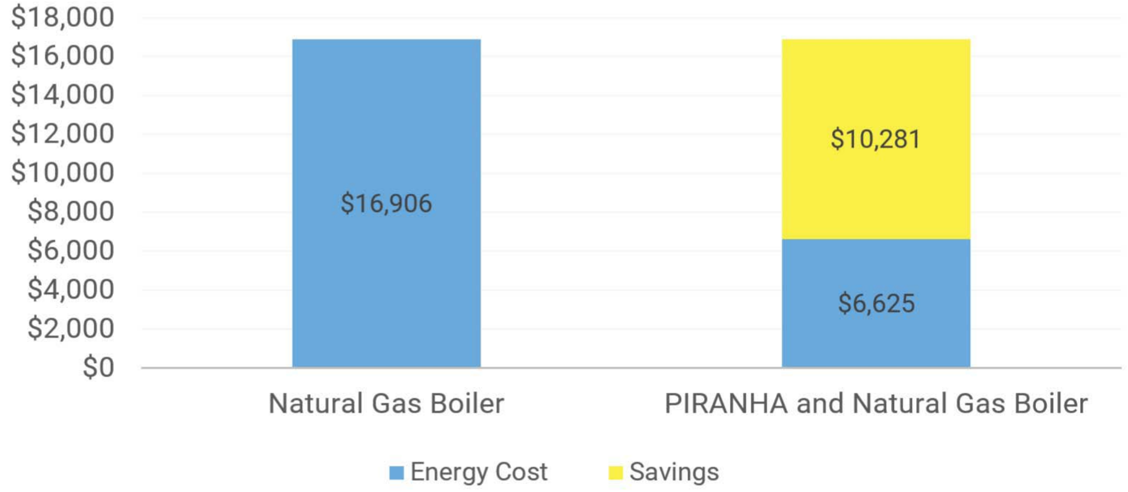
- The first multi-family LEED® for Homes Platinum building in Canada
- Certified BuiltGreen Gold
- 60 Residential Units
    - **PIRANHA T10** Commissioned Spring 2016
    - **9,350 Therms Natural Gas reduction**
    - **GHG Emission reductions of approximately 49.6 t CO_2e/year**
- PIRANHA system provides domestic hot water preheating
- Piranha contributed to LEED® Platinum certification
- **PIRANHA HC EPRI Challenge Site**

Seven35

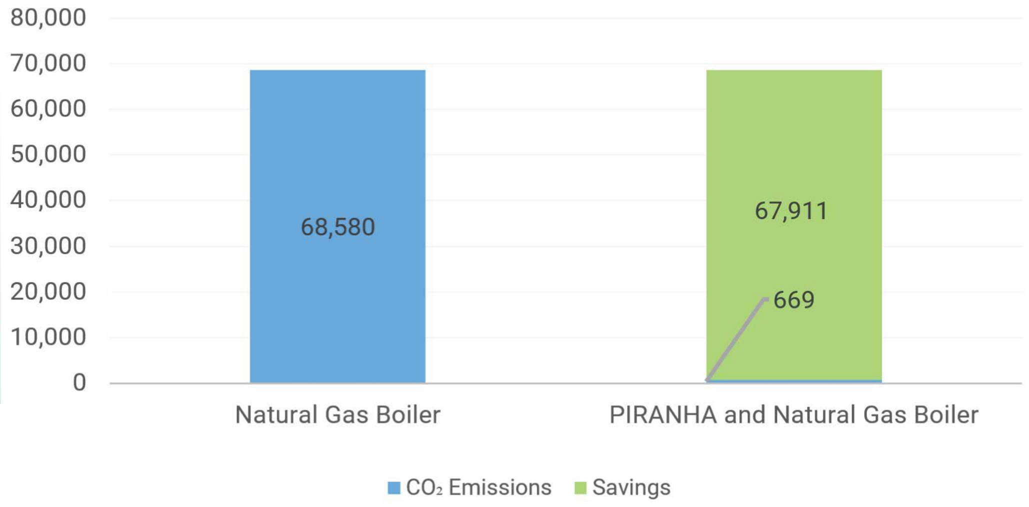
North Vancouver, BC

SHARC CASE STUDY

ANNUAL ENERGY COSTS & SAVINGS



CO2 EMISSIONS (KG/YEAR)



Lake Louise Inn

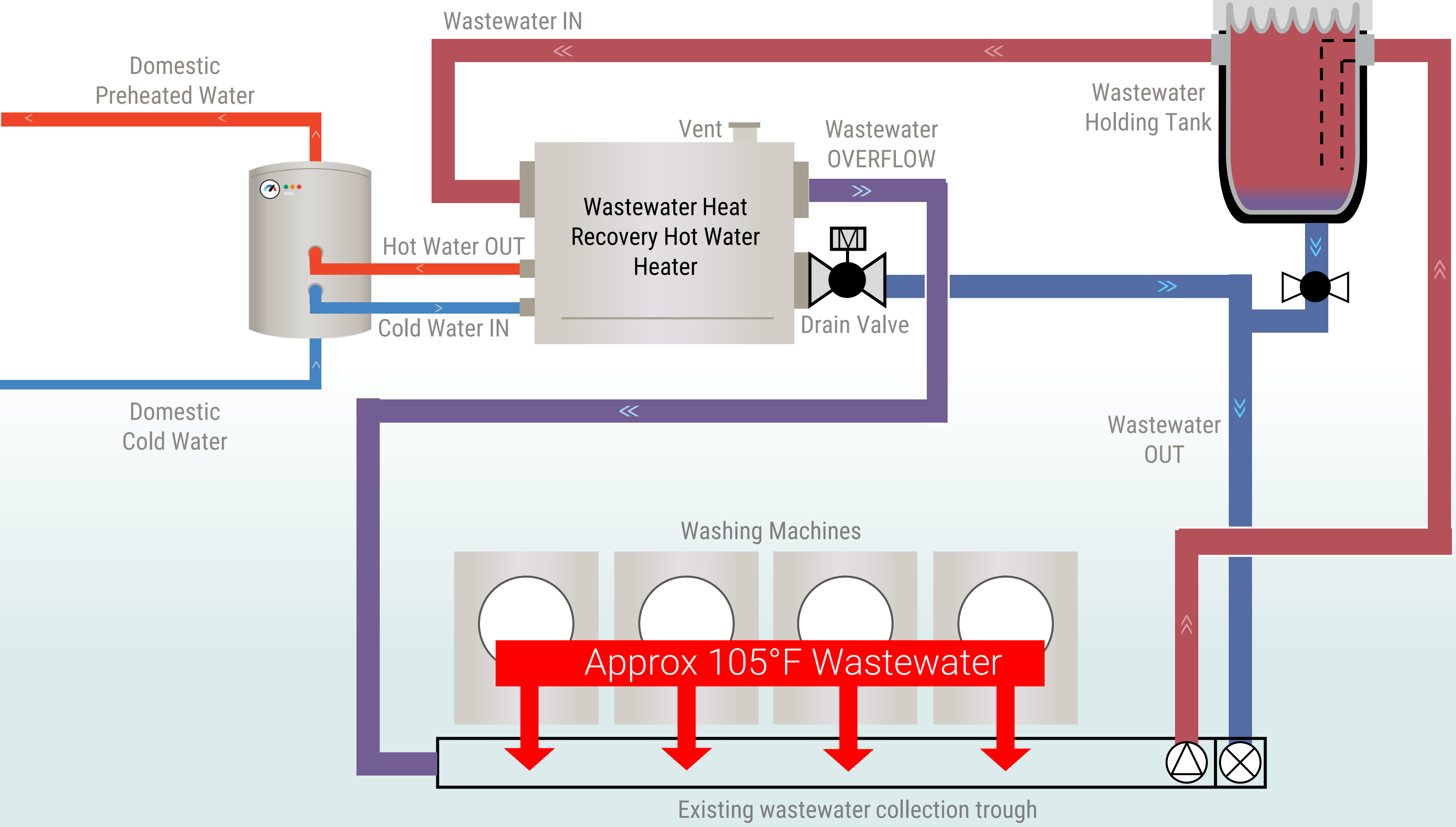
Lake Louise, Alberta

SHARC CASE STUDY

- Commissioned Summer 2018
- 247 room Hotel
- In-House Laundry
- PIRANHA T10 recovering heat from 4 commercial laundry washing machines
- Produce an average of **1700 Gallons** of Hot water per day
  - **Average COP of 5.25**
- Main fuel source – Propane
  - **Approximate load reduction of 22,680 liters/year**
  - **GHG emission reduction of approximately 35 t CO_2e/year**

The Solution

Hotel Laundry Example



PIRANHA project highlight

Lake Louise

- 247 room Hotel
- In-House Laundry
- PIRANHA T10 recovering heat from 4 commercial laundry washing machines
- Main fuel source – Propane

CUSTOMERS.sharcenergy.com

DC Water Headquarters

Washington, DC

SHARC

CASE STUDY

- Commissioned Summer 2018
- **SHARC 660 System**
- **250 Gallons Per Minute (GPM) flow**
- **Design heat transfer of 1.25 MMBH**
- **Estimated 30+ MMBtu/day transfer**
- Heat Demand – **3.3%**
    - Natural gas boiler offset – **est. 12.6 t eCO_2/year reduction**

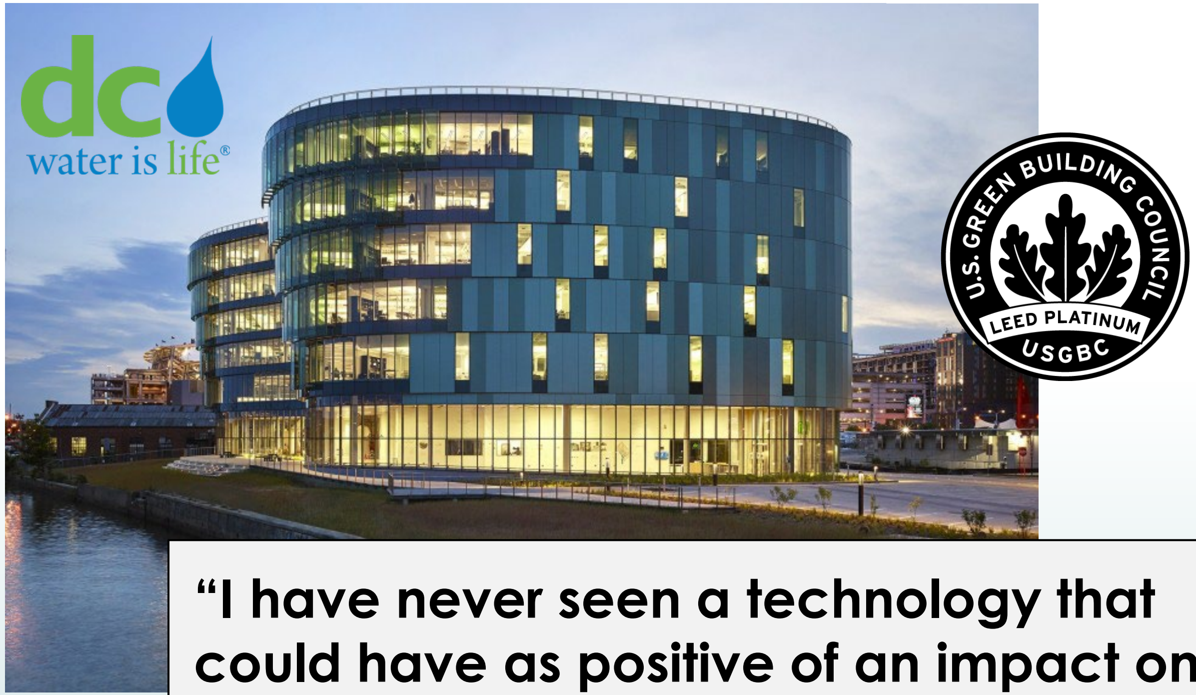
- Cooling Demand – **96.7%**
- Cooling tower offset **est. 1.5M gallons of water saved annually** (evaporation & blowdown)

- Wastewater lift station sees 5M gallon per day average sanitary flow

- 150,000 ft^2 facility w/ 350 to 400 tons water-cooled HVAC (HPs / Chilled Beams / DOAS)

- LEED® Platinum

Cooling Tower offset saves the use of an estimated 1.5M gallons of fresh water annually



"I have never seen a technology that could have as positive of an impact on energy as what I have seen at the DC Water Headquarters"

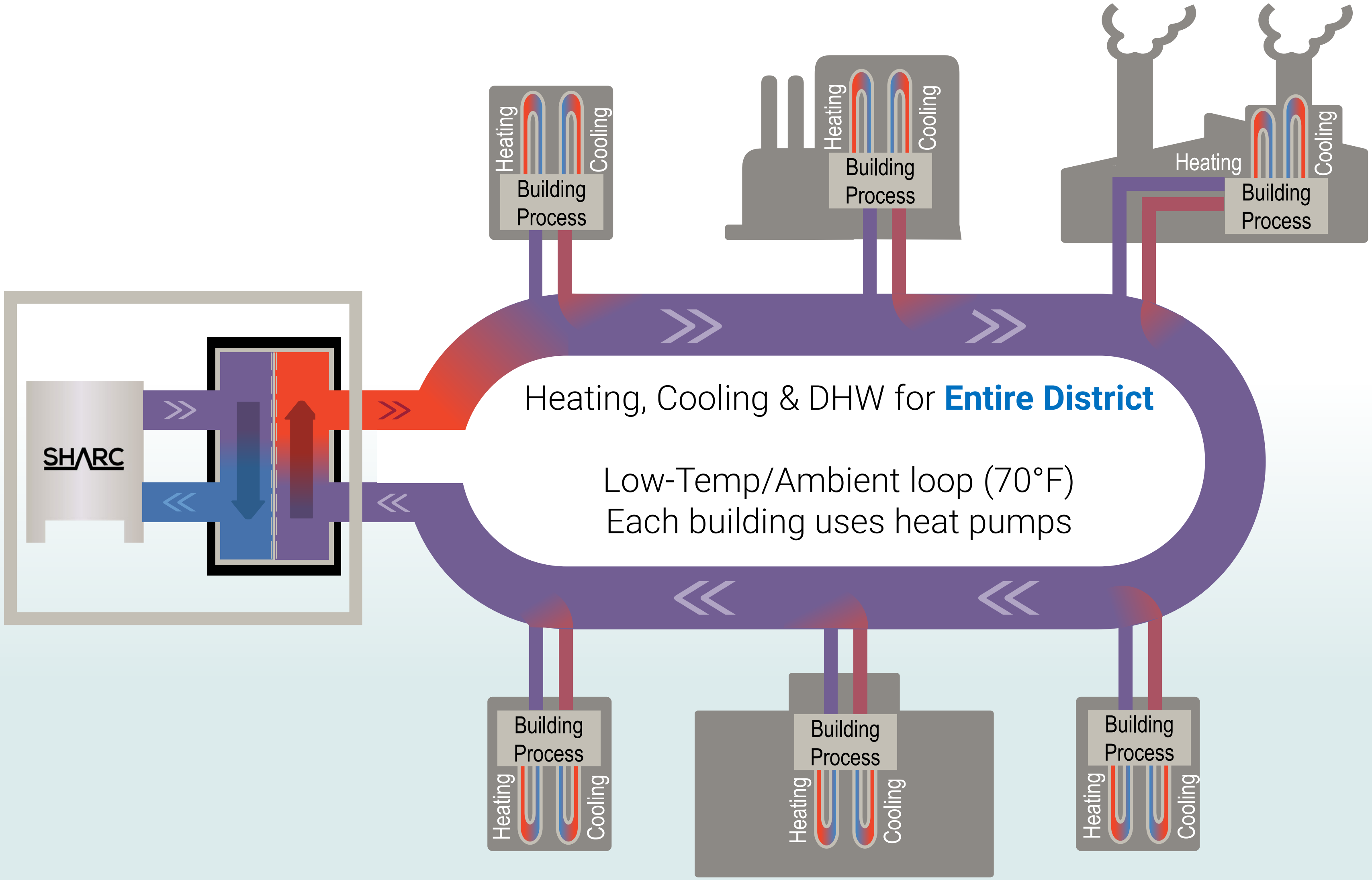
- *Congresswoman Marcy Kaptur, Chairwoman of the House Appropriations Subcommittee on Energy and Water Development*

Southeast False Creek Neighbourhood Energy Utility

Vancouver, BC

- 3.2MW$_{th}$ (2x) SHARC 880
- Expanding to 9MW$_{th}$ (5x) SHARC 880
- Provides heat for 20M ft^2 of mixed-use space

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

leləm̓ 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

CUSTOMERS.sharcenergy.com

Alexandria Center for Life Sciences

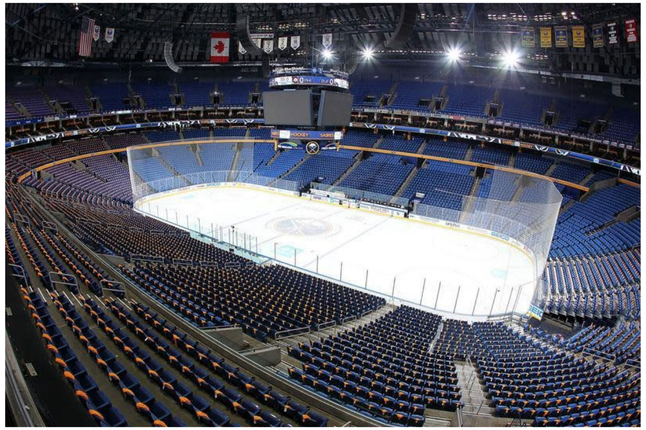
Seattle, WA

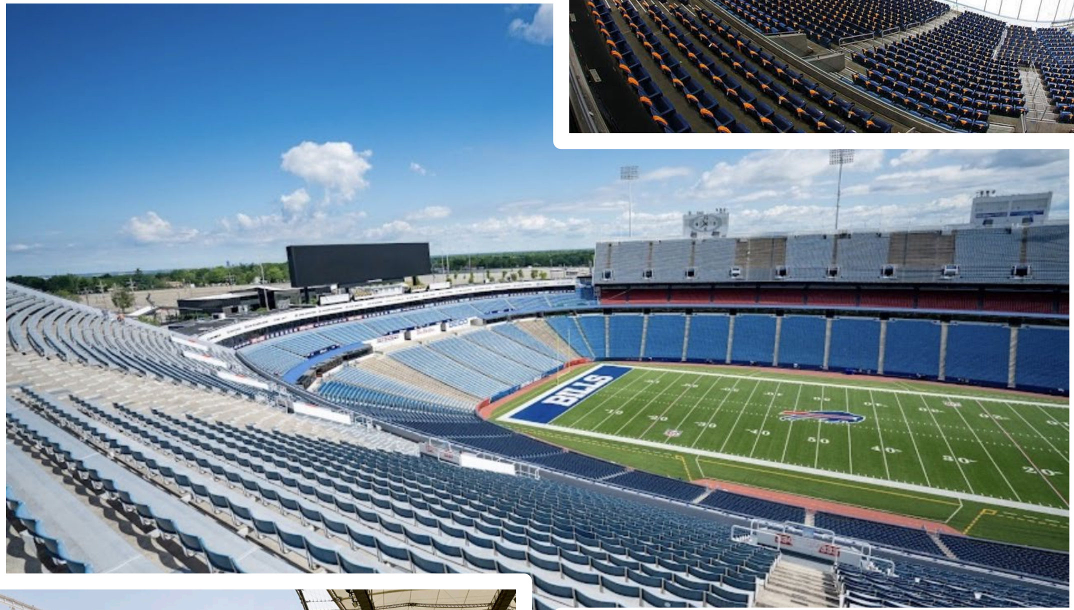
CASE STUDY

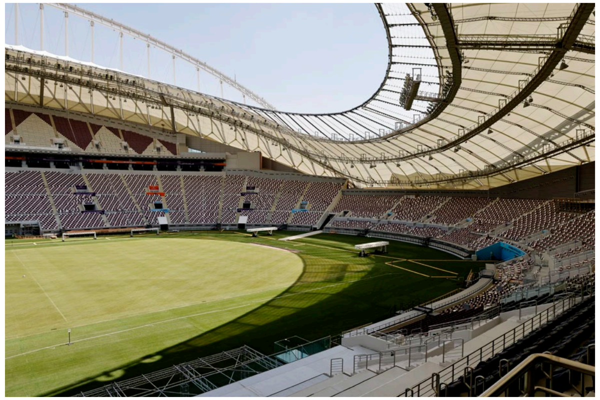
- Alexandria Real Estates 1.6M sq ft science campus in Seattle's South Lake Union
- SHARC 660, expected to be commissioned 2025
- Leverages King County's groundbreaking legislation that enables public-private partnerships to access city sewer lines
- 99% carbon emissions reduction (compared to standard lab) while producing 70% of the heat for campus buildings

Arena Wastewater Energy

The opportunity is beneath your feet







Sports stadiums are hotspots in more ways than one.

Wastewater generated during sporting events can provide simultaneous space heating, cooling & hot water production in a small footprint.

"The future of our cities and communities will rely on an equitable and sustainable transition toward renewable energy sources and electrification of our built environment and mobility systems.

Thermal Energy Networks will play a critical part in this transition and SHARC Energy has the track record and proven solutions to make this transition more possible than ever."

Jason Twill, LEED Fellow
Founder, Green Sports Alliance
Co-Founder, International Living Future Institute

UBS Arena

Elmont, NY

Sustainable Ice Resurfacing

Study the feasibility of using wastewater from club level to produce 140F potable hot water

- 2x PIRANHA T15 HC
- Provides 91% of hot water for resurfacing fleet
  - 2400 gallons used on game days
  - 1400 gallons used on off days
- Ancillary space cooling provided by HC
  - ~288 MBTU/hour
- Estimated COP of 2.5

Turn Your Wastewater into Opportunity.

SHARC ENERGY

Thank you!

www.SHARCenergy.com

OXYGEN8

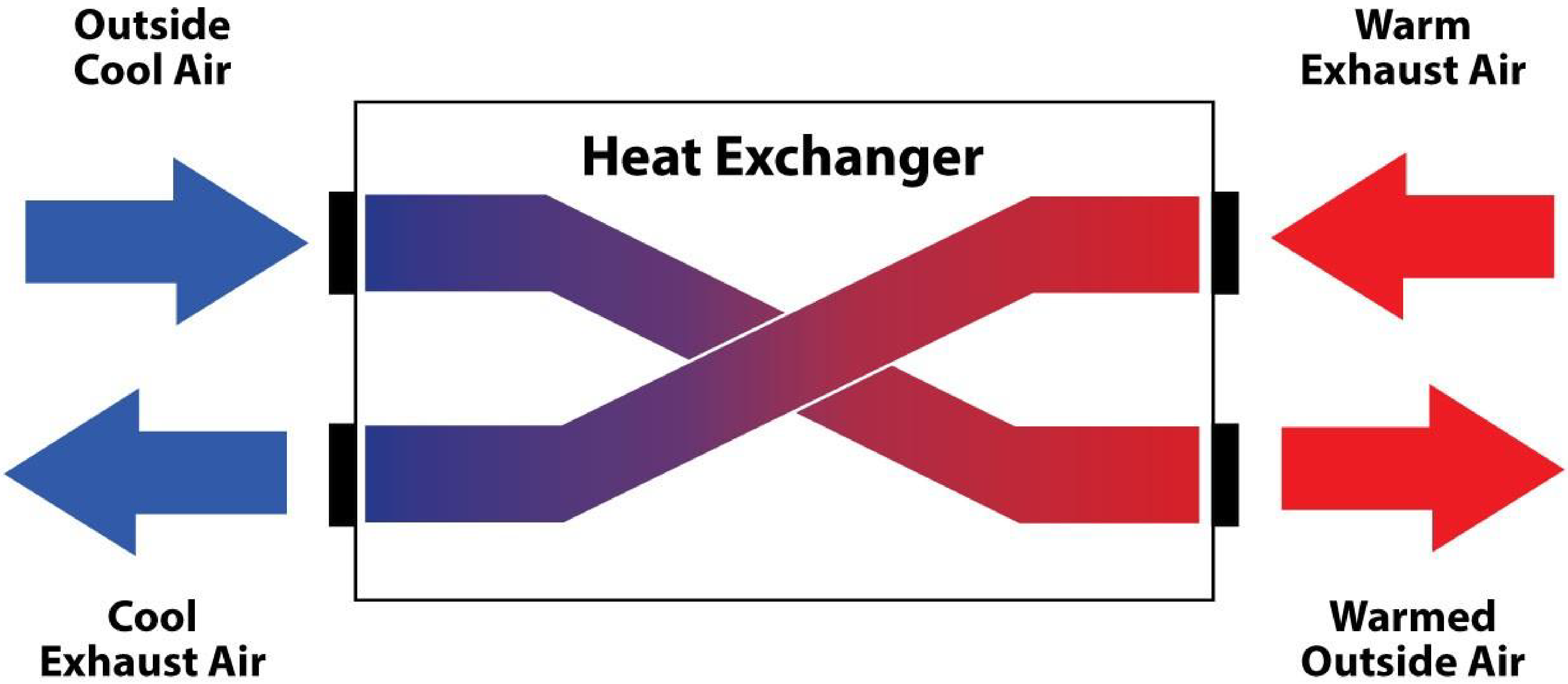
High Efficiency Energy Recovery & Split DOAS

Todd Pfahl | Todd@oxygen8.ca

Agenda

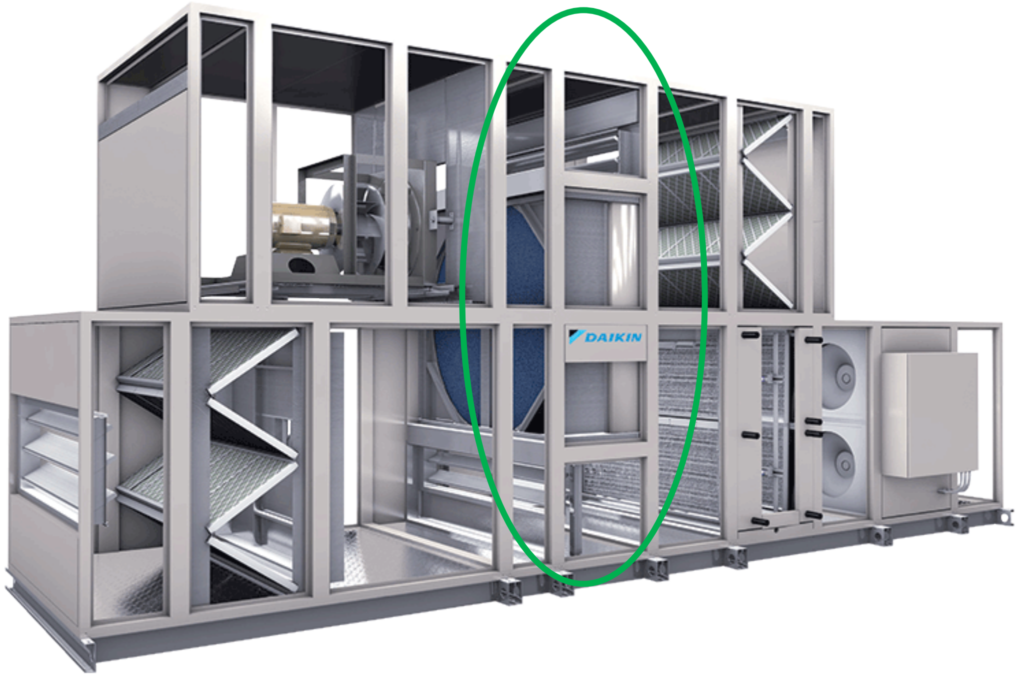
- Air-to-Air Energy Exchanger Technology
- Low Profile Split DOAS with Energy Recovery
- Frost Prevention and Defrost
- About Oxygen8

What is Airside Energy Recovery?



Traditional Centralized DOAS with Energy Recovery

Semi Custom AHUs



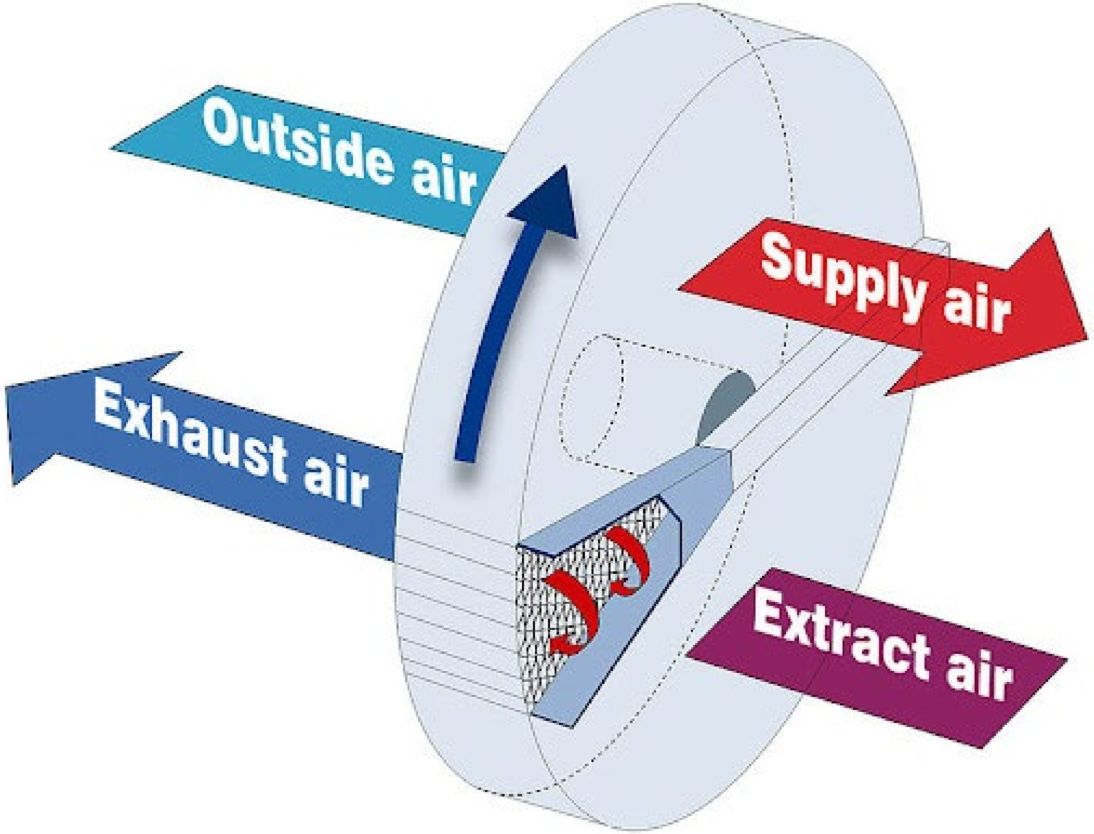
Packaged Rooftops

Rotary Heat Exchangers

- Rotating wheels moving between exhaust and outdoor airstreams

- Wheel construction: Polymer (Plastic) or Aluminum

- ERV moisture transfer desiccants: Silica gel or molecular sieve



Rotary Heat Exchangers – Components

Drive and Air Sealing Components

- Drive motor & belts (VFD for frost control)
- Shaft, hub, and bearings
- Air separation plate & seals
- Purge Section

- Efficiency determined by thickness & materials

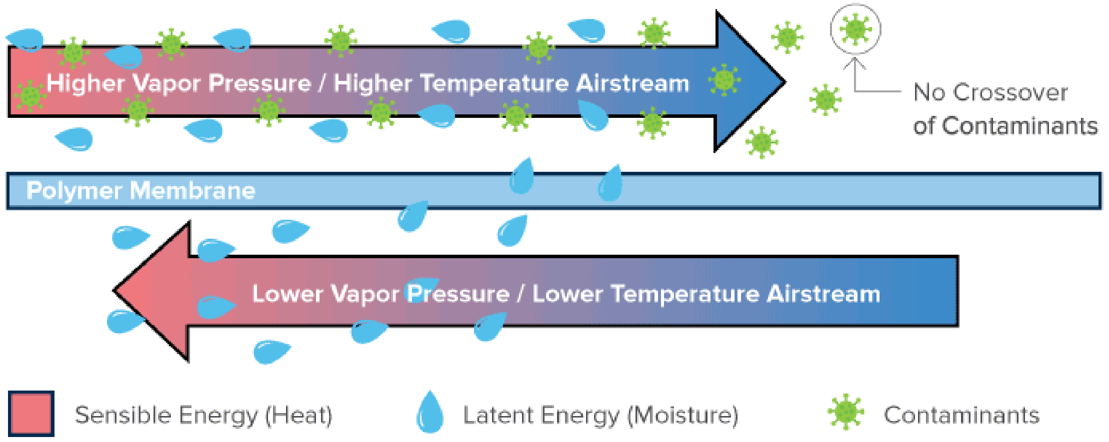
Plate Heat Exchangers ERV & HRVs

- Static Plates (No moving parts)
- Low Profile Geometry
- Standard Efficiency Cross Flow
- High Efficiency Counter Flow
- Matrix Design for Higer Airflows

Plate Heat Exchanger Cores

Transferring Temperature and Moisture

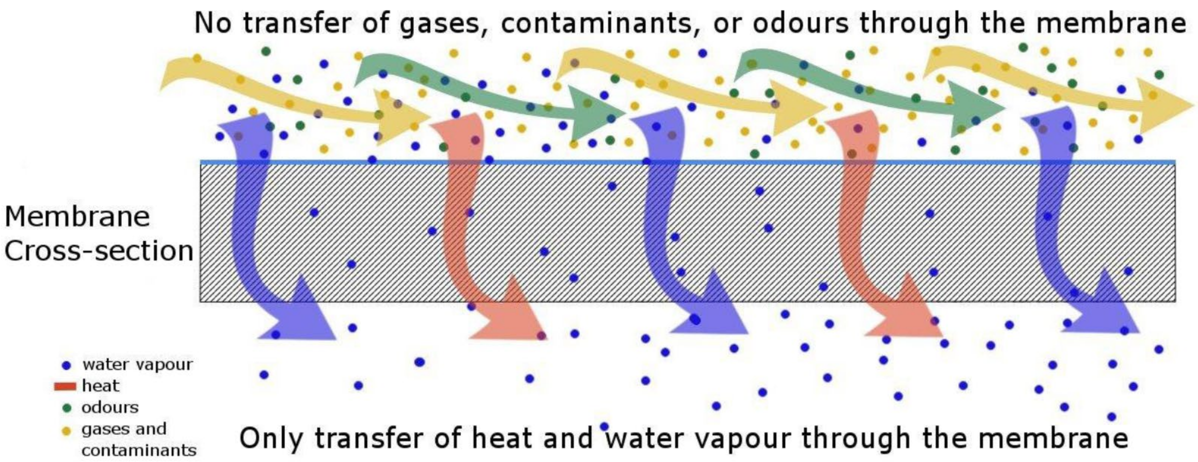
- Alternating layers of outdoor air and exhaust air pass through the core
    - Cross-flow cores – air moves in x-pattern
    - Counterflow cores – air moves in opposite directions

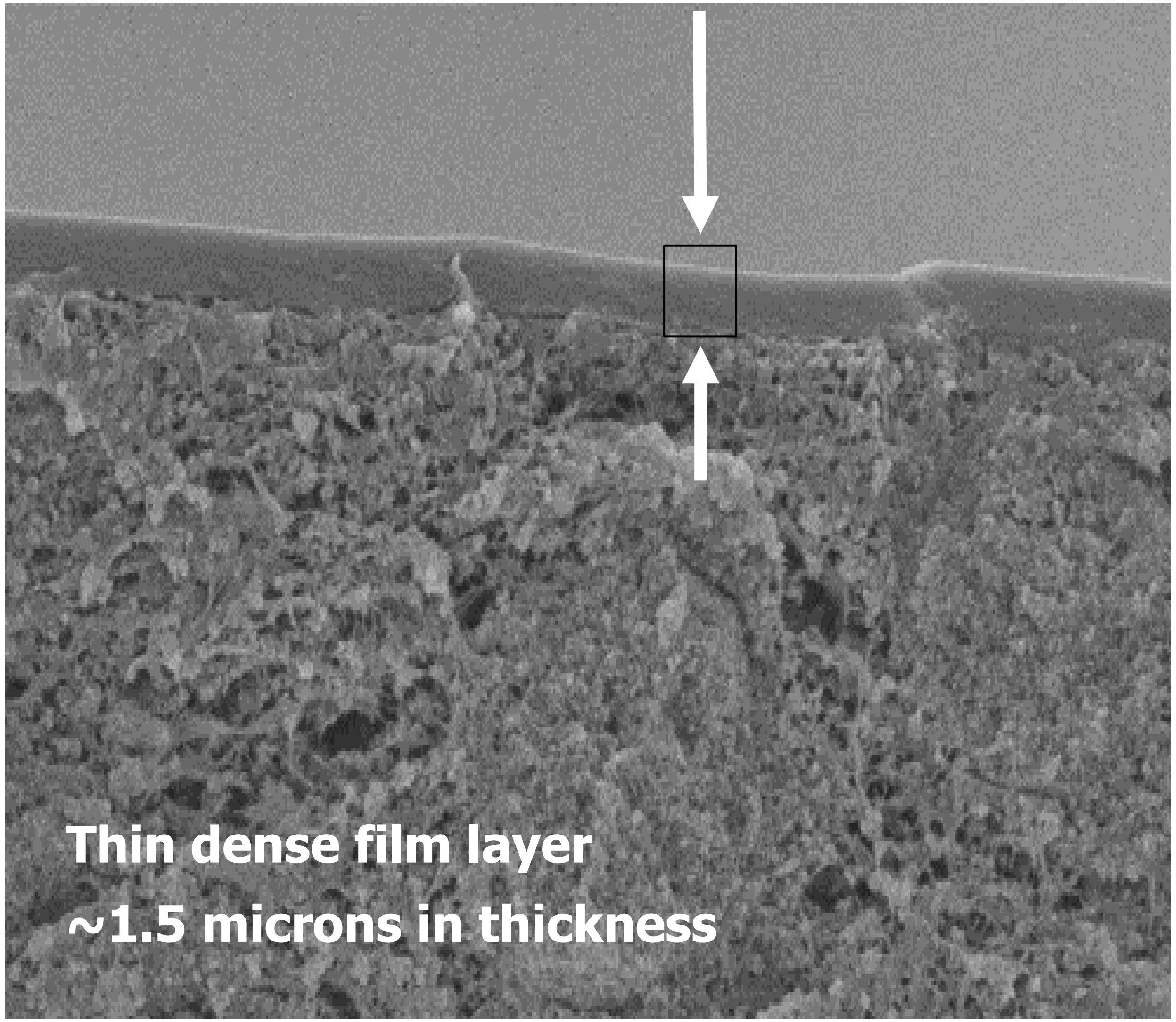


- Airstreams are sealed (No cross contamination)

ERV Cores using Patented Polymer Membrane

Heat and Humidity Recovery

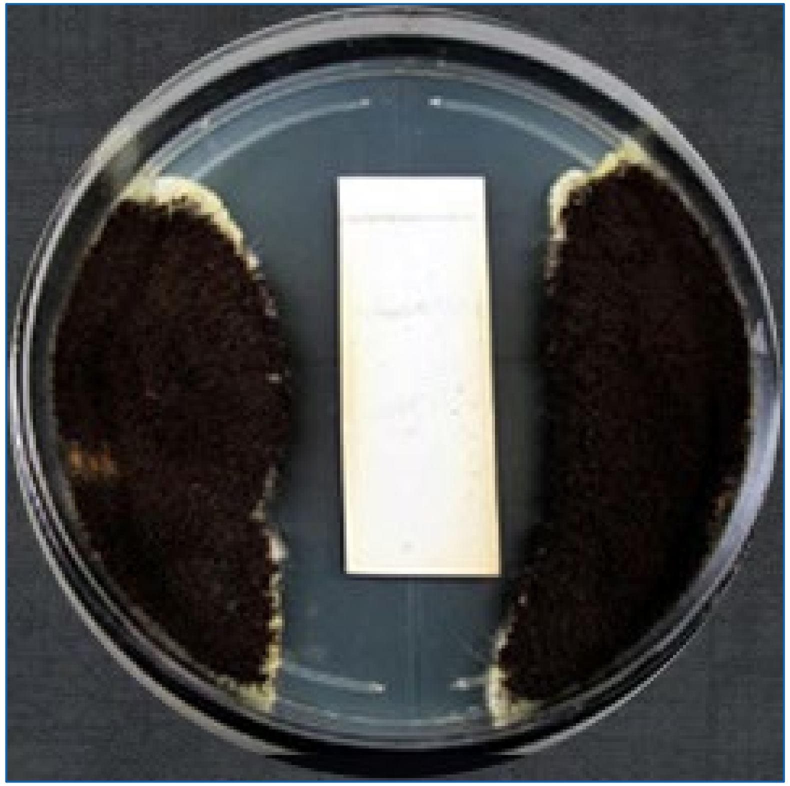


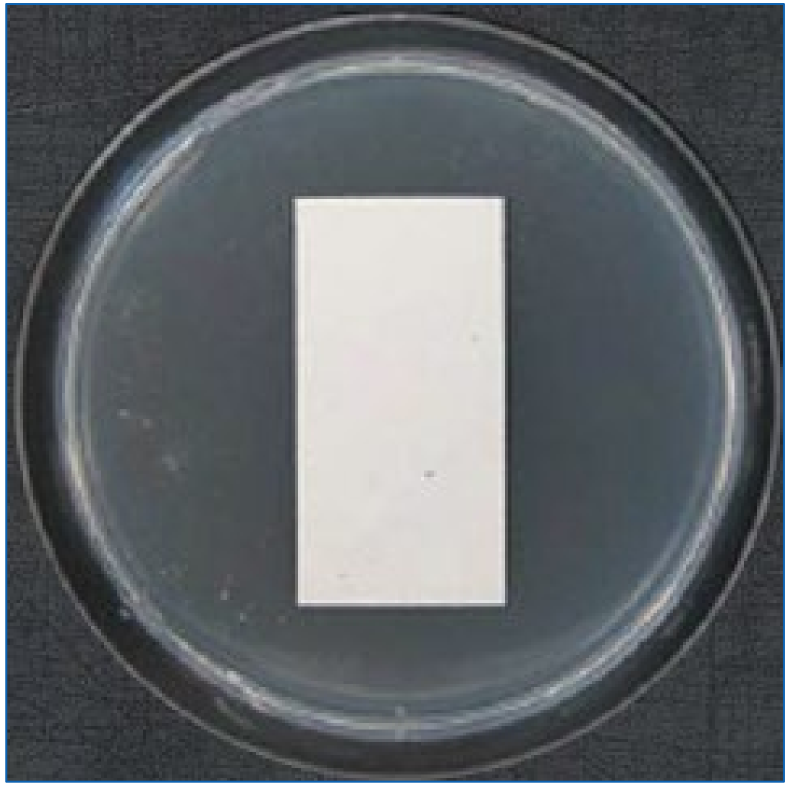


Hygiene – Think 'Healthcare'

ISO 846 rated for no mold & bacteria growth

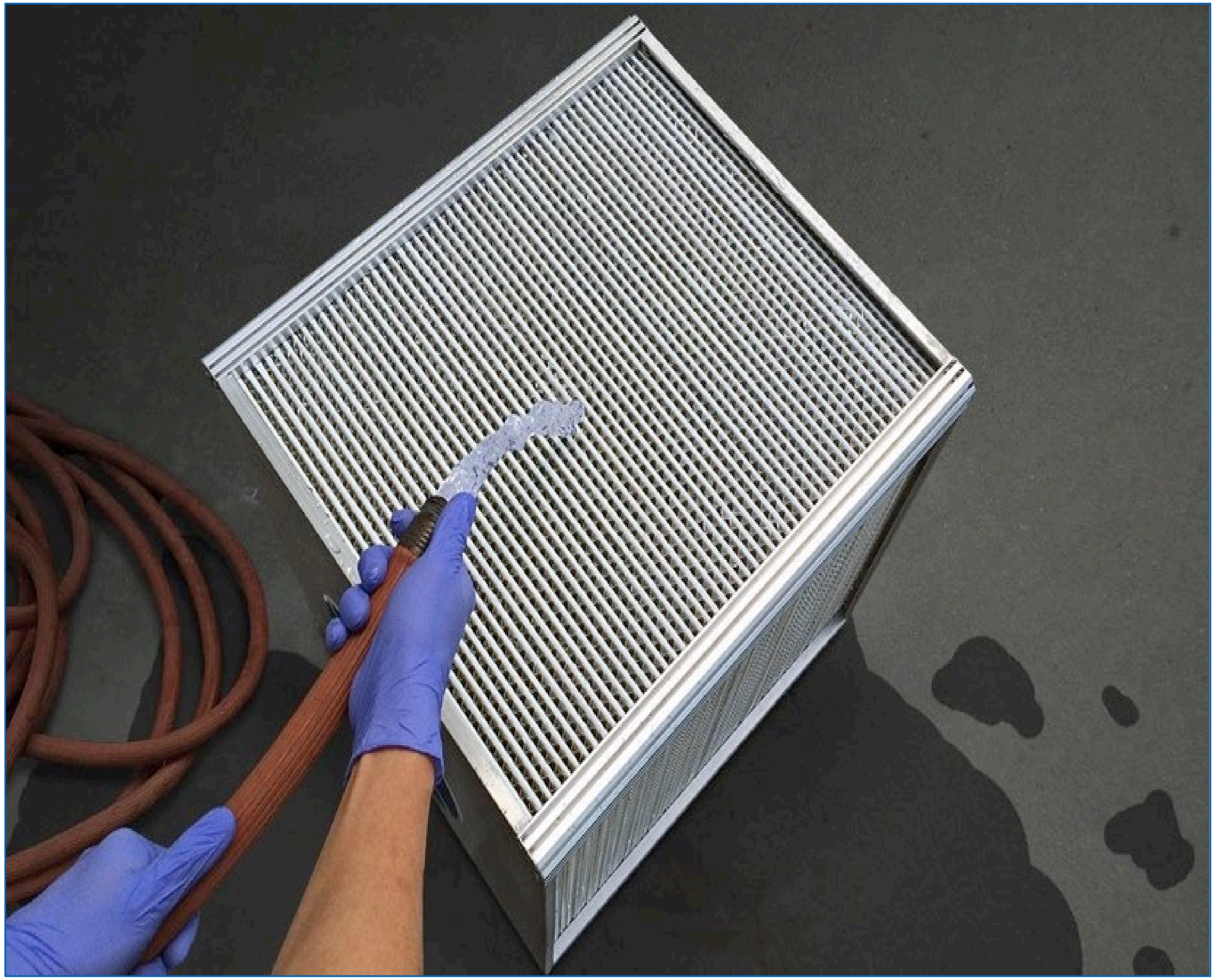
ASTM F-1671 tested with no virus transfer – COVID-19





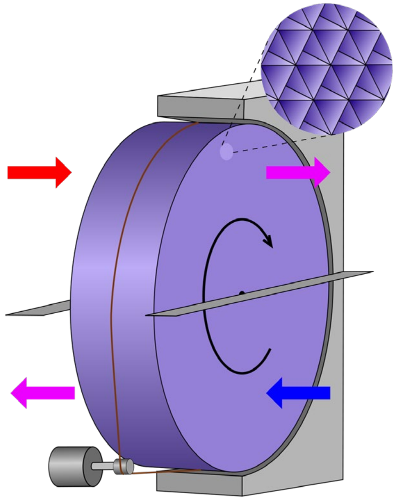
Reliability – Think "Peace of Mind"

- Water Washable
- Freeze tolerant
- Low maintenance
- UL 723 Certified



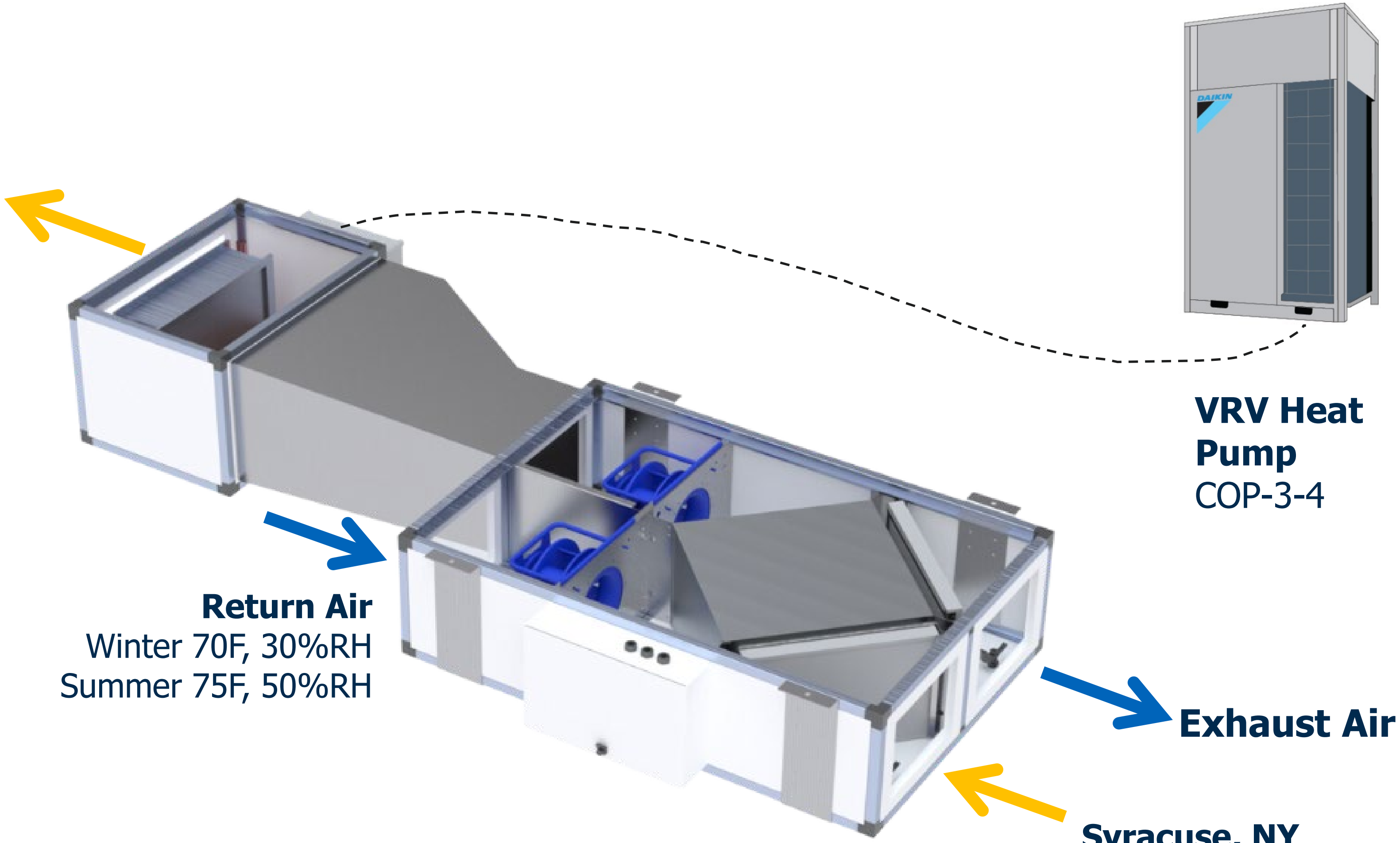
Technology & Metrics of Performance

Metric	Wheels	Fixed Plate
Performance (Total Energy Efficiency)	70 – 80%	55– 72%
Exhaust Air Transfer Ratio	1 – 10%	0 – 1%
OA Correction Factor	0.95 – 1.5	0 – 1.06
Maintenance	Motor/Belt/Bearing	None
Application	High flow rate Compact size	Low cross contamination Low maintenance



Low Profile Split DOAS with Energy Recovery

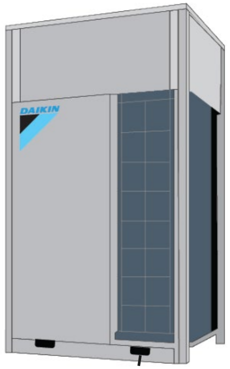
Standard Efficiency ERV



	2000 CFM, OA/EA	
	Summer	**Winter**
SRE (%)	65.1	65.1
LRE(%)	44.7	44.7
TRE (%)	53.3	60.8
kBTU/H Saved	40	110.8
LAT from HX (DB/WB)	80/68	46.9
DX Capacity (kBtu/h)	**91.7**	**54.2**

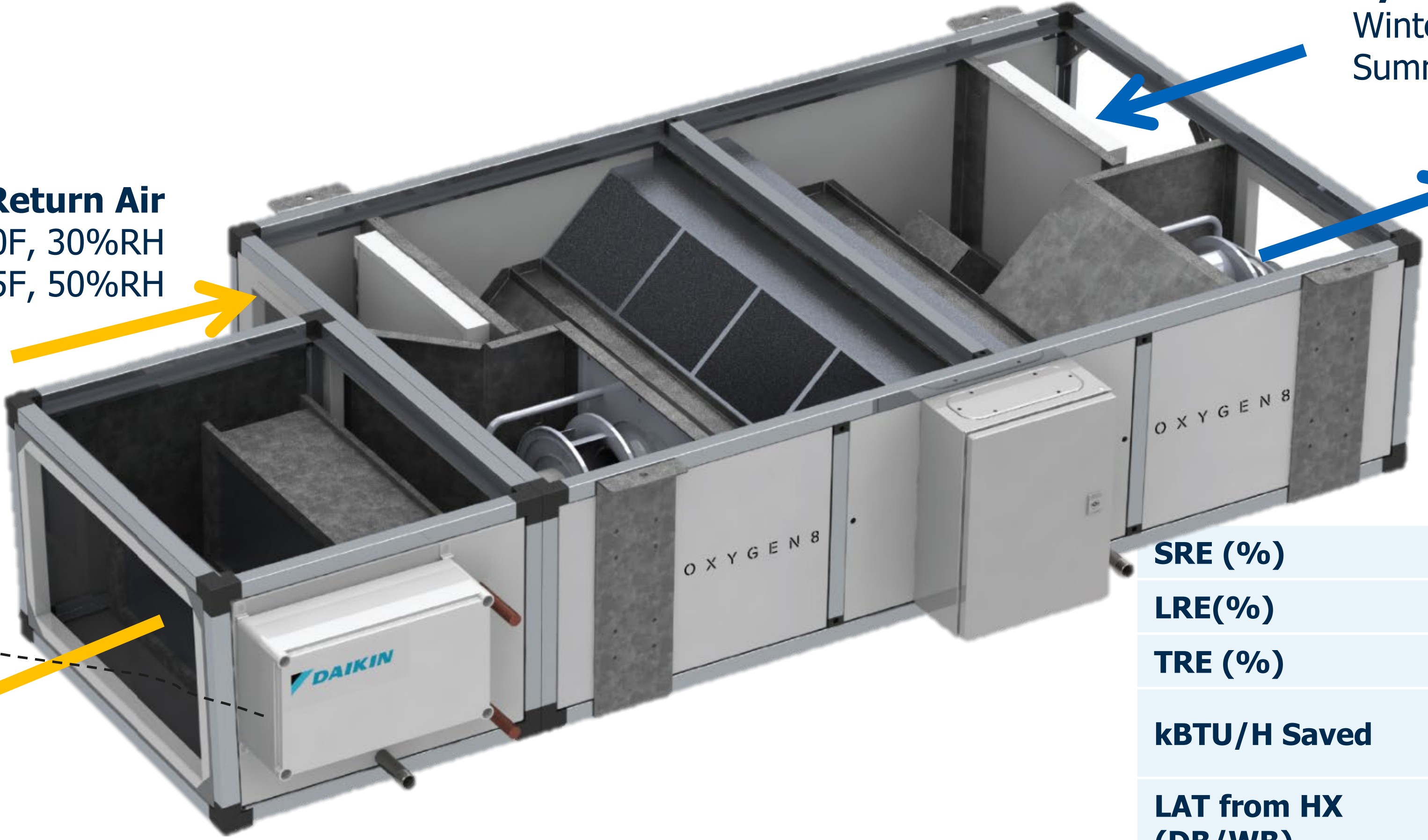
8T VRV Heat Pump ODU

High Efficiency ERV



VRV Heat Pump
COP-3-4

Return Air
Winter 70F, 30%RH
Summer 75F, 50%RH



Syracuse, NY
Winter -1F
Summer 89F/73F

Exhaust Air

Discharge Air Temperature Control
Winter 72F
Summer 55F

	2000 CFM, OA/EA	
	Summer	**Winter**
SRE (%)	73.7	72.9
LRE(%)	64.5	64.3
TRE (%)	68.3	71.2
kBTU/H Saved	52.3	132.876.1
LAT from HX (DB/WB)	78.7/66.4	51.5
DX Capacity (kBtu/h)	**80.1**	**40**

6T VRV Heat Pump ODU

Summary

METRIC	ERV Crossflow	ERV Counterflow	No ERV 100% OA
SRE	65.1%	73.7%	N/A
LRE	44.7%	64.5%	N/A
Summer LAT from HX (DB/WB)	80/68	78.7/66.4	N/A
Winter LAT from HX (DB/WB)	46.9	51.5	N/A
VRV Heat Pump Capacity	8T	6T	12T
Pre-electric heater	Yes	Yes	Yes

Conditions:

Syracuse, NY
Summer 89F/73F
Summer Indoor 75/63
Winter -1F
Winter Indoor 70/52.9

SA/RA Ventilation Rate
2,000CFM

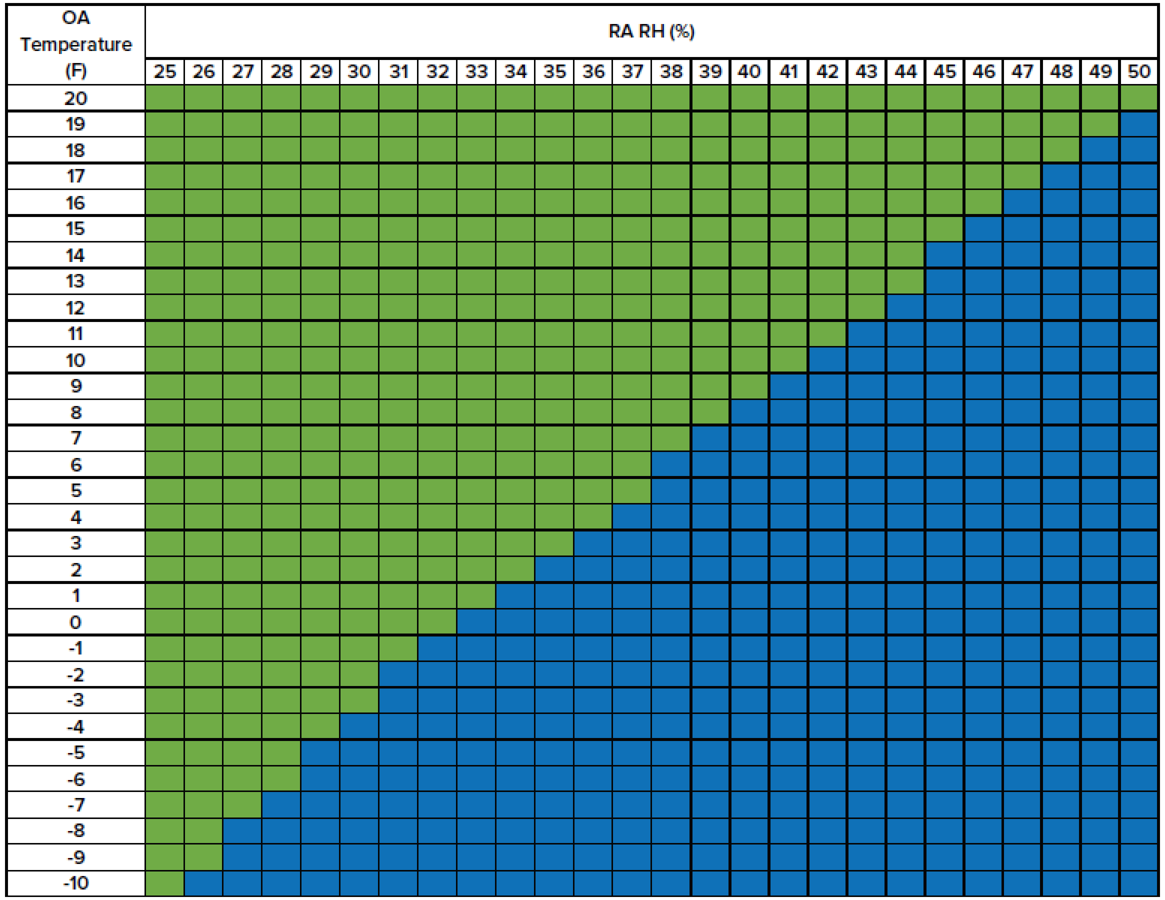
Offices & Retail

Educational Facilities

Large Airflow (10,000 cfm) Split DOAS

Frost Prevention and Defrost with Air-to-Air Energy Exchangers

Condensation on ERV in Winter



Assumptions
SA/RA 2700 CFM
RAT = 70°F
OA RH = 90%

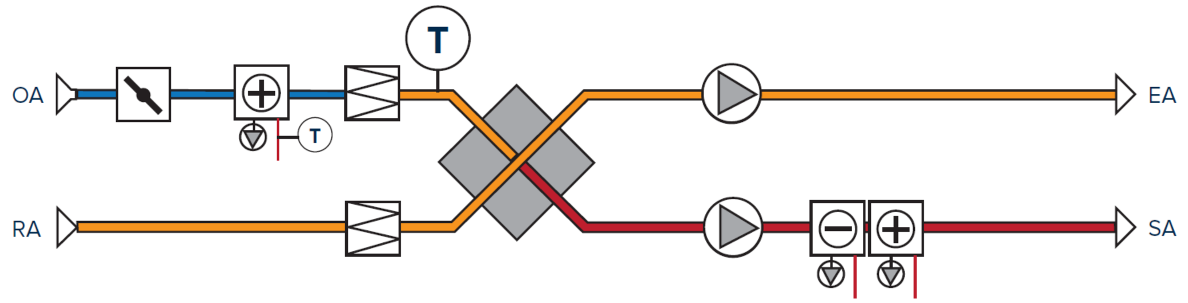
No Condensation

Condensation

- Cross-Flow Core

Frost Prevention Strategies

1. Hydronic Pre-Heat



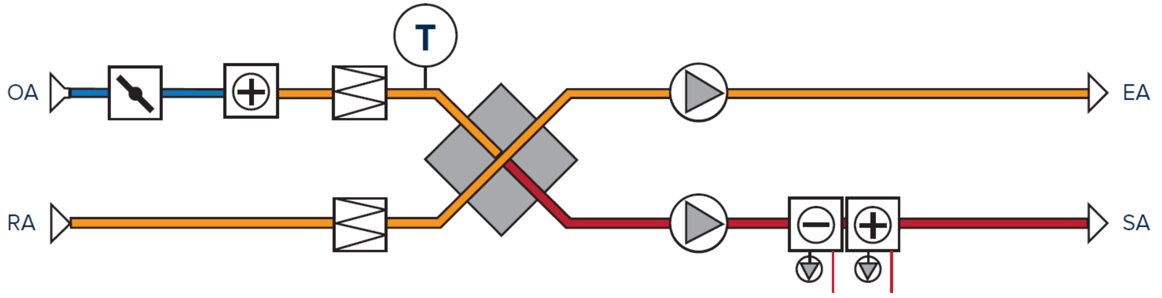
The hydronic pre-heat coil maintains the minimum setpoint temperature.

Actuator Control: 0-10V.

A temperature sensor is attached to the P-HWC return pipe to protect against frost damage, and another one is installed in the unit, positioned in the outdoor air stream.

Options: glycol or recirculation pump

2. Electric Pre-Heat



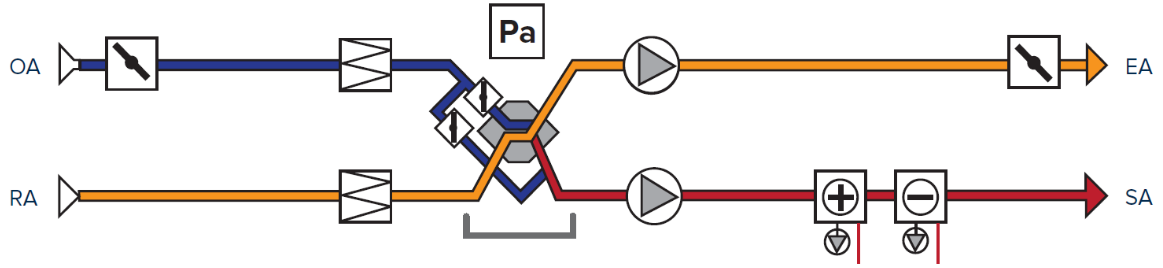
An electric pre-heat coil ensures that the temperature entering the heat exchanger is maintained at a required minimum temperature.

SCR 0-10V Control.

The pre-heat temperature sensor will come installed in the unit, positioned in the outdoor air stream.

Defrost Strategies

1. Monitoring Pressure Across the Heat

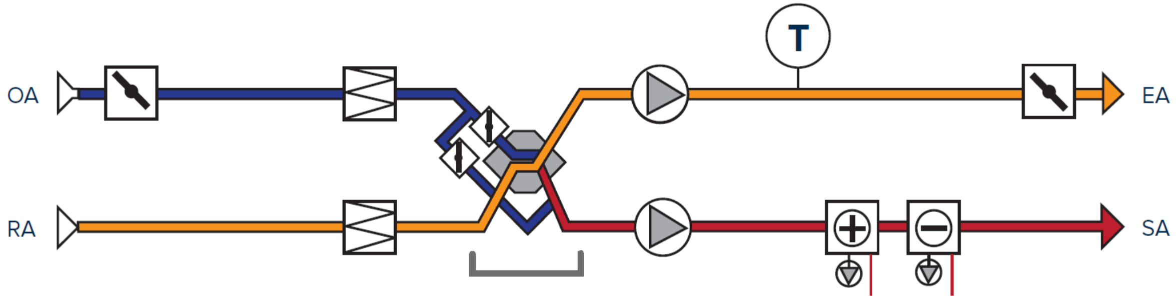


A. Static: The defrost will activate when the actual pressure drop across the heat exchanger exceeds the setpoint.

B. Dynamic: The defrost will activate when the actual pressure drop across the heat exchanger exceeds the calculated setpoint (Percentage rise of the pressure drop on the heat exchanger).

The defrost will activate when the actual pressure drop across the heat exchanger exceeds the calculated setpoint (Percentage rise of the pressure drop on the heat exchanger).

2. Monitoring Exhaust Air Temperature

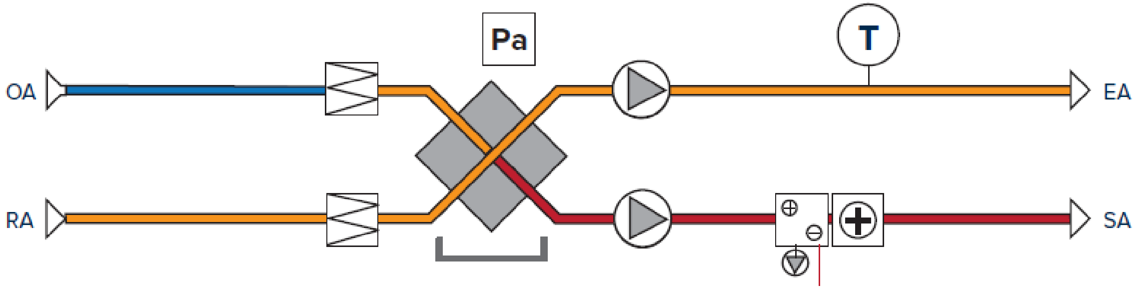


At temperatures below exhaust temperature set value, frost protection will override the bypass damper modulating to 100% open.

* Internal bypass required
* Drain pan required

Defrost Strategies

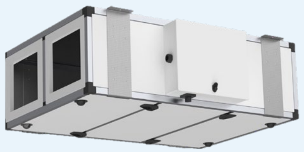
3. Timed Defrost



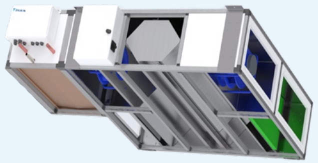
When frost accumulation is detected (based on the exhaust air relative humidity) or by monitoring the pressure drop Across the Heat Exchanger), the supply fan ceases operation for 5* minutes (*adjustable), while the exhaust fan continues to operate and thaw the ice accumulation on the heat exchanger. After 5 minutes, the supply fan will resume normal operation until frost is accumulated again. This cycle repeats itself until the minimum normal operating cycle time, 30* minutes (*adjustable).

About Oxygen8

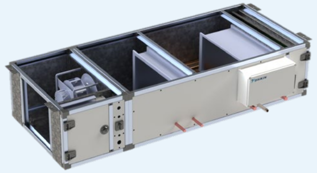
We Are Oxygen8



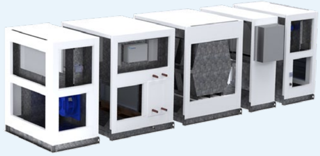
Nova Indoor/Outdoor
(325 – 8,100 cfm)
Standard Efficiency Cross-flow ERV



Ventum
(350 – 3,000 cfm)
High Efficiency Counter-flow ERV



Terra
(425 – 4,800 cfm)
DOAS with VRV Integration



Ventum+
(1,200 – 10,000 cfm)
High Efficiency Modular DOAS

At Oxygen8, we help create healthy spaces for people to live, work and play in an energy efficient way.

Energy & Heat Recovery Ventilation Solutions
- High Efficiency Energy Recovery
- MERV 13 Filtration
- Heating & Cooling
- Dehumidification & Humidification
- Intelligent Controls

Unique Features
- 100% Outside Air with Low Energy Consumption
- Low Profile Design (16-30")
- All Electric HVAC Solution with VRV Integration

Applications
- Schools (K-12, Post-Secondary)
- Offices
- Banks & Retail
- Multi-Family Residential

@oxygen8canada | oxygen8.ca | #freshairthatfits

Made in British Columbia, Canada

The Fresh Air Factory
30,000 ft^2 Manufacturing Facility in East Vancouver

+1,000 Projects Won/Shipped/In Production

+282 SCHOOLS

+339 OFFICES

+355 Other Applications

Airports, Banks, Cannabis, Cemeteries, Churches, Clinics, Community Centers, Day Cares, Fire Stations, Fitness Studios, High-Rise Residential, Hospitals, Hotel, Libraries, Medial Clinics, Mid-Rise Residential, Military, Mixed-Use Residential, Museums, Retail, Senior Care, Shelters, Town Halls, Restaurants

End Customers

ARITZIA
TESLA
BEST BUY
WHOOP
REI
7 ELEVEN
Nestlé
food Basics

THE HUMANE SOCIETY
goodwill
THE SALVATION ARMY
Boys & Girls Clubs of Canada
George Derby Centre
HOME2 SUITES BY HILTON
CANADA POST / POSTES CANADA
TELUS
PlentyofFish
O.P.P.

VantageOne CREDIT UNION
usbank
QuadReal
Spear Street Capital
transalta
PCI DEVELOPMENTS
BOSA PROPERTIES
slalom
Le MERIDIEN

UBC
BOSTON COLLEGE
OHIO STATE
uOttawa
PRINCETON UNIVERSITY
VANDERBILT UNIVERSITY
MICHIGAN STATE UNIVERSITY
PURDUE UNIVERSITY
Cornell University
MEMORIAL UNIVERSITY

Fresh Air That Fits

In an Office

In a Mechanical Room


In a Classroom

Through a Door

In a Closet

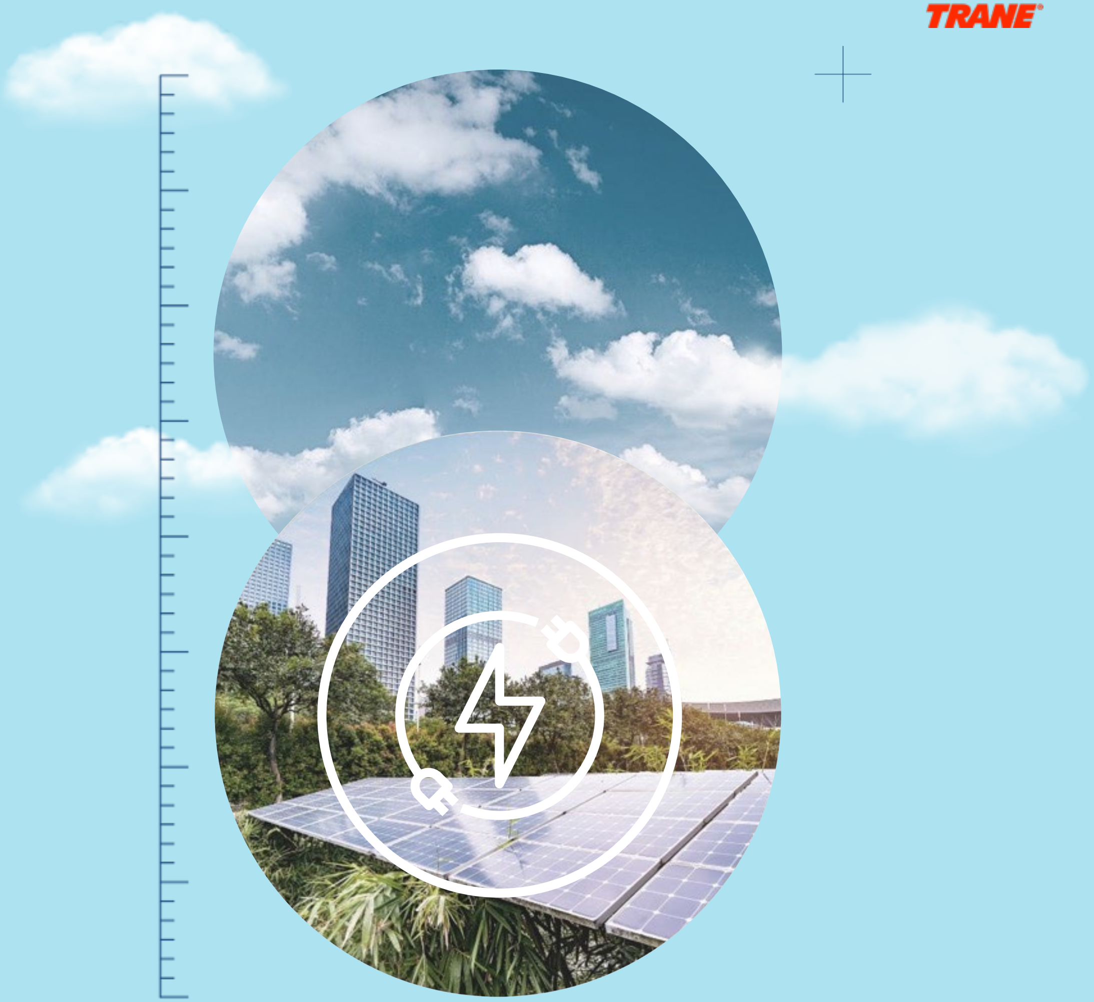
On a Wall

Questions?

@oxygen8canada
oxygen8.ca

Electrification

All Electric. All Weather Comfort.



Chris Devins, Strategic Sales Leader

TRANE

TRANE TECHNOLOGIES

Heating with Heat Pumps is a $CO2_e$ Winner

………..

but there are challenges…

<u>Colder climates hamper ASHP Performance</u>

- Requires even more space for more heat pumps as capacity and efficiency diminish when temperatures drop

<u>Heat Pumps are more expensive than gas boilers</u>

- Capital costs are considerably higher than gas boilers

<u>Heat Pump electrical demand</u>

- At design heating conditions, COPs are low and electric demand is very high

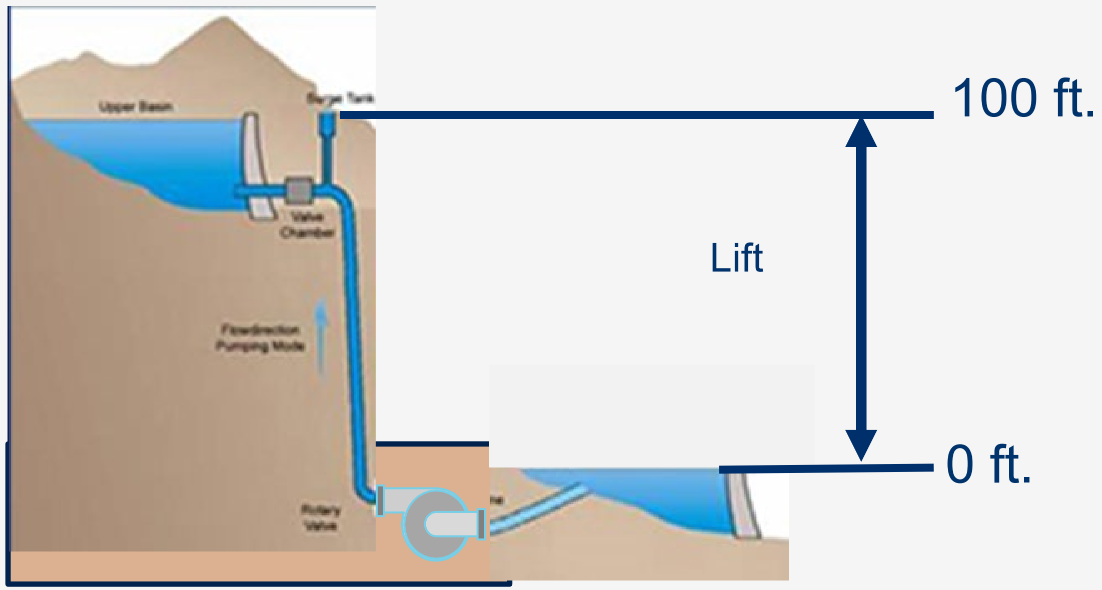
<u>Thermal Balancing - Loads are NOT equal and synchronized</u>

- Heating loads peak in the morning
- Cooling loads peak in the afternoon

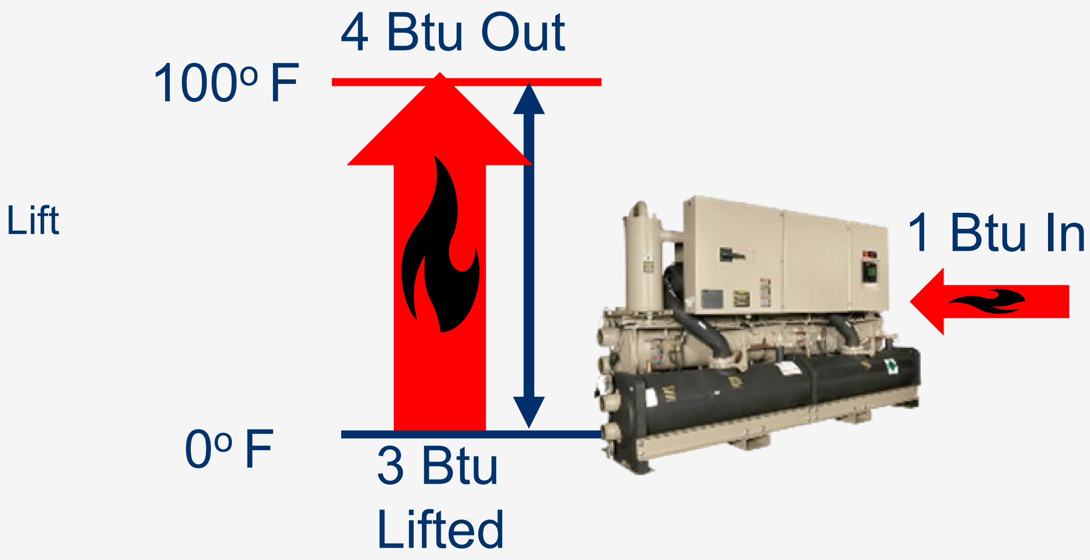
TRANE®

Chillers Pump Heat

Water pumps do not make water.
They use energy to move water from a ***low*** level to a ***higher*** level.



Chiller-Heaters (Non-reversing Heat Pumps) do not make heat.
They use energy to move heat from a ***low temperature*** level to a ***higher temperature*** level.



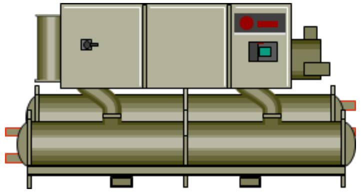
Cooling COP of 3

Heating COP of 4

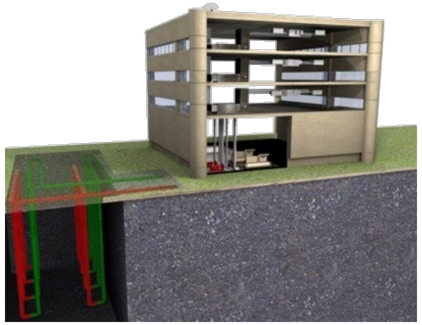
Heat Sources

Electrified Systems

Ambient Air



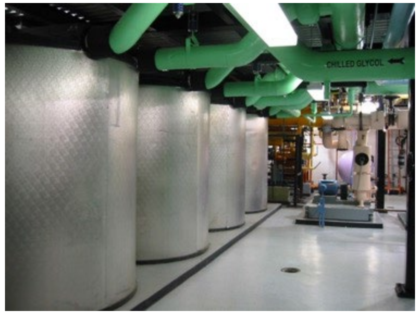
Cooling Load
(Heat Recovery)



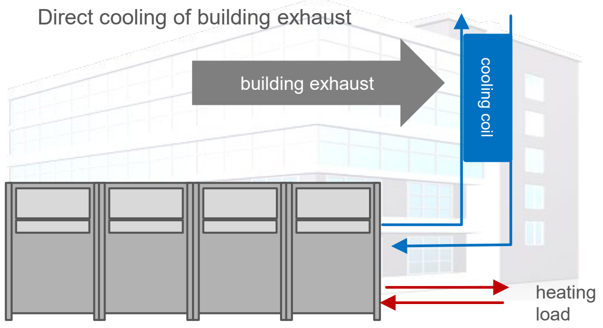
Geothermal loop

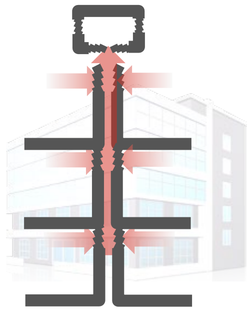
Lake, river, pond

Storm and sewer



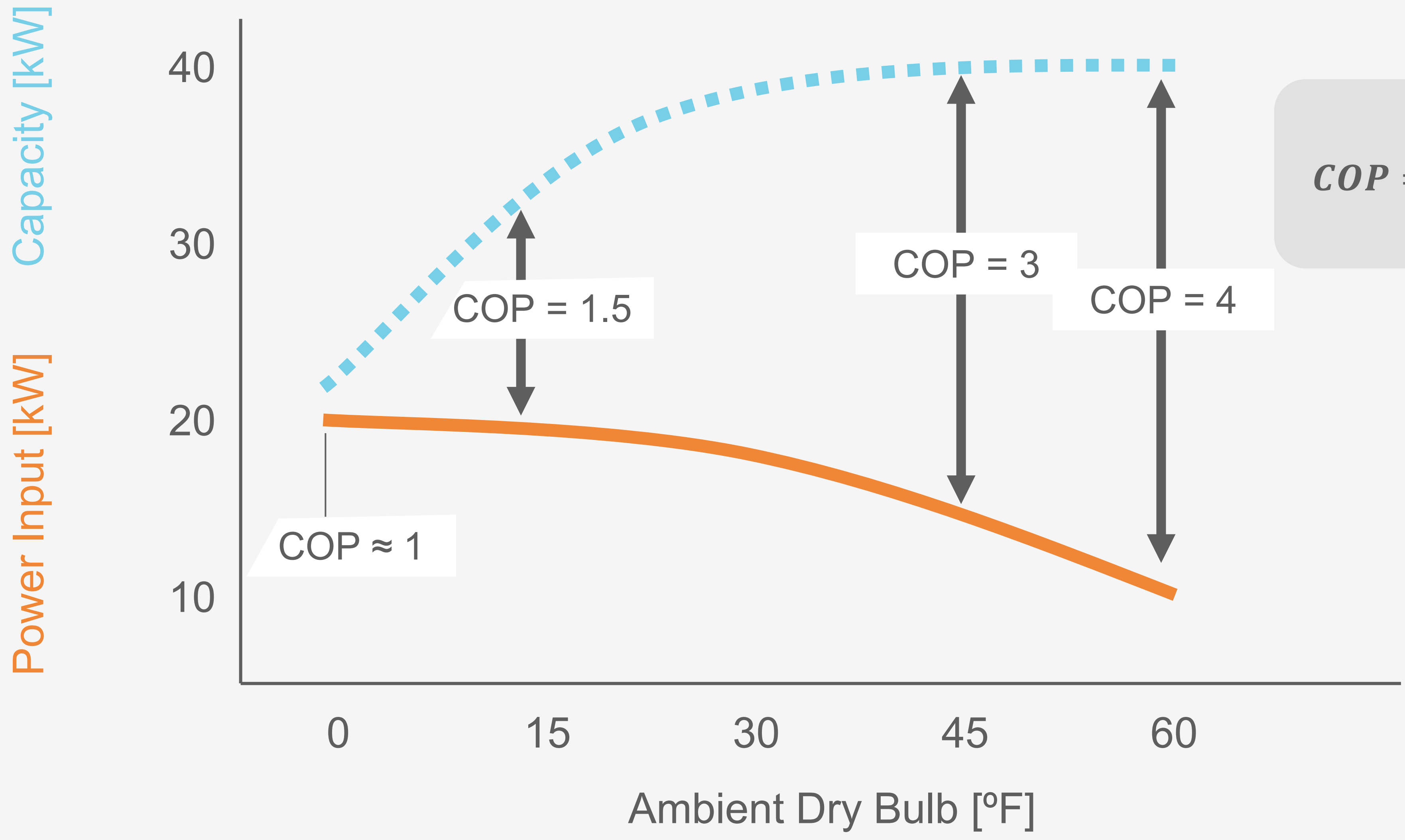
Thermal energy storage battery
"Storage Source Heat Pump"





Exhaust air coil

Impact of Ambient Temp Performance



$$COP = \frac{Capacity\ Output\ [kW]}{Power\ Input\ [kW]}$$

Impact of Ambient Temp Performance

- 4.2 MMBTU System
- 120F LWT, 30% PG
- Modular AWHPs

$$COP = \frac{Capacity\ Output\ [kW]}{Power\ Input\ [kW]}$$

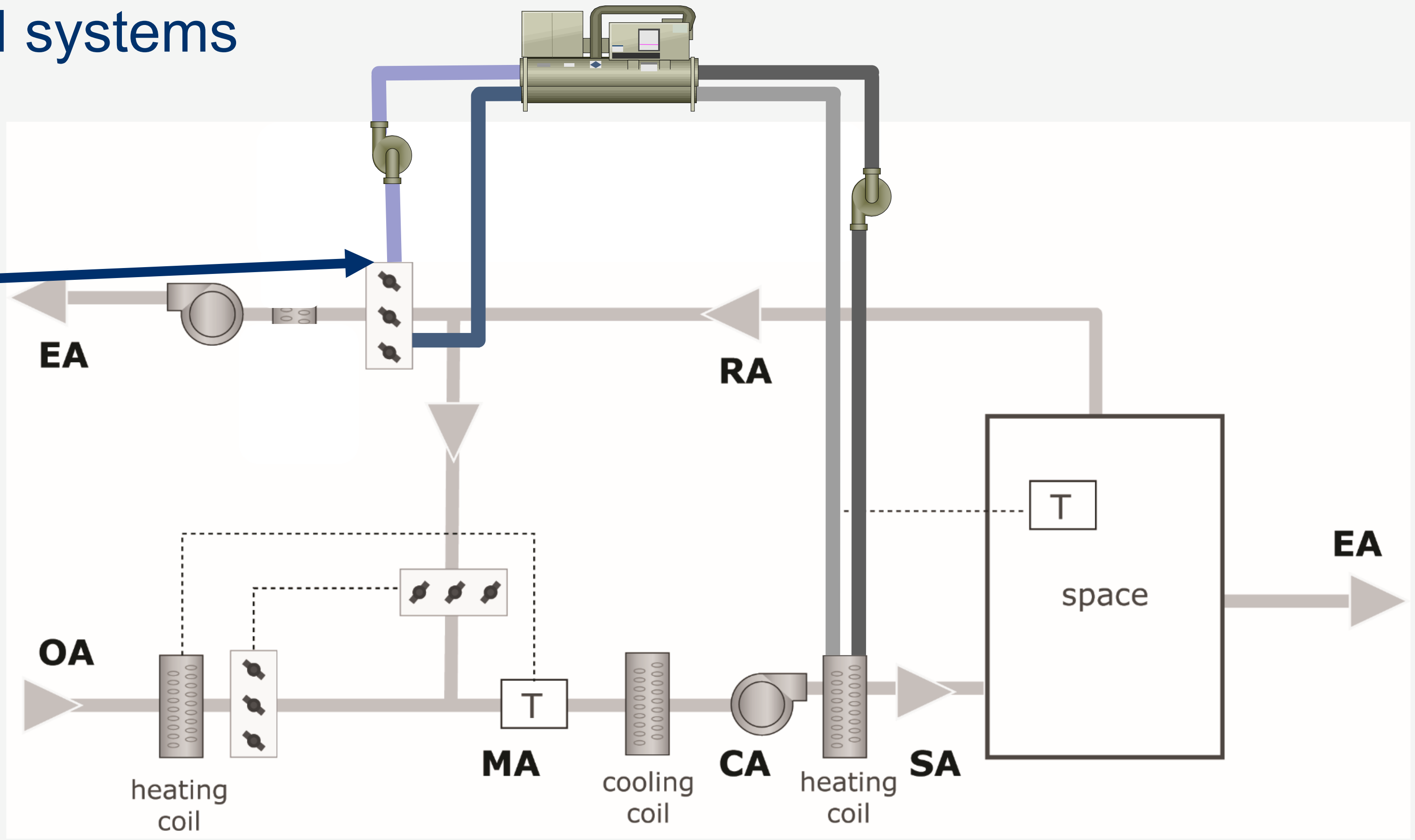
Ambient Temperature	**45F**	**0F**
COP	3.0	1.8 (-40%)
Equipment Required	(2) Banks - (6) 30-ton mods (2) 24' x 8'	(2) Banks - (10) 30-ton mods (2) 40' x 95' (+70%)
Equipment Budget	$1.15 MM	$1.9 MM (+65%)

Heat Sources

Electrified Systems

- BTU value > in electrified systems

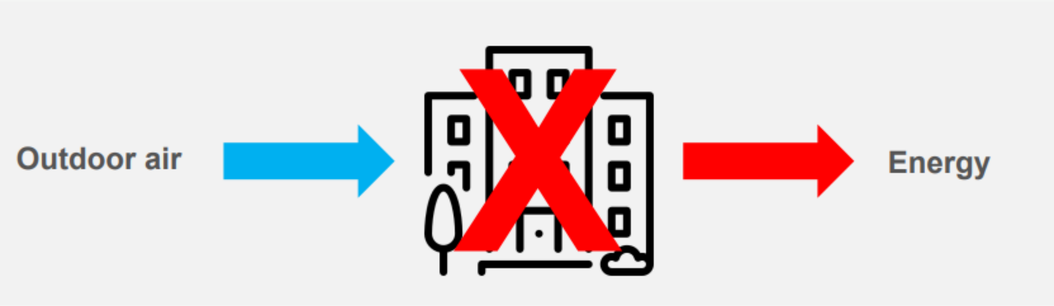
- Potential heat sources:
  - Exhaust air
    - Need to re-evaluate HR!
  - Load-shedding economizer
  - Mechanical/electrical rooms
  - Labs

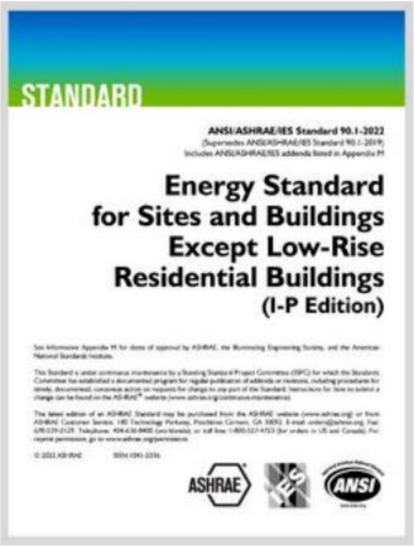


Heat Sources

Electrified Systems

- Disable/Limit economizing
  - Limit the air side economizer when a source is needed





> ***6.5.1.4 Economizer Heating System Impact.***
> *"HVAC system design and economizer controls shall be such that economizer operation does not increase the building heating energy use during normal operation."*

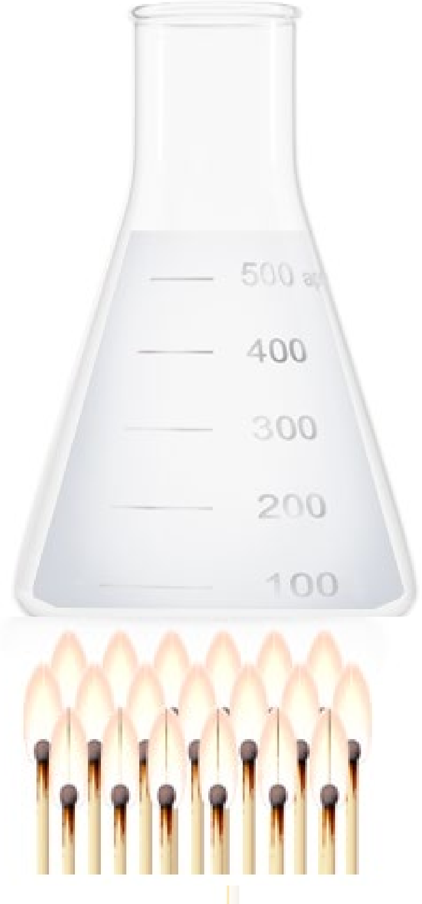
Thermal Energy Storage

When you take heat out, water turns to ice
When you put heat in, ice melts

Water's phase-change (Btus)

One British Thermal Unit (Btu) is the amount of energy that
will raise the temperature of 1 pound of water by 1 degree Fahrenheit.

1 match takes
1 lb. of water
from
32°F to 33°F
176°F



144 Matches

144 matches takes 1 lb.
of Ice from
32°F Ice to 32°F water.

Changing water's
phase (solid to liquid)
stores tremendous
amounts of thermal
energy.

144 matches

IRA: Energy Investment Tax Credit (48 ITC)

TRANE

- Long-standing **tax credit** for **private** and **non-taxable** entities
- Historically for qualified "energy property,"

  incl: solar, geothermal heat pumps, combined heat and power, and more

Key Changes from the IRA:

- **Tax credits** of **up to 50% of the cost** for energy property projects
- Expanded to addt'l technologies, incl. **thermal energy storage property** – defined as property comprising a system which:

  (I) is directly connected to a heating, ventilation, or air conditioning system,

  (II) removes heat from, or adds heat to, a storage medium for subsequent use, and

  (III) provides energy for the heating/cooling of the interior of a residential/commercial building

Updated Energy Investment Tax Credit	
Base Rate	**6%**
Increased Credit Amount*	**Up to 30%**
Meets Domestic Content Requirements**	**2%-10%**
Meets Energy Communities Requirements***	**2%-10%**
Total Potential Credit Value	**Up to 6% Base + Up to 50% Bonus**

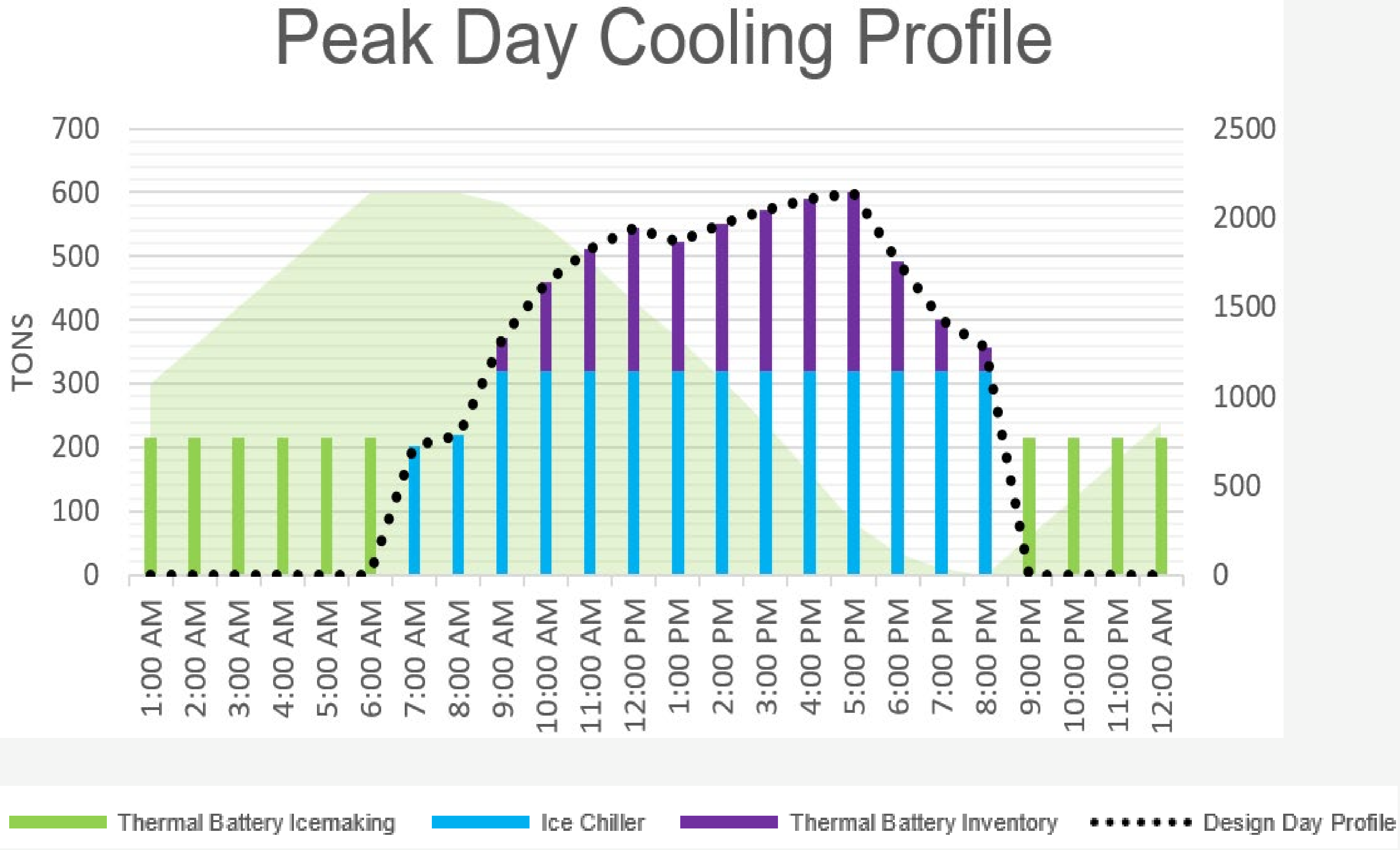
*Increase Credit Amount: must meet prevailing wage and apprenticeship requirements **Domestic Content: i.e., materials are made in the USA

***Energy Communities: a brownfield site (as defined by the EPA); a community with above-average unemployment rate and 1) $0.17 direct employment or 2) 25%+ local tax revenue from coal, oil or nat gas processes; census tracts containing mines and/or coal-fired generating units that have retired after 12/31/1999 or 12/31/2009

Source: full text of the legislation (Link)

Office Building: Partial Storage Example

- Partial Storage 8AM-8PM
- 215 tons in ice-making (320 nominal tons)
- 2,141 ton-hours of TES
- On-Peak kW = 426

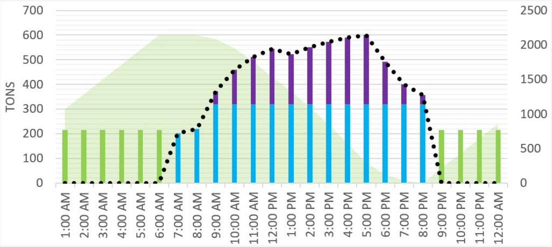


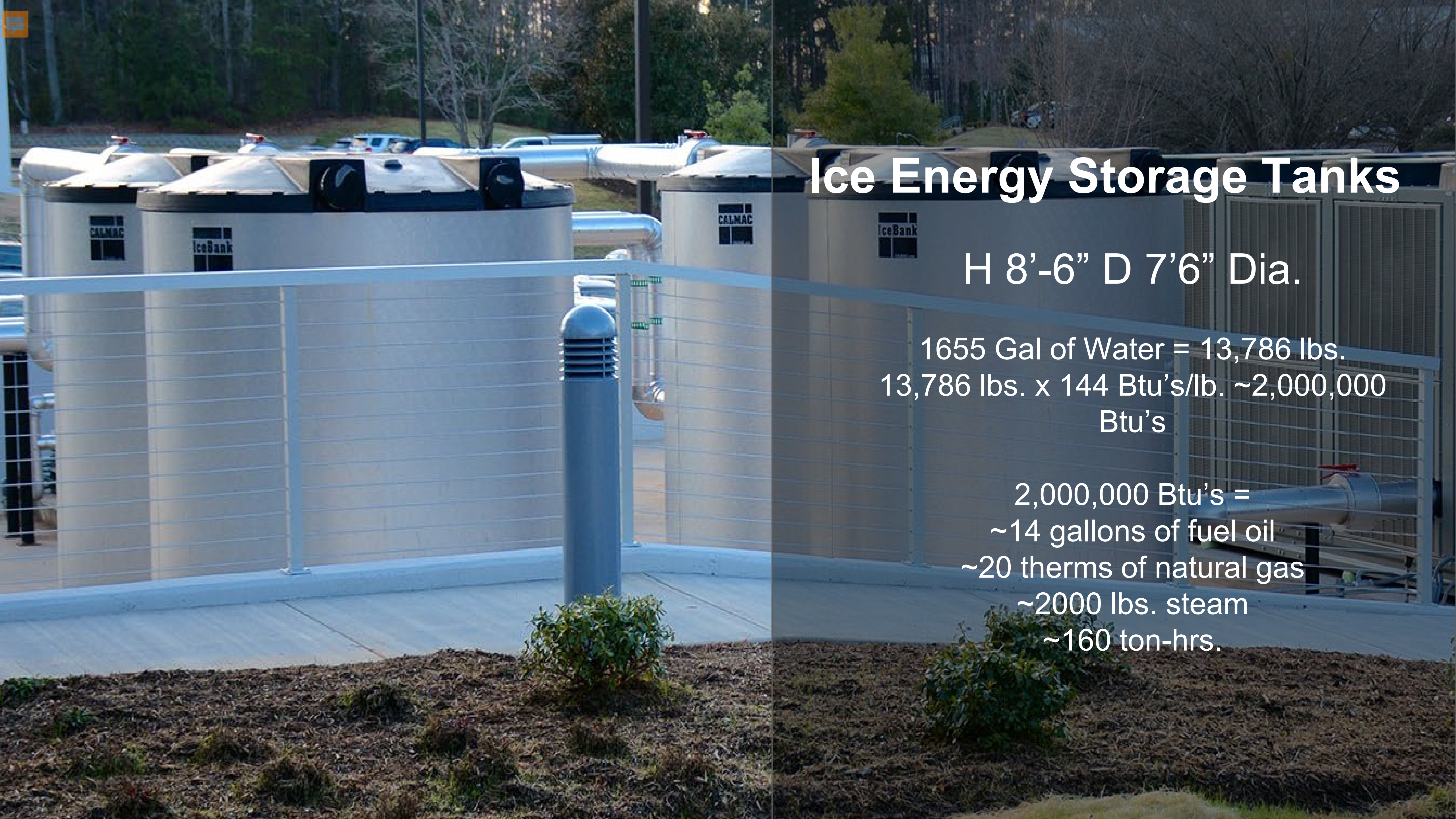
Estimated Chiller Plant Cost Summary

Disclaimer: Consult your tax advisor for specific details on your project.

	Conventional		Partial Storage
Chillers	(2) 300-ton AC		(1) 350-ton AC
TES tanks & accessories	N/A		(2,141 ton-hr) $625k
Utility Cost Savings*	N/A		$78k
First Cost	$900k		$1,150k
Tax Credit (40%)	$0		($460k)
Revised First Cost	$900k		**$690k**

* Annual estimated electric utility savings for the chillers



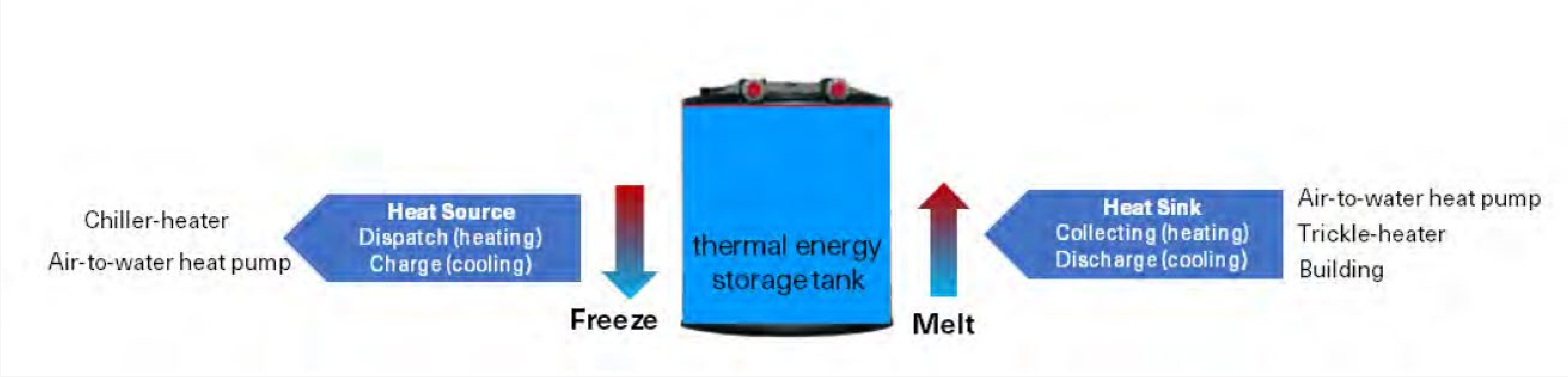


Ice Energy Storage Tanks

H 8’-6” D 7’6” Dia.

1655 Gal of Water = 13,786 lbs.
13,786 lbs. x 144 Btu’s/lb. ~2,000,000 Btu’s

2,000,000 Btu’s =
~14 gallons of fuel oil
~20 therms of natural gas
~2000 lbs. steam
~160 ton-hrs.


Chiller-heater
Air-to-water heat pump
Heat Source
Dispatch (heating)
Charge (cooling)
Freeze
thermal energy storage tank
Melt
Heat Sink
Collecting (heating)
Discharge (cooling)
Air-to-water heat pump
Trickle-heater
Building

Storage Source Heat Pumps

System Benefits

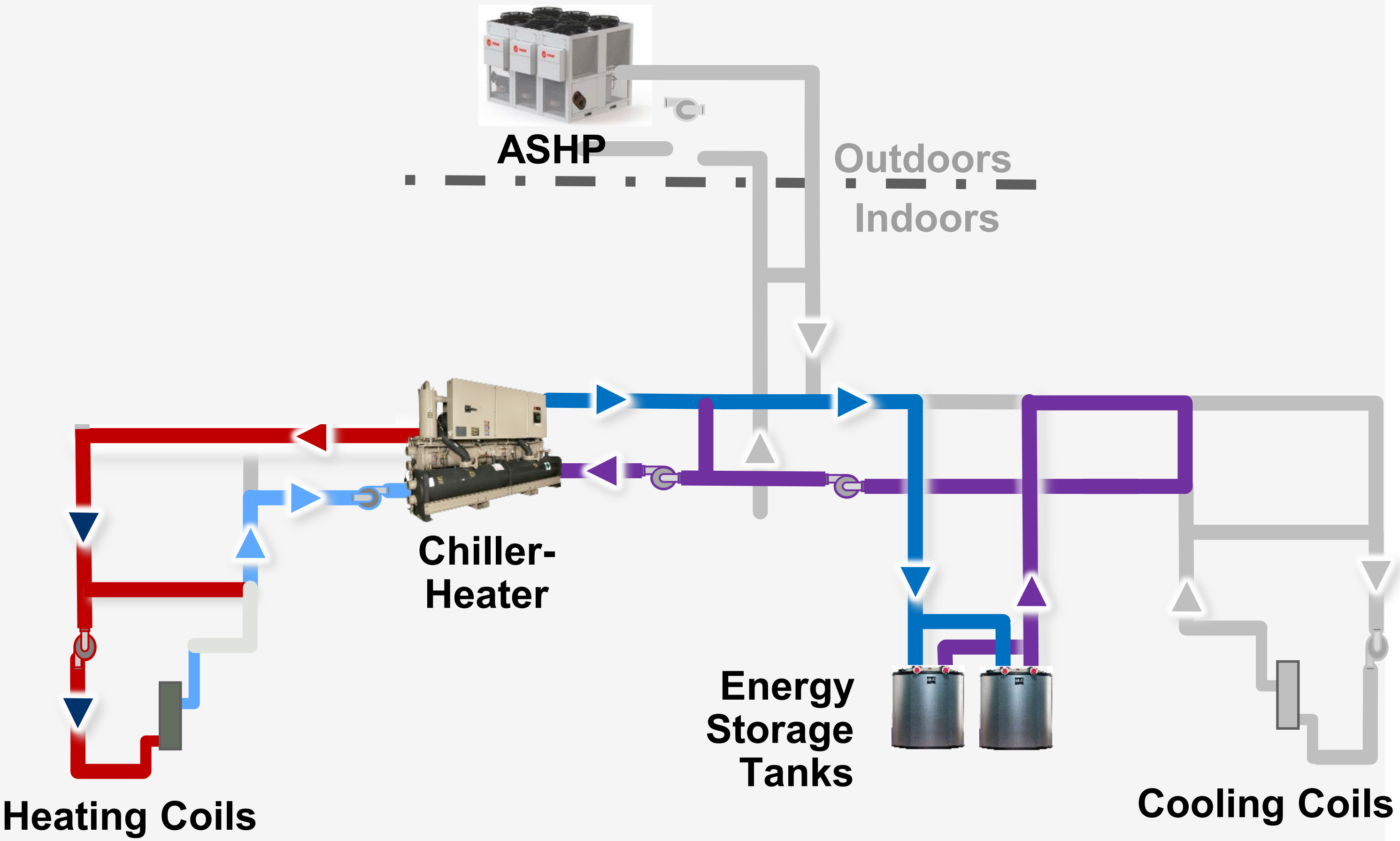
Lower carbon footprint

Lower peak cooling **and** heating demand charges

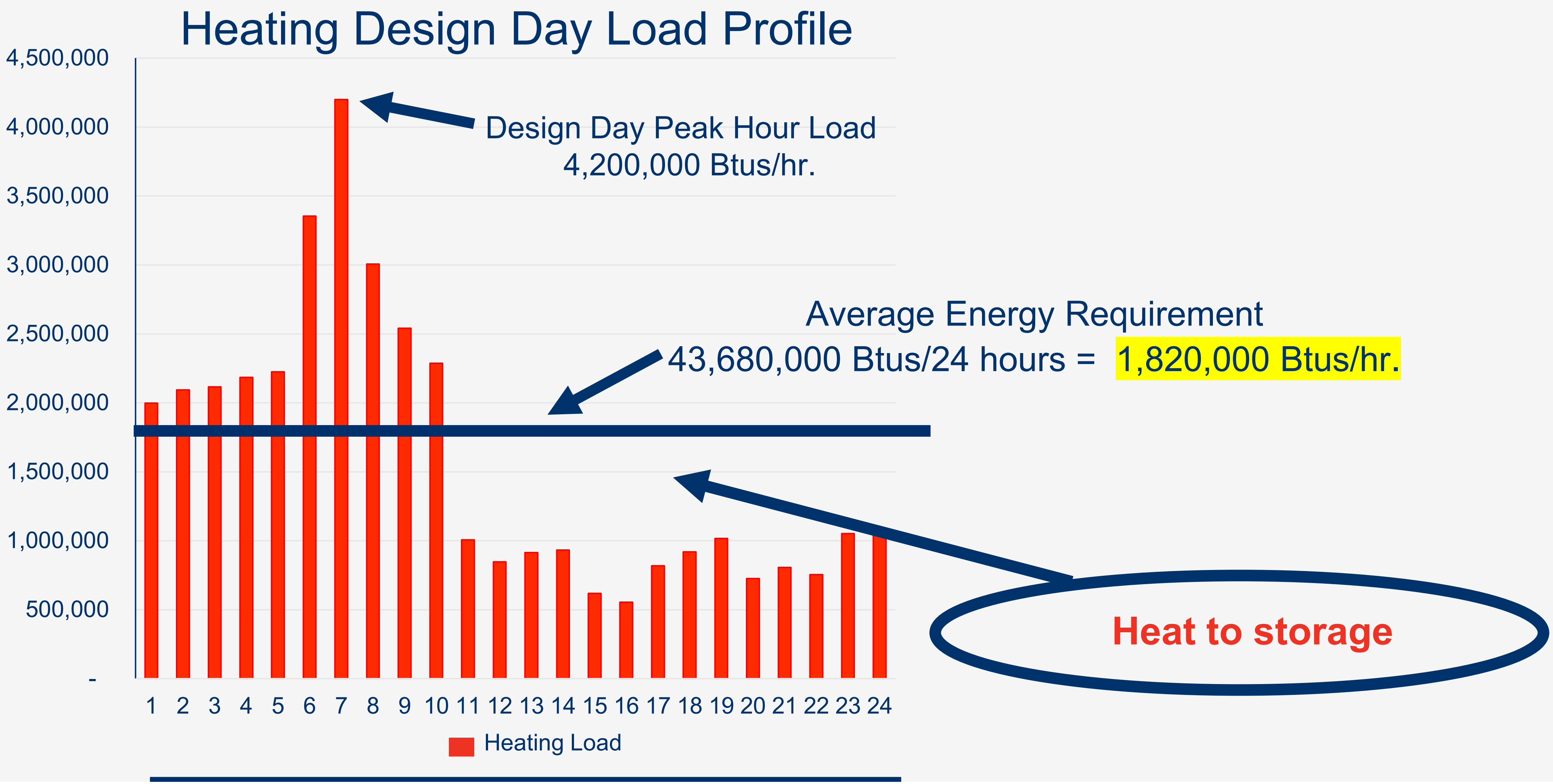
Reduce AWHP

Capture stranded energy

Tax Credits/Rebates



Storage Source Heat Pumps: AWHP Sizing



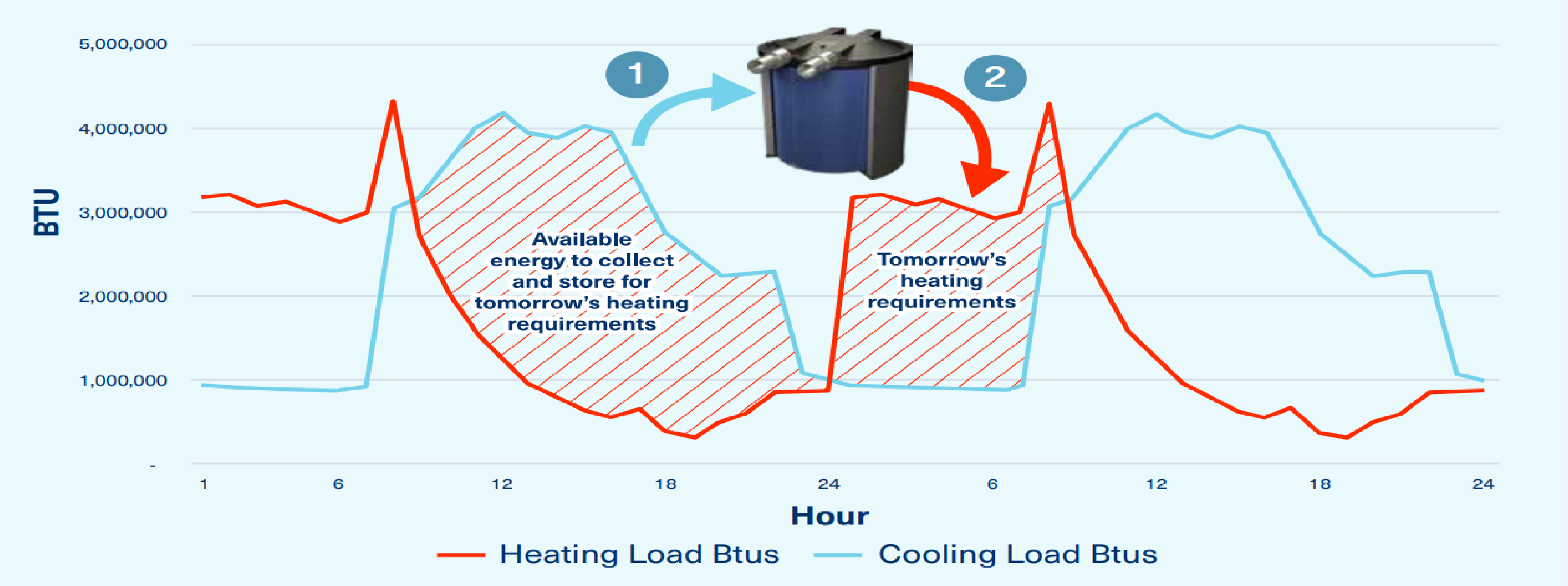
Storage Source Heat Pumps: Space Flexibility

- Heating load: 4,200,000 BTUs
- HW: 120F, 30% PG
- Heat Source: 0F Ambient only **(No HR Included!)**

	Modular AWHPs	**SSHP**
Equipment Required	(2) Banks - (10) 30-ton mods (2) 40’ x 8’ -> outside	(2) 180 Ton AWHPs (2) 250-ton Chiller/heaters (8) Ice storage tanks (2) 23’ x 7’ -> outside (2) 11’ x 4’ -> inside (8) 8’ Dia -> buried?

Storage Source Heat Pumps: AWHP Sizing

- Capture stranded BTUs -> Store for heating later -> Reduce AWHP Size
- Take advantage of non-simultaneous loads



<u>Reduce AWHP Size -> Increase efficiency -> Reduce First Cost</u>

System Comparison

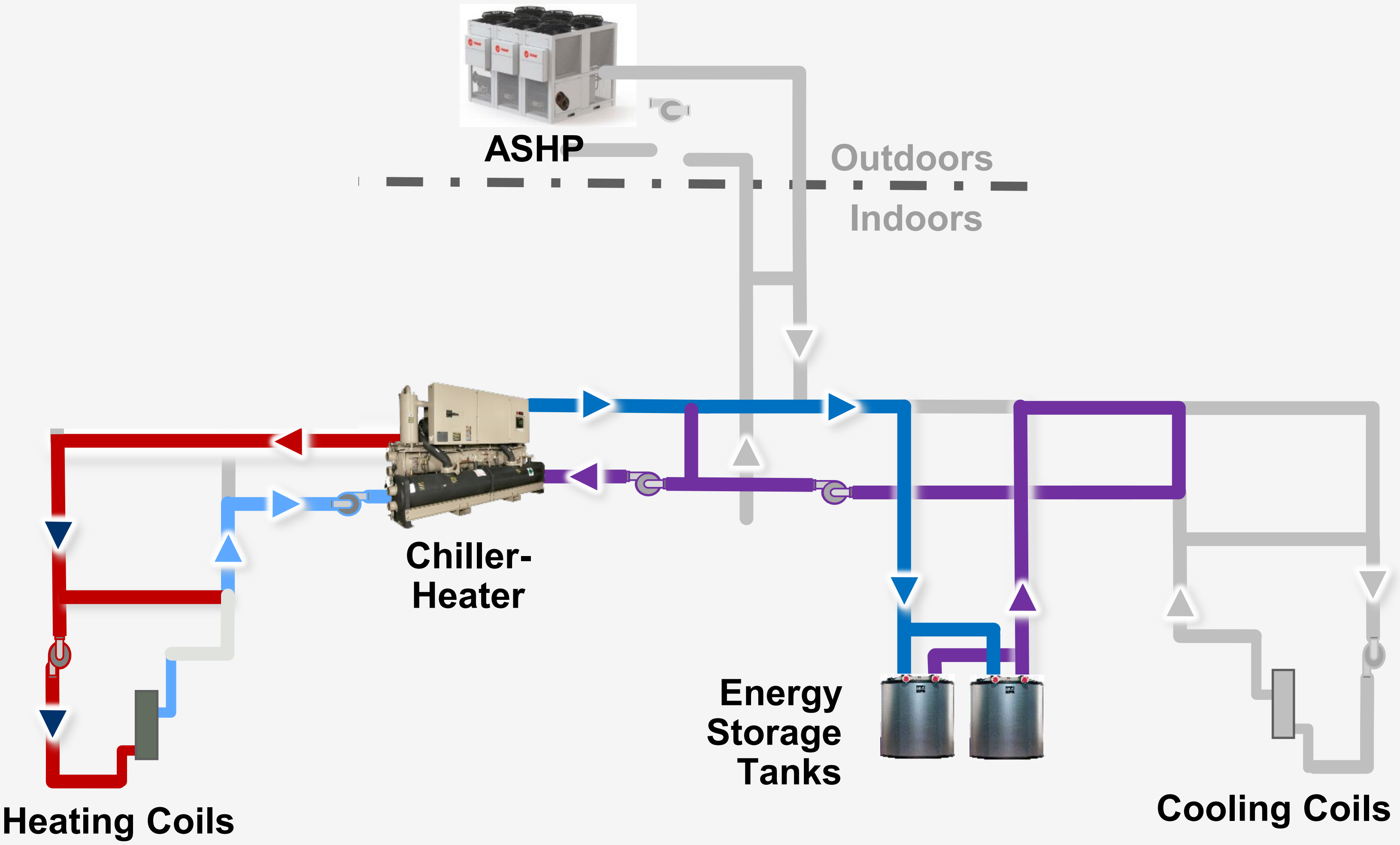
- Heating load: 4,200,000 BTUs
- HW: 120F, 30% PG
- Heat Source: 0F Ambient only **(No HR Included!)**

SSHP - Energy Savings Summary (Peak Heating and Cooling)			
SSHP System	vs. Chiller+Gas Heat	vs. Chiller+Elec. Heat	vs. Chiller+Heat Pump
Energy Demand Cost Savings	*-$15,055*	*$58,802*	*$21,874*
Energy Utility Rate Savings	*-$1,204*	*$52,695*	*-$7,351*
Annual Operating Cost Reductions	*-$16,259*	*$111,497*	*$14,523*

SSHP - Business Case			
SSHP System	vs. Chiller+Gas Heat	vs. Chiller+Elec. Heat	vs. Chiller+Heat Pump
First Cost Premium	*$567,436*	*$157,259*	*-$541,448*
Net Present Value	*-$650,018*	*$777,095*	*$612,067*
Internal Rate of Return	*0.0%*	*70.9%*	*Infinite*
Payback Period	*No Payback*	*1 years 4 months*	*Immediate*

SSHP - Heating Carbon Estimates			
SSHP System Total Output Emission Rate		*491,777 lbs CO2e*	
	Gas Heat	Electric Heat	Heat Pump
Conventional Systems (lbs CO2e)	*1,764,976*	*1,588,440*	*619,879*
Additional Carbon vs. SSHP	*258.9%*	*223.0%*	*26.0%*

Storage Source Heat Pumps



Questions?

Clean Green Schools Initiative

(PON 4924)

Program Goal:

- The goal of the program is to help under-resourced **public** schools decarbonize their building portfolio and improve indoor air quality (IAQ) across their buildings.

Budget:

- $160 M

Eligibility:

- All existing public school buildings across NYS that meet the definition of an under-resourced school per the Program (e.g. schools which are High-Needs or located in a disadvantaged community).

This program provides funding in two tracks to support a school's pathway towards decarbonization:

Track I Planning: Open Enrollment (accepting apps until 12/30/25)

- Provides funding for services which will help schools evaluate, plan for and facilitate energy reduction projects, clean energy projects and indoor air quality projects.
- Track I project costs are up to 100% funded and NYSERDA's funding ranges from $650,000-$1,250,000 per district depending on the district's annual energy spend.

Track II Installation: Competitive (proposals due 6/6/24)

- Provides funding to implement construction projects which will help schools decarbonize their buildings.
  - Electrification of building systems
  - Comprehensive retrofits
  - Electrification readiness
- Track II project costs are up to 100% funded, with a maximum possible funding amount of $5,030,000 per building and $10,100,000 for multiple buildings.

Questions: Hannah.morgan@nyserda.ny.gov

Overview of Clean Green Schools Initiative

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Track I Planning: Eligible Projects

- **Eligible services include, but are not limited to:**
  - Engineering & Architecture Services
    - Energy Benchmarking
    - Energy Studies
    - Energy Efficiency and Clean Heating and Cooling Design Services
    - Energy Master Planning and Decarbonization Roadmaps
    - Clean Transportation Studies
    - Indoor Air Quality Evaluation and Management
  - On-Site Energy Manager
    - District level or across districts
  - Services Associated with Clean Energy Projects
    - Grant Writer
    - Fiscal Advisor
  - Clean Energy Educational and Professional Development Activities
    - *This must be paired with an above bullet and is ineligible as a standalone project.*

Track II Installation: Eligible Projects

- **Clean Heating and Cooling Projects:**
  - Ground Source Heat Pump
  - Air Source Heat Pump
  - Variable Refrigerant Flow System

- **Capital Projects to Move Towards Decarbonization:**
  - Comprehensive retrofits that impact energy consumption and overall building load
  - Electrification of building systems (e.g., kitchen equipment & domestic hot water heaters)
  - Building electrification readiness projects:
    - High performance building envelope (e.g., air sealing, insulation, window film)
    - Heating/cooling projects
    - Conversion of distribution systems (e.g., steam to hot water) to support potential future electrification

Ineligible Projects:
- System conversion to natural gas
- Full system replacement to new fossil fuel-based system

Flexible Technical Assistance Program (FlexTech)

PON 4192

Example Eligible Projects:

- Energy audits
- Investigation of clean heating and cooling systems (heat pumps and/or district thermal networks)
- Targeted or comprehensive analysis of equipment or systems
- Energy Master Planning
- Retro-commissioning analysis
- Load reduction studies
- Indoor air quality studies

Higher Education:

- An institution that has not previously participated in FlexTech (PON 4192) may be eligible for a 75% cost-share if the project includes investigation of electrification opportunities.
- All other institutions will receive a 50% cost-share

P12 Schools:

- P12 Schools that are ineligible to participate in NYSERDA's Clean Green Schools Initiative (PON 4924) are eligible to participate in FlexTech (PON 4192) if they pay into the electric System Benefits Charge (SBC).
- Non-public schools located in a Disadvantaged Community are eligible for up to 100% funding.
- All other schools are eligible for a cost-share up to 75%.

Learn More:
Program Website
Program Fact Sheet
Higher Education Fact Sheet

Questions: flextech@nyserda.ny.gov

Questions

P12: Hannah.Morgan@nyserda.ny.gov

FlexTech: flextech@nyserda.ny.gov

NEW YORK STATE OF OPPORTUNITY. | NYSERDA

Heat Recovery turns a problem into an opportunity.

Buildings waste heat through a variety of processes including ventilation, cooling, & wastewater.

Recovering wasted heat and recycling it directly at point of use or storing it for later represents a promising approach to large building decarbonization.

Heat Recovery projects accepted in NYSERDA's Heat Recovery Program receive up to 75% cost share across two categories:

Open to all existing commercial, multifamily, industrial, and institutional buildings in NYS who pay the System Benefits Charge [SBC].

1 Opportunity Assessment

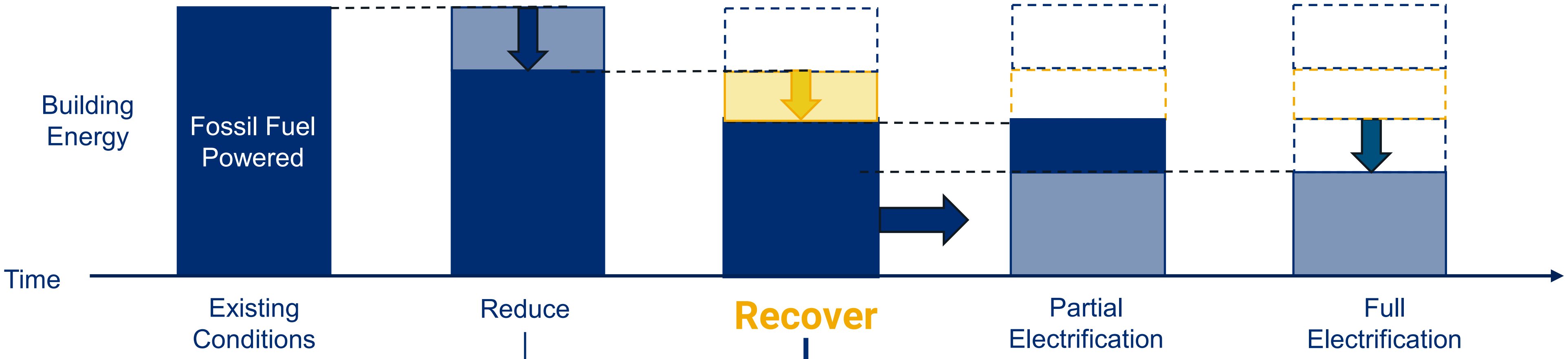
- Document current operations and define heat recovery opportunity
- Up to $40k

2 Project Design

- Develop schematic designs for technically and economically viable heat recovery projects
- Up to $80k

Heat Recovery Project Development -- PON 5547

Heat Recovery is an essential step in Phased Decarbonization



Reduce Energy Load and Reconfigure

- Building Envelope Improvements
- Control Optimization
- Ventilation Improvements
- Dedicated Outside Air System
- Hydronic Distribution
- Lower Heating Supply Temp.
- Terminal Units Replacement

Recover Wasted Heat

- Ventilation Heat Recovery
- Cooling Heat Recovery
- Wastewater Heat Recovery
- Thermal Storage

Partial Electrification

Replace fossil fuel inputs and prioritize the techno-economic portion of load

- Air Source Heat Pumps
- Water Source Heat Pumps
- Geothermal
- Thermal Layering

Full Electrification

In-time, replace or remove the remaining peak load equipment

- Heat Pumps
- Thermal Storage
- District Thermal Network
- Grid-interactivity

Heat Recovery opportunities arise from the heat rejected by equipment or processes within building systems.

Heating

Cooling

Ventilation

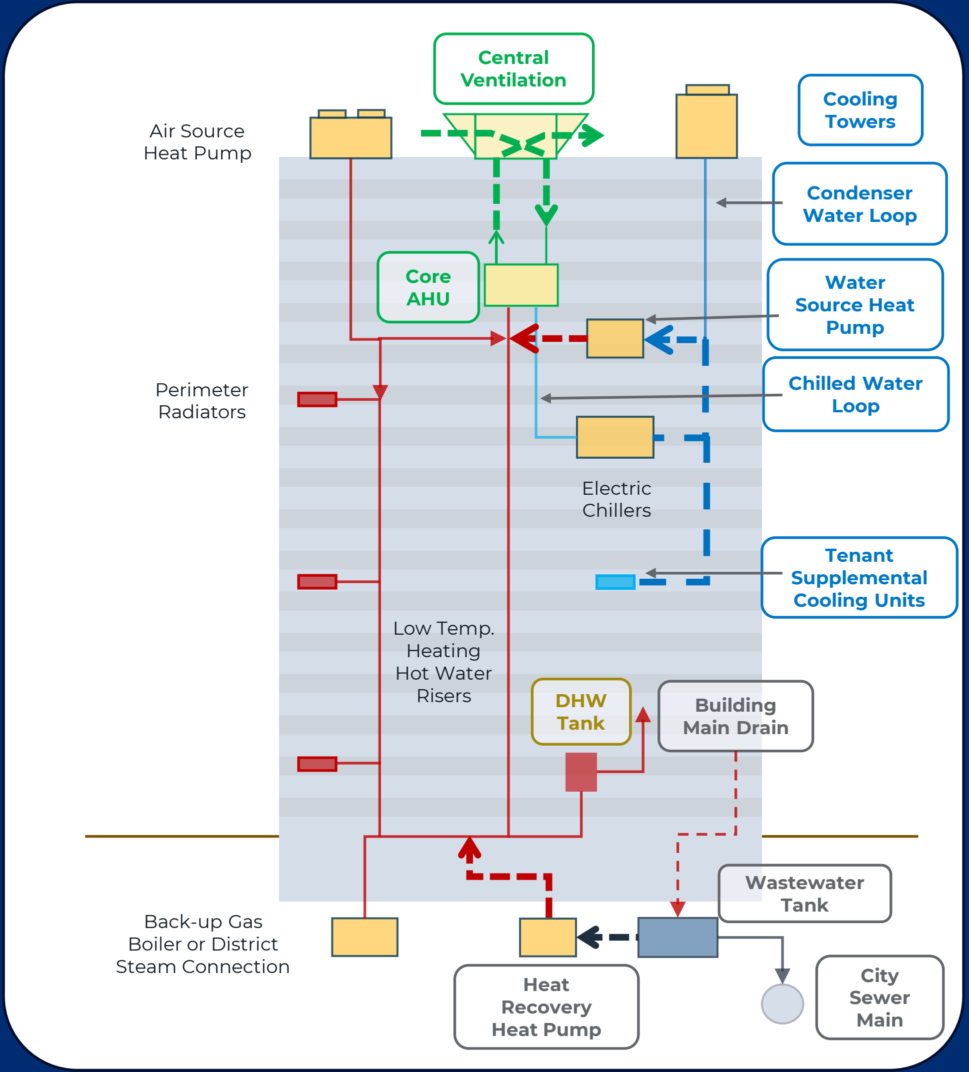
Cooling produces heat

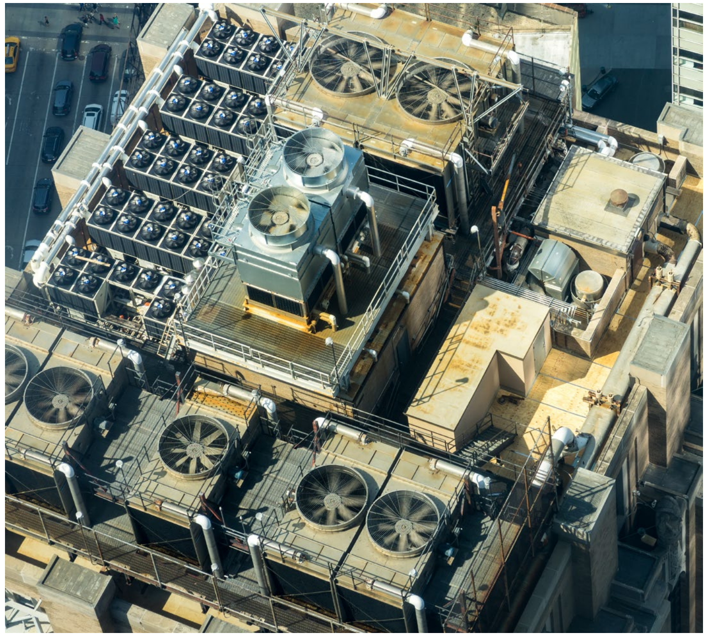
Heat is lost through ventilation…

…or goes down the drain

Internal processes also produce heat

Heat can be stored





NYSERDA is seeking **Manufacturers** that can significantly improve heat recovery efficacy, make it more practical and economical to enable new heat recovery opportunities in New York State's existing buildings.

The ***NYSERDA Heat Recovery Solutions*** qualification will recognize technologies that enable buildings to decarbonize their operations and advances the adoption of heat recovery by New York State's real estate decision-makers and the architects, engineers, and retrofit construction communities.

Through this vetting of solution providers and their products, NYSERDA will promote qualified heat recovery solutions and their real-world efficacy:

- Help qualified Manufacturers access the New York retrofit market
- Support heat recovery knowledge/technology transfer
- Participate in exchanges with key market stakeholders

Heat Recovery Solutions -- RFQL 5217

Read RFQL Documentation | Share with Manufacturers | Submit Online Application

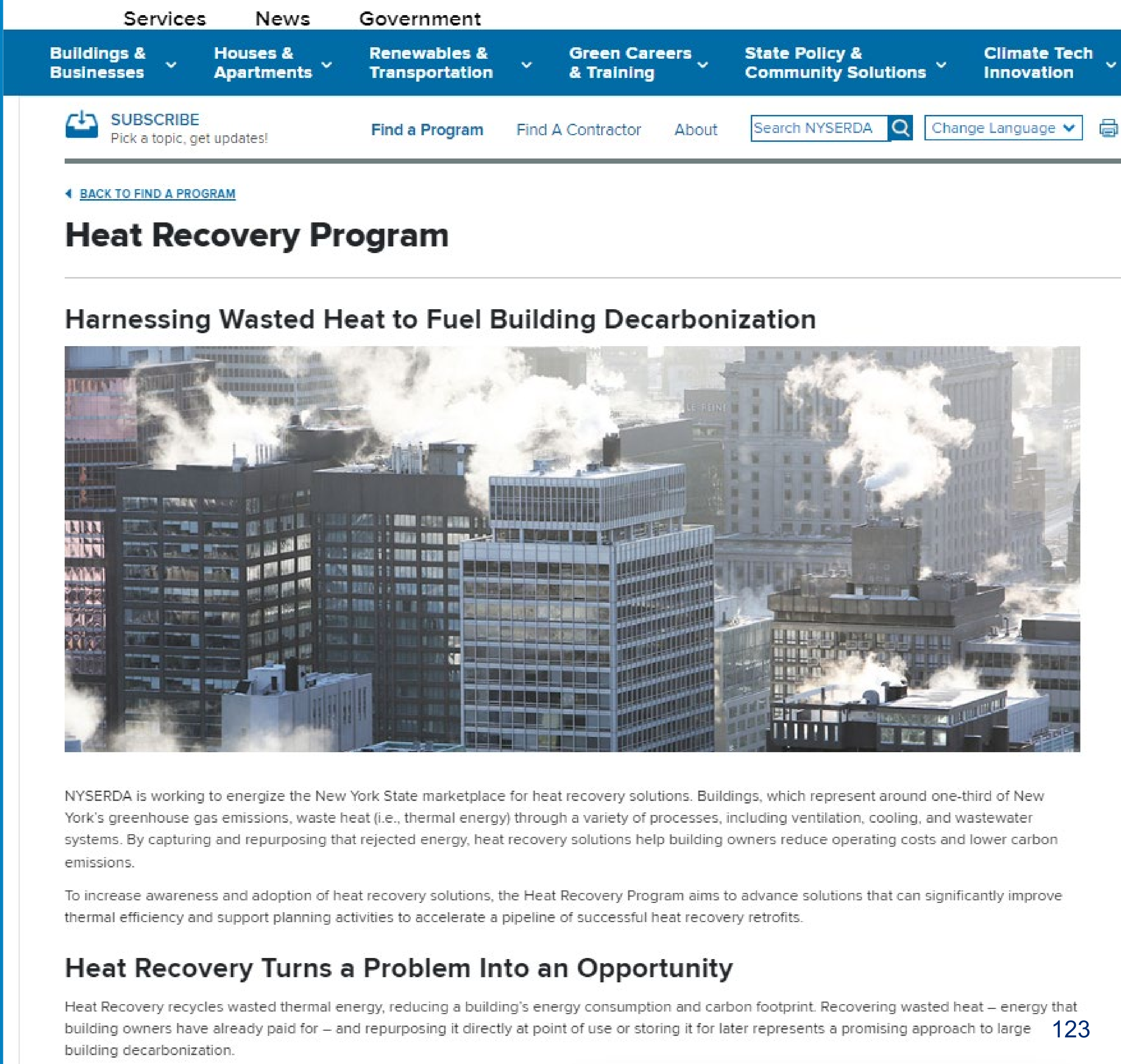
NEW YORK STATE | NYSERDA

Explore these Heat Recovery technologies through NYSERDA's new incentive program, please connect with us:

HeatRecovery@nyserda.ny.gov

NEW YORK STATE | NYSERDA

nyserda.ny.gov/ Heat-Recovery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Heat Recovery Program

Harnessing Wasted Heat to Fuel Building Decarbonization

NYSERDA is working to energize the New York State marketplace for heat recovery solutions. Buildings, which represent around one-third of New York's greenhouse gas emissions, waste heat (i.e., thermal energy) through a variety of processes, including ventilation, cooling, and wastewater systems. By capturing and repurposing that rejected energy, heat recovery solutions help building owners reduce operating costs and lower carbon emissions.

To increase awareness and adoption of heat recovery solutions, the Heat Recovery Program aims to advance solutions that can significantly improve thermal efficiency and support planning activities to accelerate a pipeline of successful heat recovery retrofits.

Heat Recovery Turns a Problem Into an Opportunity

Heat Recovery recycles wasted thermal energy, reducing a building's energy consumption and carbon footprint. Recovering wasted heat – energy that building owners have already paid for – and repurposing it directly at point of use or storing it for later represents a promising approach to large building decarbonization.