NYSERDA Heat Recovery Roundtable

Starbucks Reserve Empire State Building

January 31, 2024

NEW YORK STATE | NYSERDA

Heat Recovery Roundtable Agenda

Q&A Session after each Manufacturer Presentation

nyserda.ny.gov/ Heat-Recovery

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

- NYSERDA Heat Recovery Design & Manufacturer Program
- Con Edison Heat Recovery Implementation Offering
- Manufacturer 1: Wastewater Heat Recovery by SHARC Energy
- Manufacturer 2: Condenser Heat Recovery by Trane Technologies
- Manufacturer 3: Exhaust Air Heat Recovery by Howatherm / Ruhl
- Uptime Institute – Heat Reuse: A Management Primer [data centers]

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

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

Heating
Cooling
Ventilation

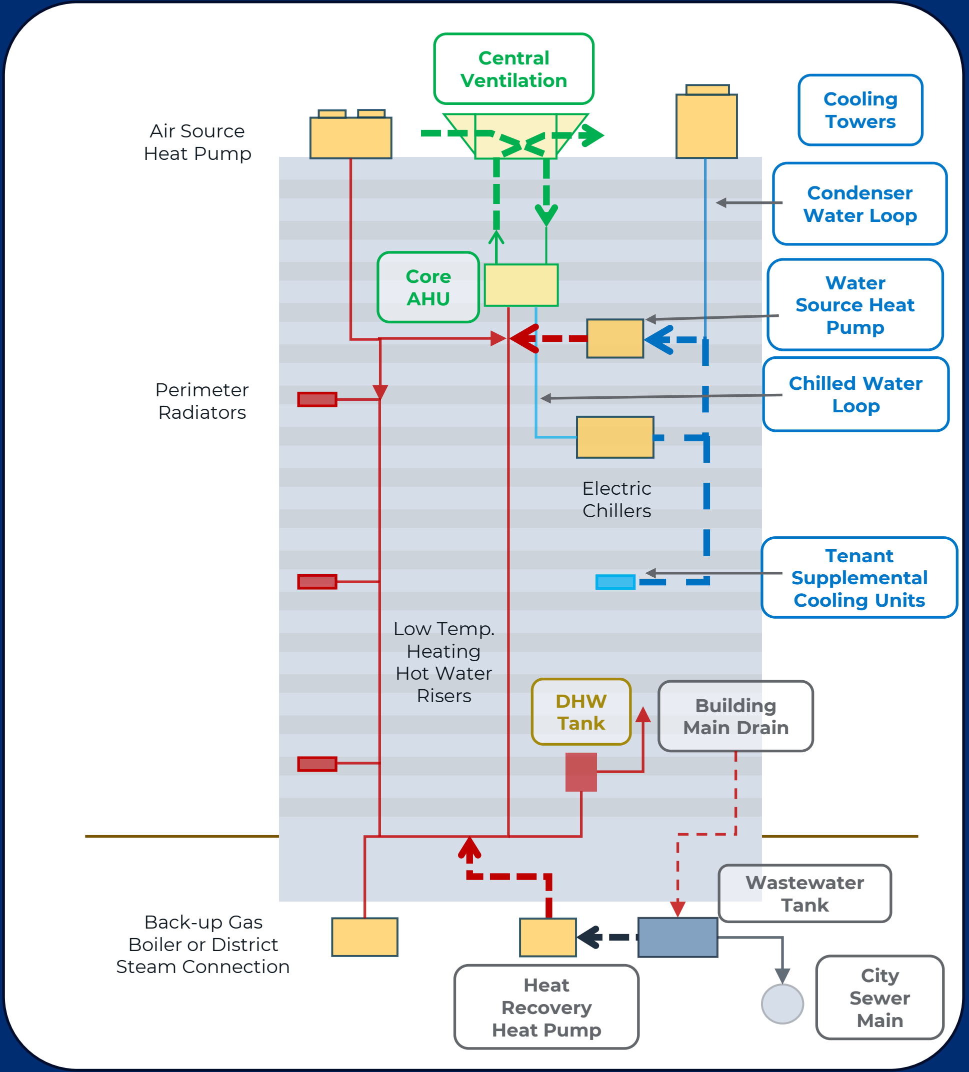
Cooling produces heat

Heat is lost through ventilation…

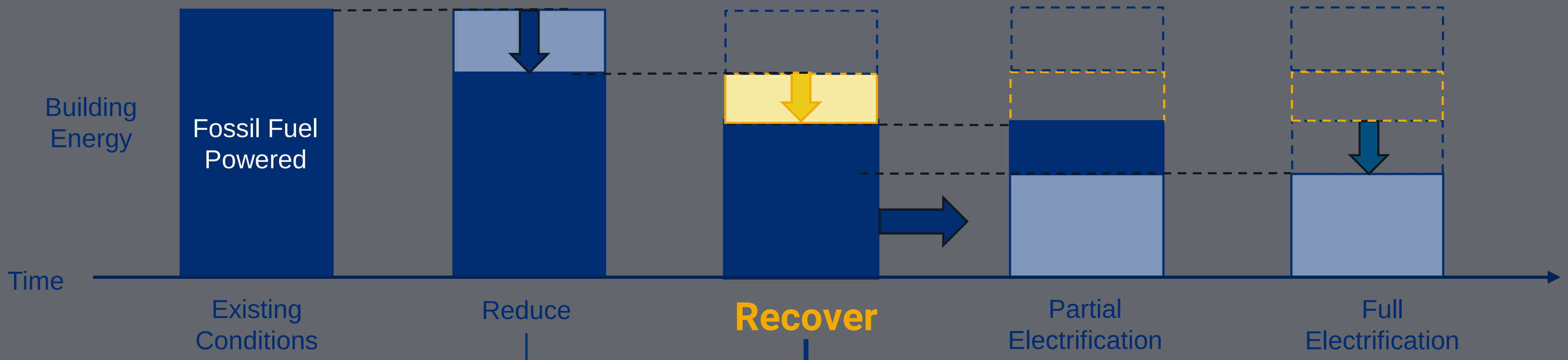
…or goes down the drain

Internal processes also produce heat

Heat can be stored



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

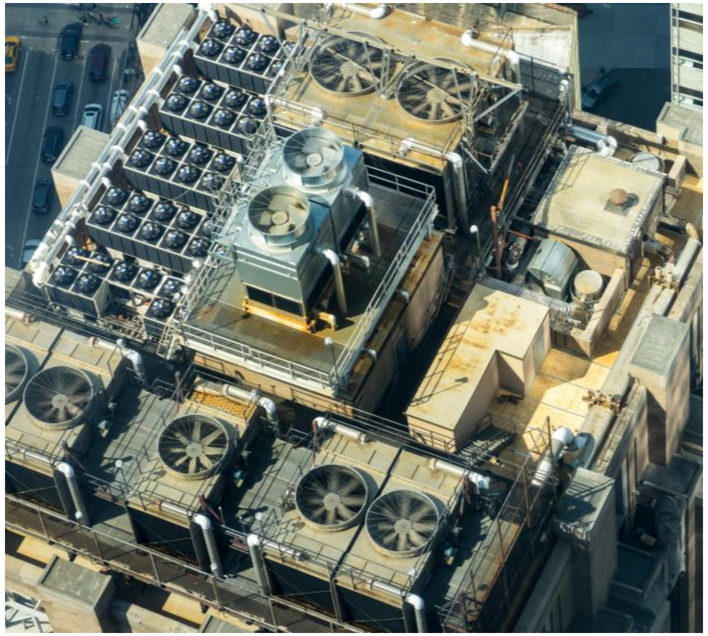
Replace fossil fuel inputs and prioritize the techno-economic portion of load

- 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



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

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

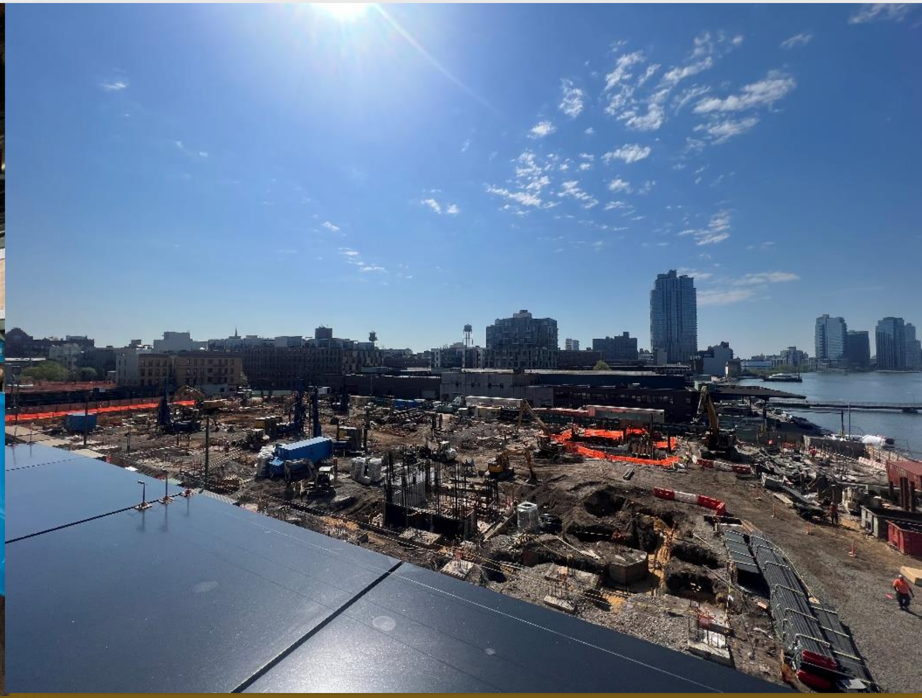
2 Project Design

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

Heat Recovery Project Development -- PON 5547

Heat Recovery Incentives

Laziza Rakhimova



Con Edison Incentive Programs – Clean Heat, *Heat Recovery Track*

Con Edison provides *installation incentives* for Heat Recovery projects which result in energy savings.

C&I and MF - NYS Clean Heat Program

Systems Incentivized	Ground Source Heat Pumps Incentives[1] *Existing & New Construction*	All Other Heat Pump Technologies *Existing Buildings[1]*	Heat Recovery Technologies Incentivized
•Full Load Space Heating •Full Load Space Heating + Envelope •Partial Load Space Heating •Custom Hot Water Heating	$100-$225/MMBTU	$70-$200/MMBTU	•Heat Recovery Chillers •Heat Pump Chillers •HRV/ERV •WSHP •Waste to Energy Technologies

[1]*Project incentives cannot exceed 50% of the project cost. Total incentives are capped at $1,000,000 for all projects, per account per year.*

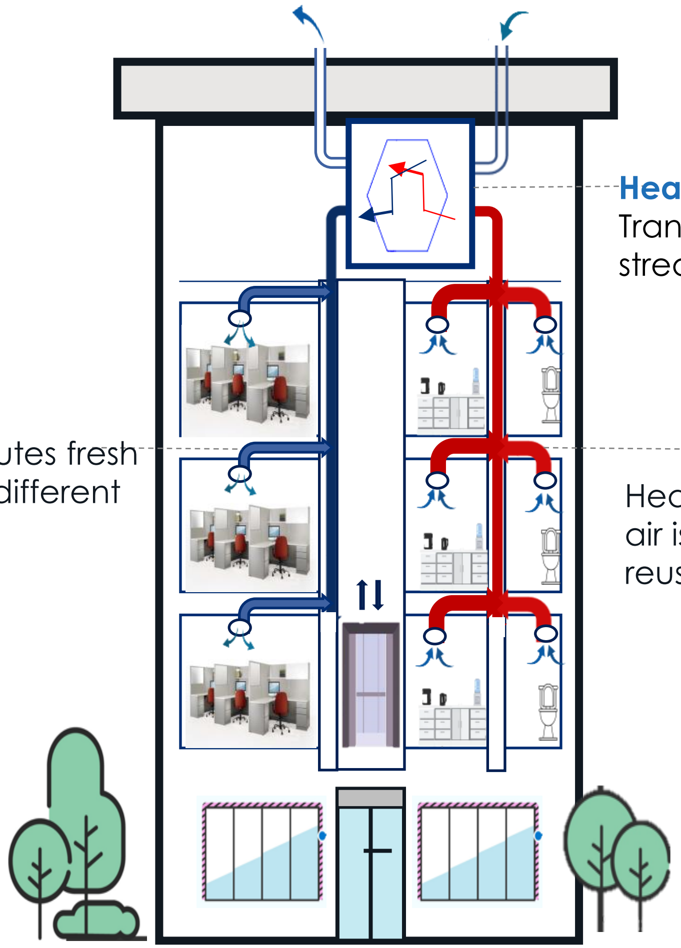
To be eligible for partial incentive, the project must displace at least 50% or min 4000 MMBTU of annual baseline heating consumption or alternative case fossil fuel consumption.

Project Example – less than 50% of fossil fuel displacement

Project Cost	kWh Savings	kW Savings	Mlbs (District Steam) Savings	MMBtu Savings	ConEdison Potential Incentive
$4,400,000	**560,000**	**275**	**10,345**	**10,370**	**$726,000** (preliminary)

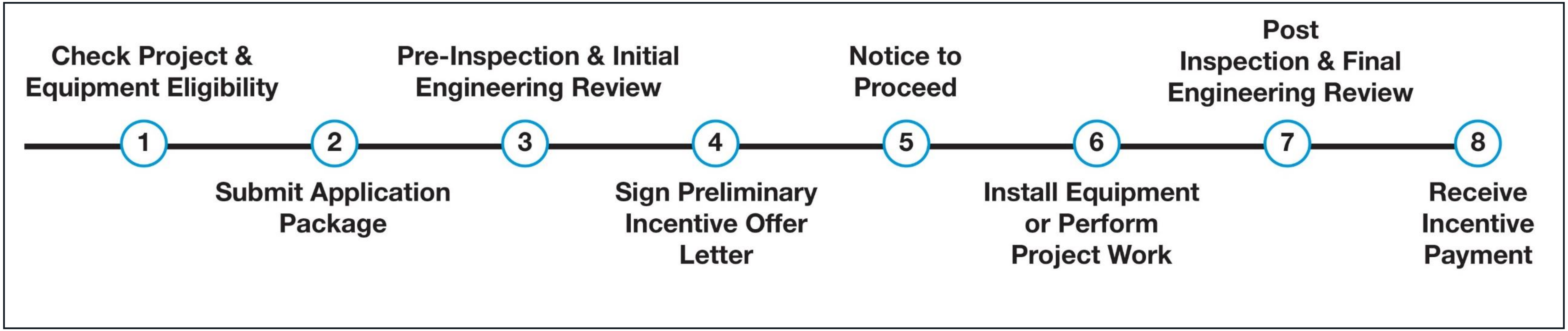
•Full Load Space Heating •Full Load Space Heating + Envelope •**Partial Load Space Heating** •Custom Hot Water Heating	**$70-**$225/MMBTU	•Heat Recovery Chillers •Heat Pump Chillers •HRV/ERV •**WSHP** + heat recovery from condenser water loop •Waste to Energy Technologies

C&I Heat Recovery Track – Energy Efficiency Program



Incentives	Heat Recovery Technologies Incentivized
Electric	• Systems that beneficially reuse waste heat for space conditions or DHW • Heat recovery ventilators (HRV), and energy recovery ventilators (ERV)
Gas	
Steam	

C&I/MFEEP/Clean Heat Energy Efficiency Program Process



**Large Projects, Complex Projects, New Tech Projects are sent through Measurement and Verification per IPMVP to report more accurate savings.*

C&I/MF Business Development Manager: Laziza Rakhimova, rakhimoval@coned.com
C&I Program Manager: Danielle Sitro, sitrod@coned.com

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

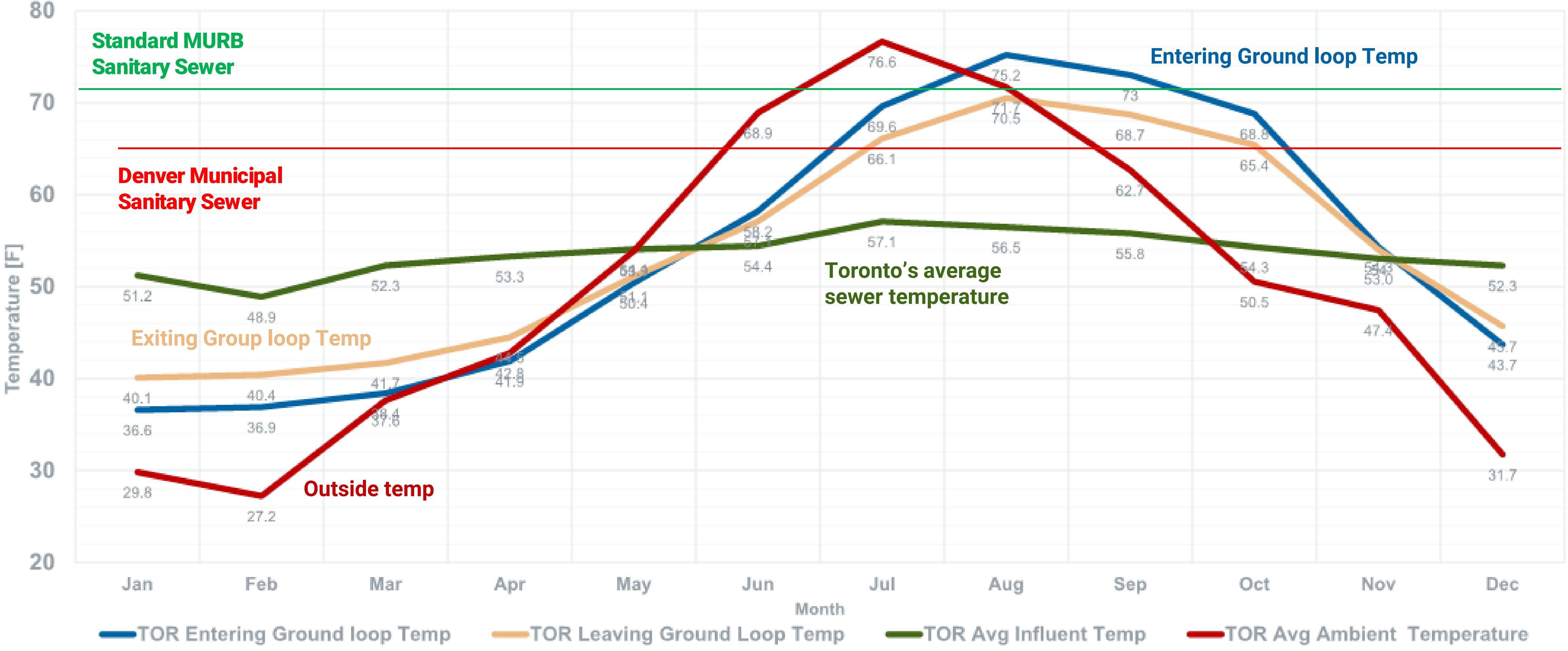
Reduces

- Energy Loss from Buildings
- Energy Use & Operational Costs
- GHG Emissions
  - Local Law 97

High Efficiency Electrification

- Market Demand
- NYSERDA Clean Heat Programs
- 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

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

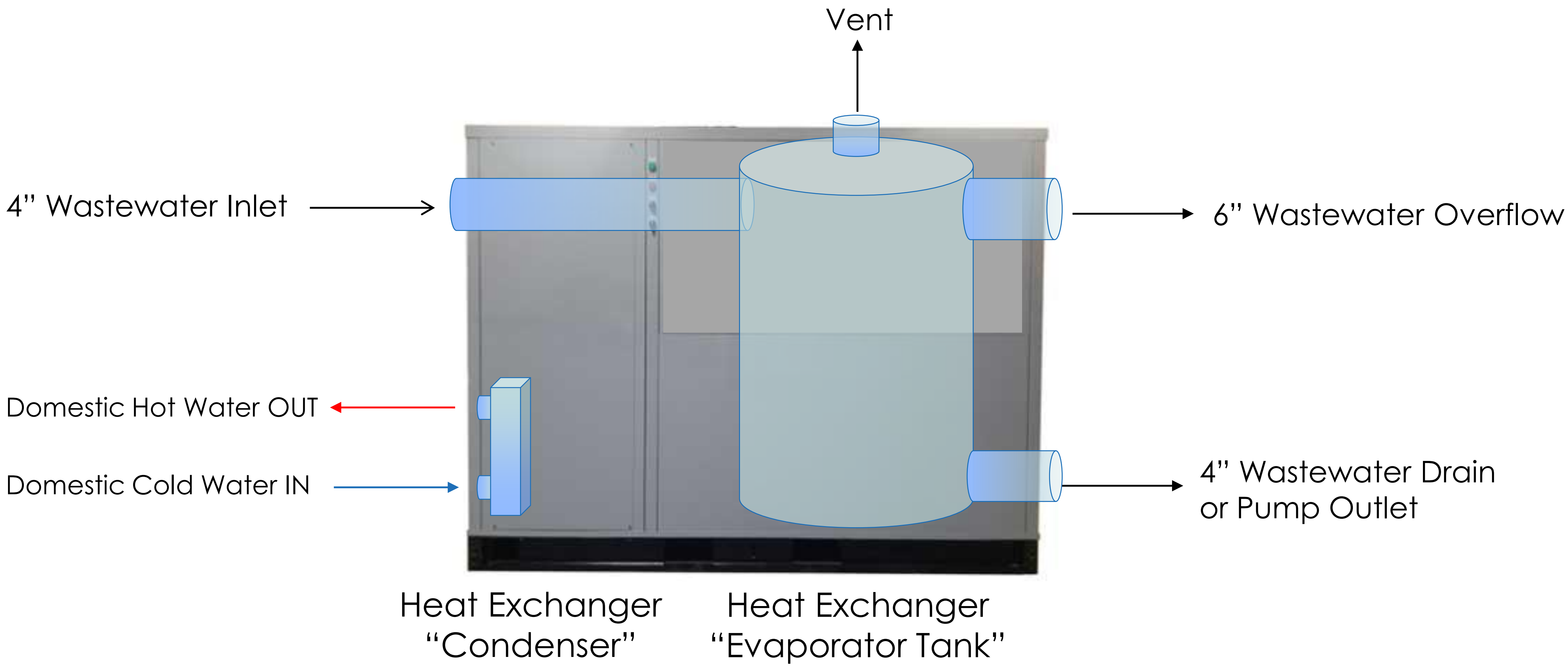
The PIRANHA is a self-contained heat pump that uses a specifically designed direct expansion heat exchanger to recover thermal energy from a building's wastewater for domestic hot water heating

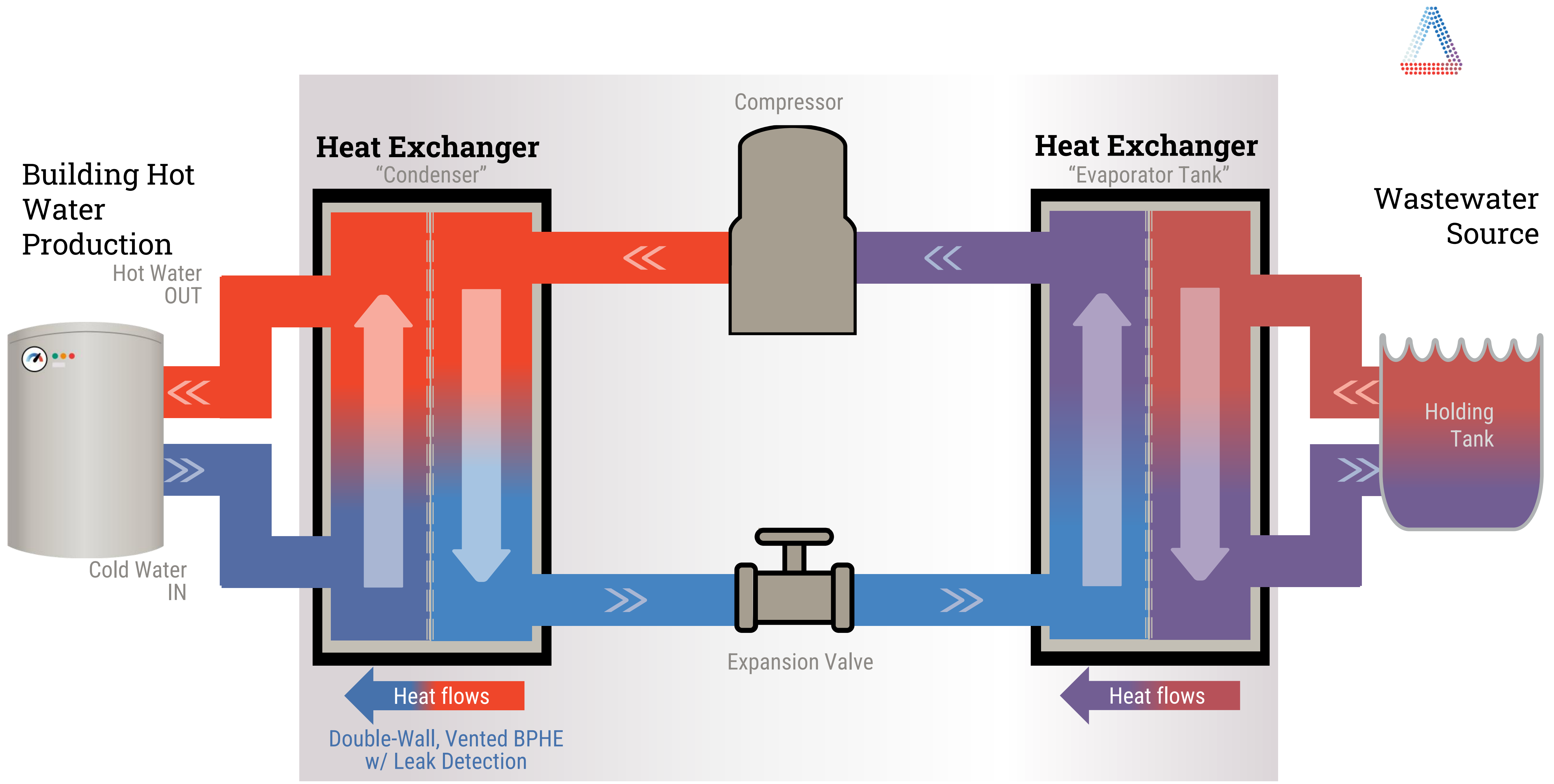
Models: T5 / T10 / T15

- 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"



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

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

SHARC

Series

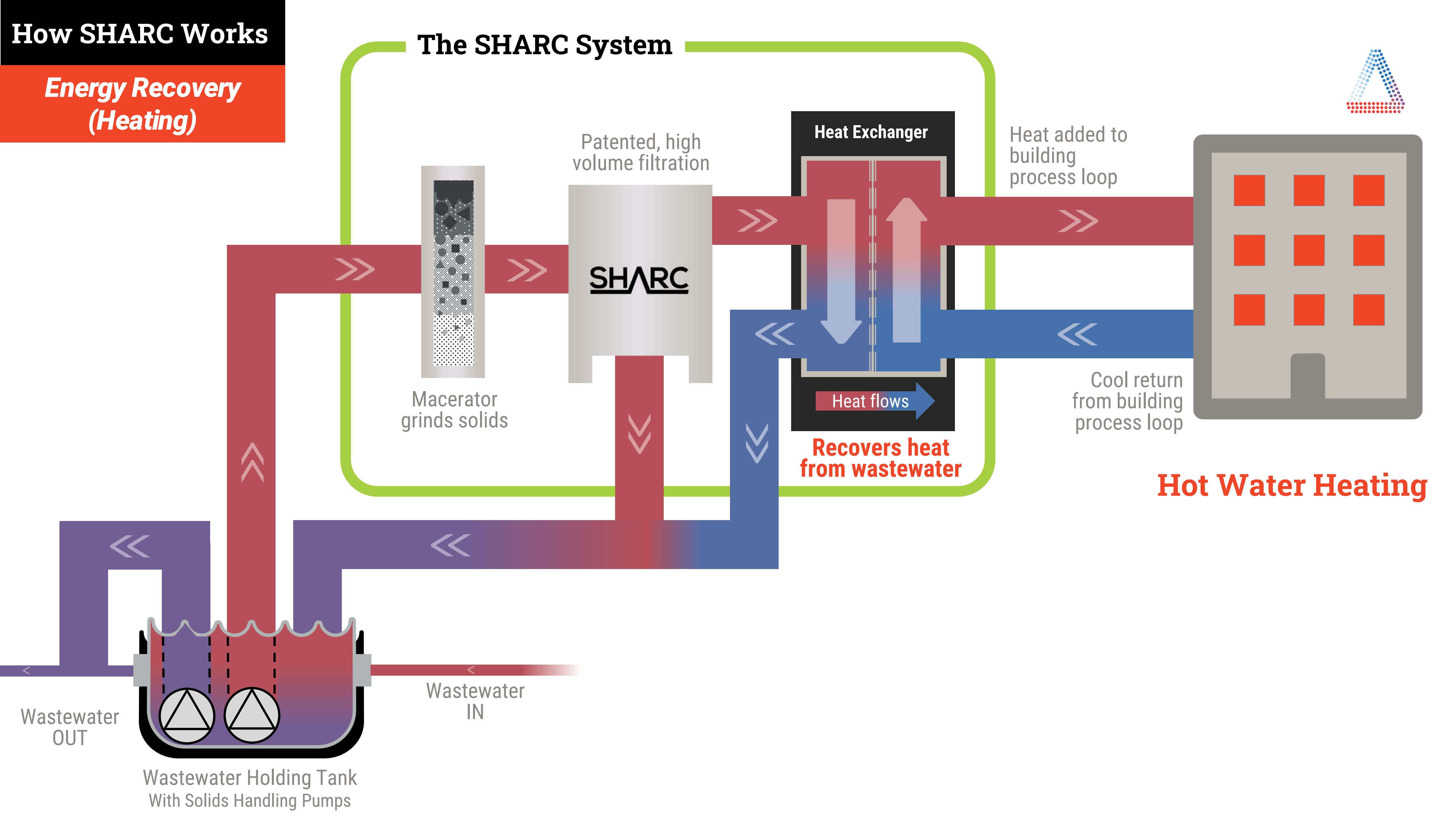
The SHARC is a wastewater separator/filter that allows access to thermal energy by temporarily removing solids from wastewater.

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

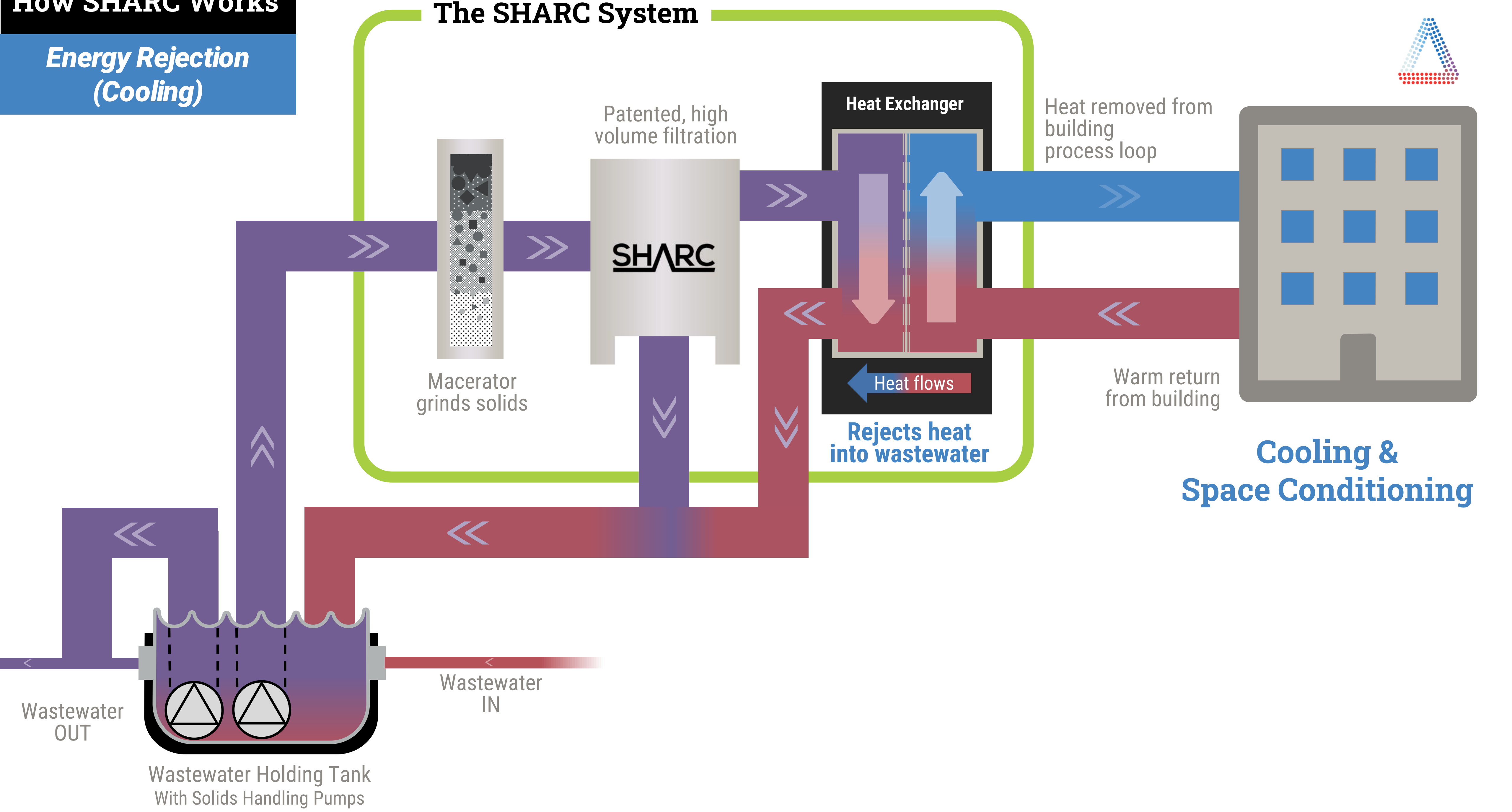
† Upcoming Product



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

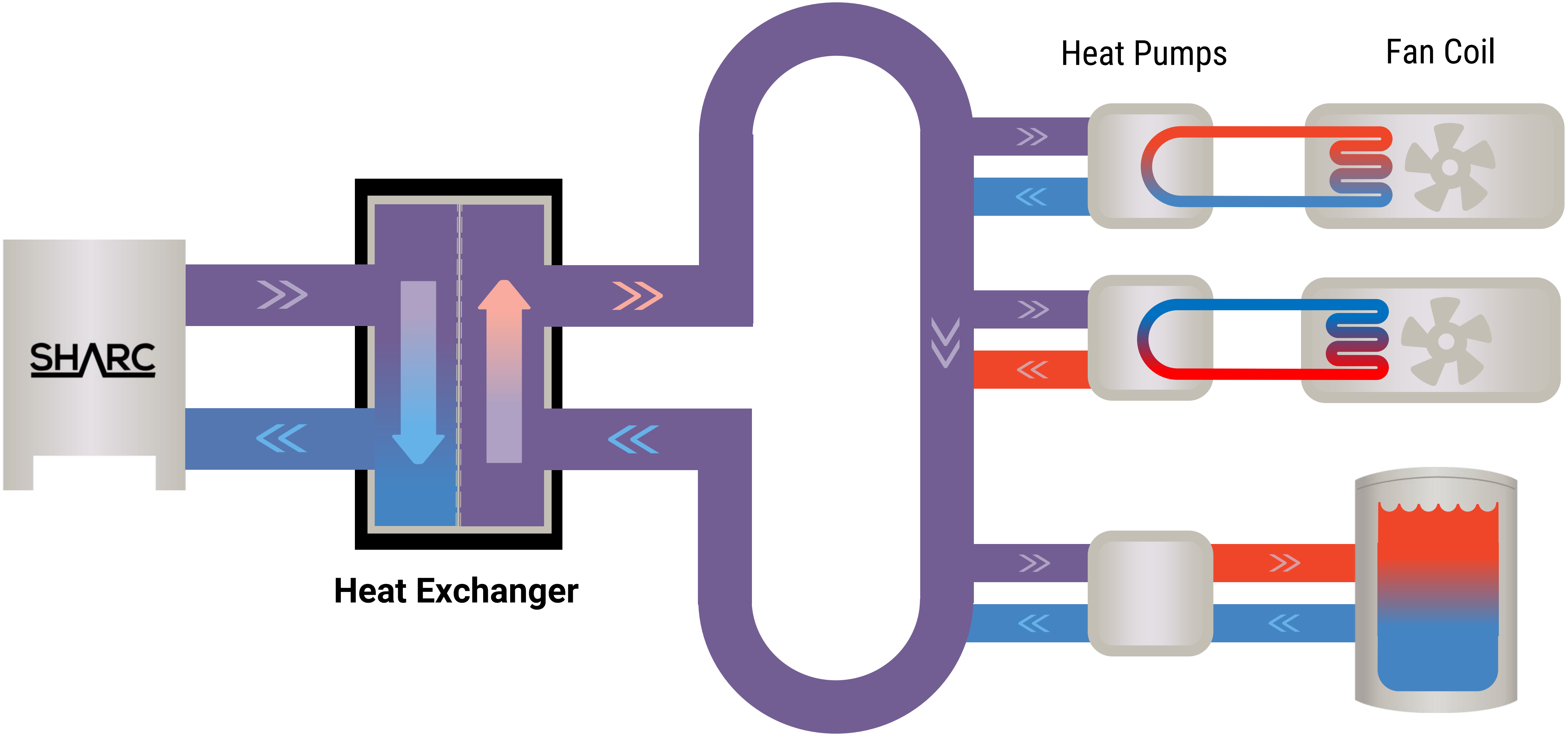
How SHARC Works

Energy Rejection (Cooling)

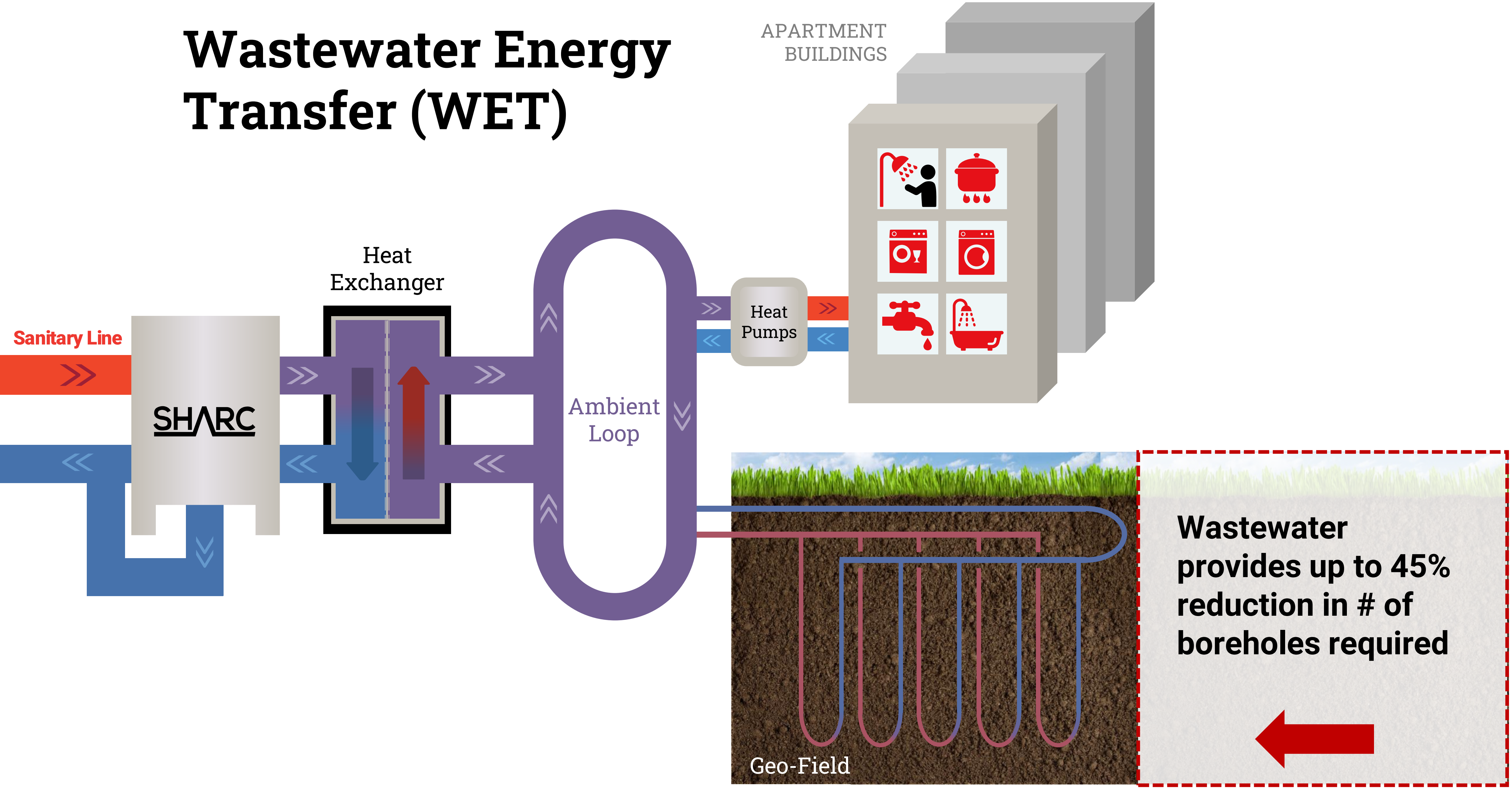


How SHARC Works

Multi-Use (Heating/Cooling)



Wastewater Energy Transfer (WET)



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

Amalgamated Housing Corp
Bronx, NY | 316 units | 425K SF
93% Reduction of tCO_2e/yr by 2035

Whitney Young Manor
Yonkers, NY | 195 units | 234K SF
81% Reduction of tCO_2e/yr by 2035

Alafia | Vital Brooklyn
Brooklyn, NY | 2,400 units | 1.2M SF
Closed loop geothermal – Passive House design standard

Alafia

Brooklyn, NY

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 tCO_2e/yr	273 tCO_2e/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

SHARC

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**

CANADA GREEN BUILDING COUNCIL • CONSEIL DU BÂTIMENT DURABLE DU CANADA •
LEED® CANADA
PLATINUM · PLATINE
2012

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 CO2e/year**

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**

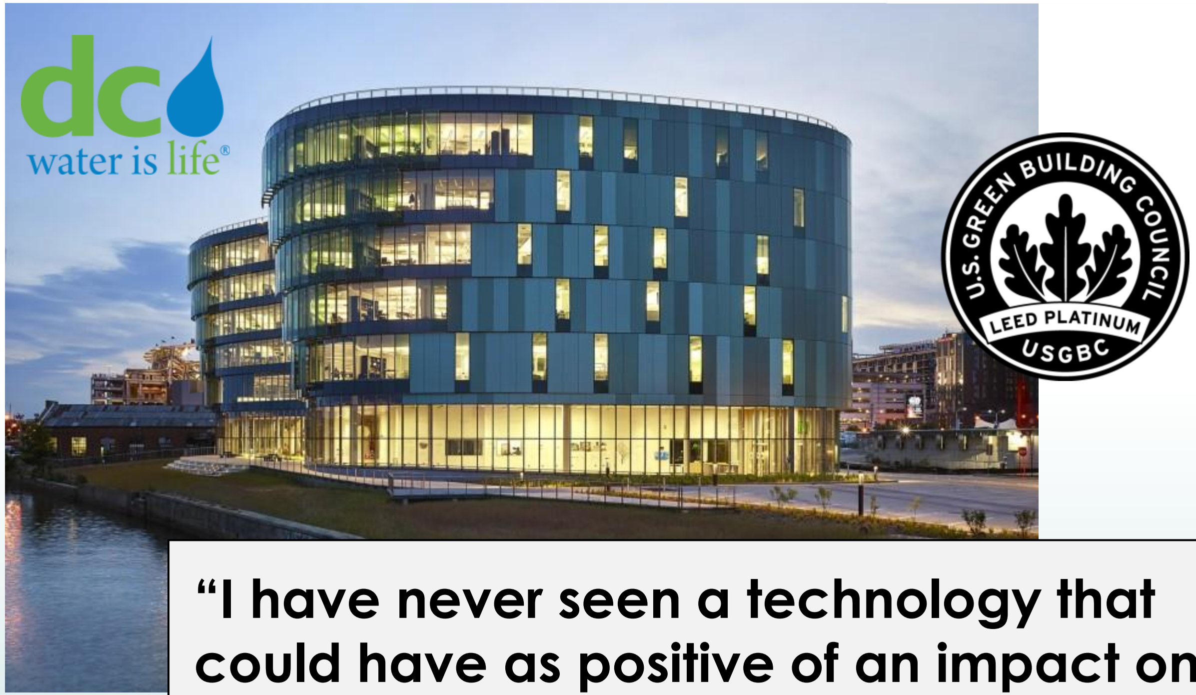
- Cooling Demand – **96.7%**
- Cooling tower offset **est. 1.5M gallons of water saved annually** (evaporation & blowdown)

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

- 150,000 ft² 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"

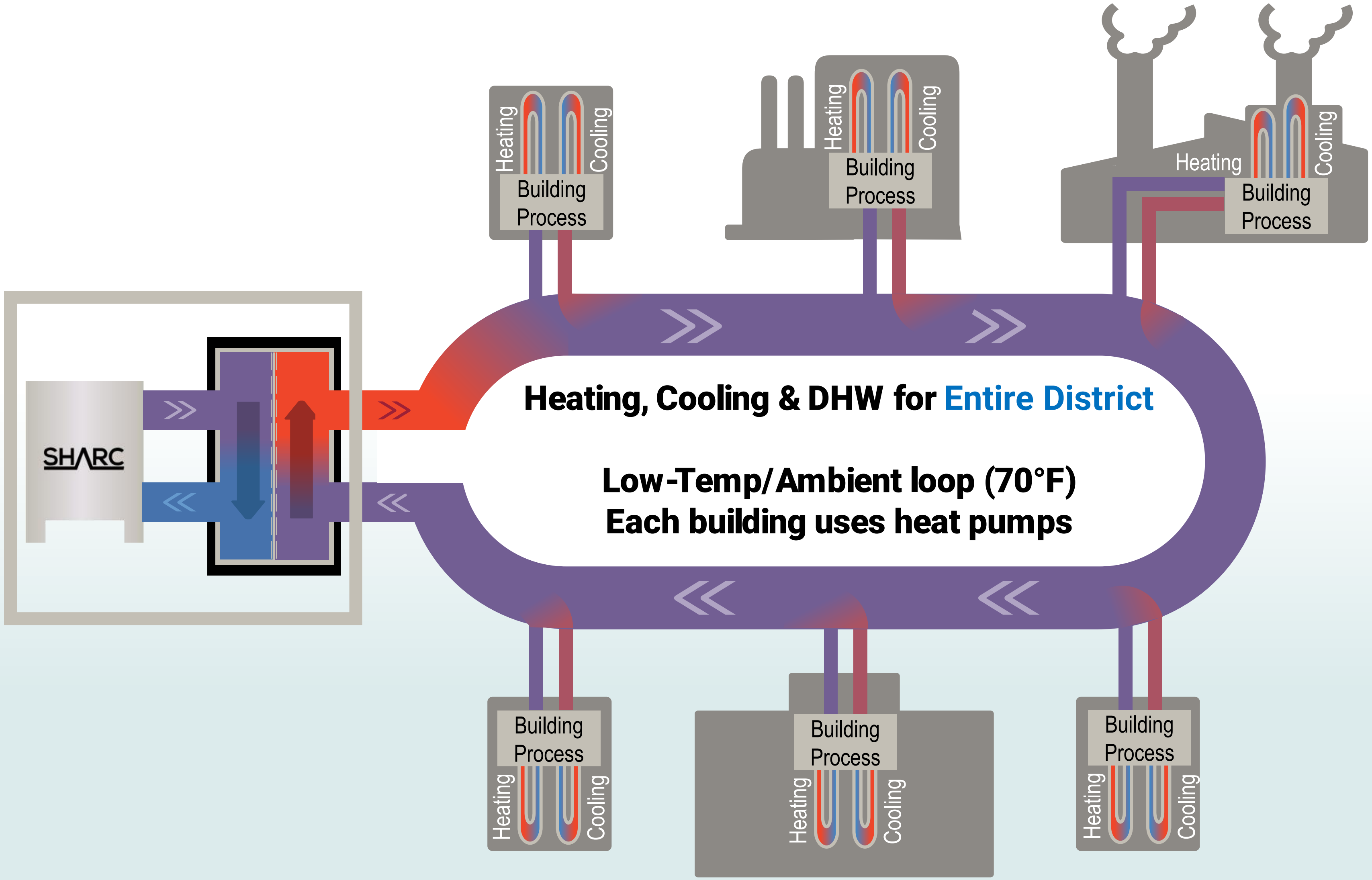
- Congresswoman Marcy Kaptur, Chairwoman of the House Appropriations Subcommittee on Energy and Water Development

Southeast False Creek Neighbourhood Energy Utility

Vancouver, BC

- 3.2MW$_{th}$ (4x) SHARC 880
- Expanding to 9MW$_{th}$ (9x) SHARC 880
- Provides heat for 20M ft² 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

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**

Turn Your Wastewater into Opportunity.

SHARC ENERGY

Thank you!

www.SHARCenergy.com

Condenser Water Heat Recovery

Corey Letcher, Comprehensive Solutions Account Executive, Trane New York

January 31, 2024

Corey Letcher, C.E.M.

- Chemical Engineer
- Formerly a field engineer in the Oil and Gas Industry
- 10 years in the HVAC/Controls/energy industry in NYC
- Experience in project financing and incentive management
- Fun Fact: father of 4 (1 month old at home, pardon my baggy eyes)

Agenda

- Why Is This Topic Important?
- Basic System Types
- Key Concepts & Terminology
- How Does Condenser Water Heat Recovery Work?
- Why Should Condenser Water Heat Recovery Be Implemented?
- Condenser Water Heat Recovery Applications
- Conclusion

The Four Pillars of Decarbonization

Energy Efficiency

Focusing on improving overall energy efficiency and reducing emissions in new construction and retrofits

Electrification

The process of switching building energy sources from on-site fossil fuel to electric sources

Renewable Energy

Also referred to as ”Clean Energy”, which comes from natural sources or processes that are constantly replenished, such as solar and wind

Refrigerant Management

Transition to low GWP refrigerants in HVAC equipment, and on-site management to minimize leaks

Reducing Indirect Emissions

Indirect GHG emissions (AKA Scope 2) are emissions related to off-site electricity production

Reducing Direct Emissions

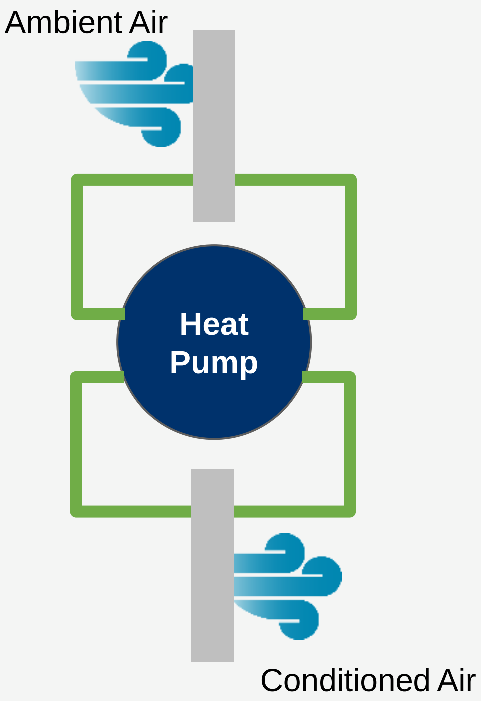
Direct GHG emissions (**AKA Scope 1**) are emissions related to on-site process fossil fuel used for heating or refrigerant leakage

Basic System Types

Basic Systems Types

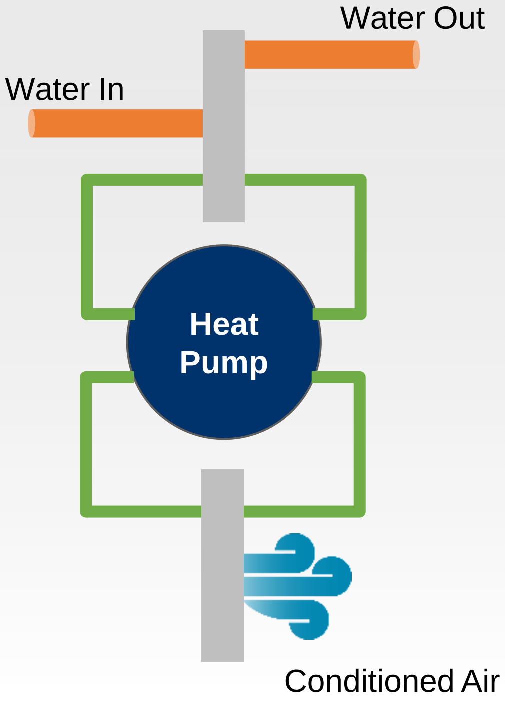
Heat Pumps

Air to Air



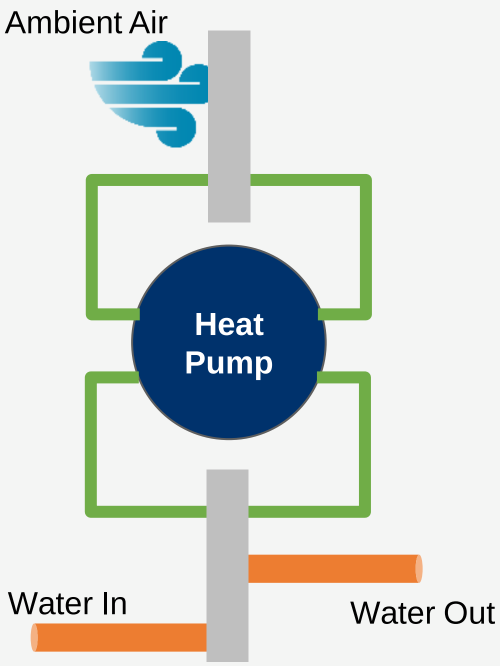
Example:
Rooftop Units
VRF

Water to Air



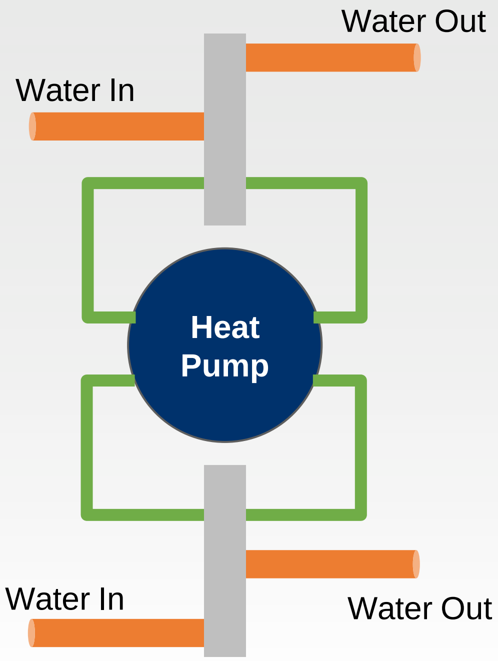
Example:
WSHP

Air to Water



Example:
Air-Source
Heat Pump Chiller

Water to Water



Example:
Water-Source
Chiller

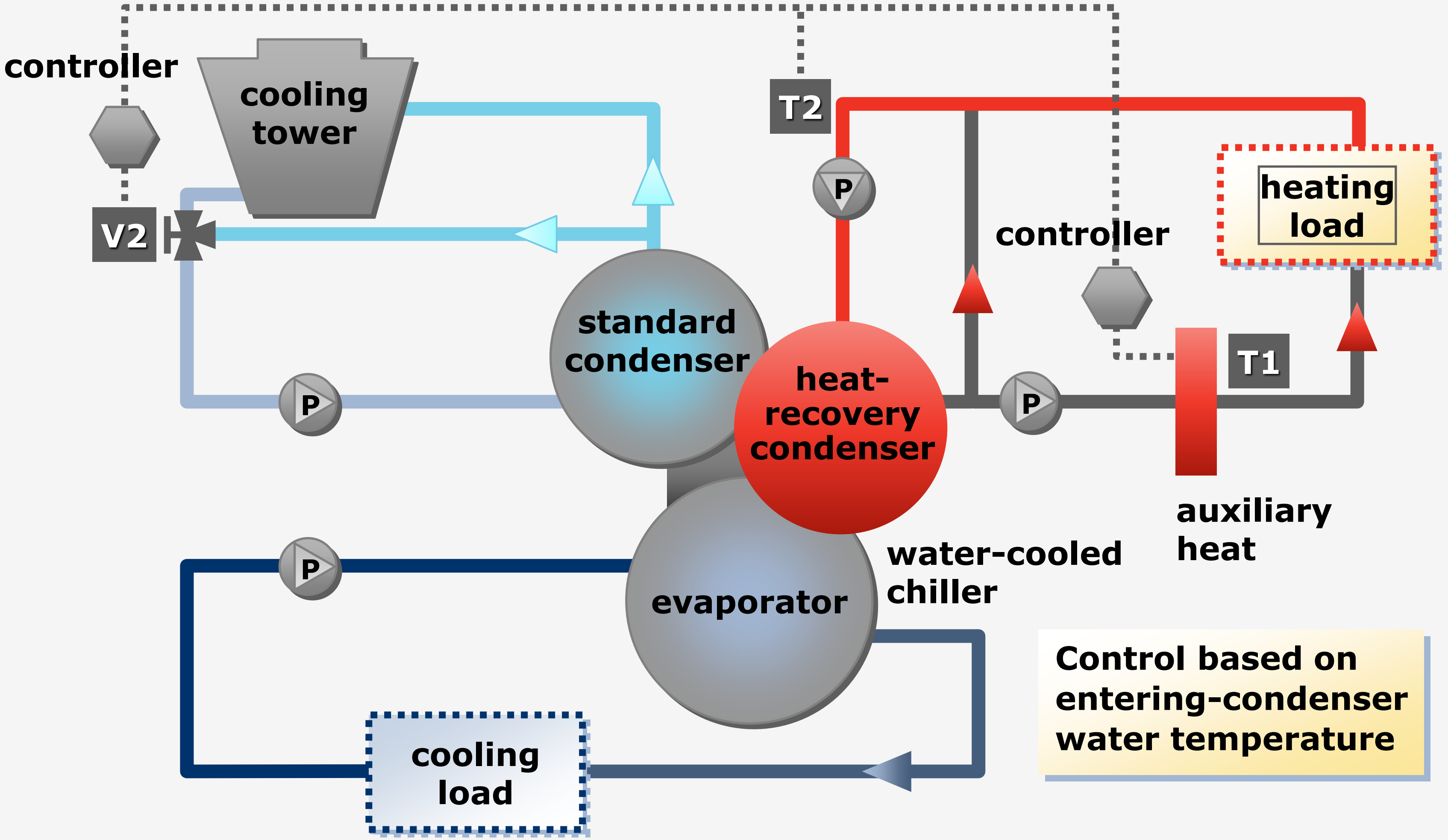
Key Concepts & Terminology

- **Heat Pump:** A refrigeration unit that includes the capability to pump heat from a lower energy state to a higher energy state and can change the roles of the evaporator and condenser via use of a reversing valve within the unit. Either the cooling or heating duty may be primary depending on the operating mode and application.
- **Heat Recovery:** The process of using waste heat from the cooling process for building heating. To be beneficial it requires a simultaneous demand for cooling and heating.
- **Heat Recovery Unit:** A refrigeration unit with the primary function to provide cooling and all, or a portion of, its condenser heat is used to satisfy heating loads.
- **Full Heat Recovery Unit:** A refrigeration unit with the primary function of providing cooling and where all its condenser heat is used to satisfy heating loads
- **Partial Heat Recovery Unit:** A refrigeration unit that primarily provides cooling but can also satisfy some heating loads, utilizing a portion of its condenser heat.

Condenser Water Heat Recovery: How It Works

Heat Recovery How it Works

Example of Large Heat Recovery System (concept)

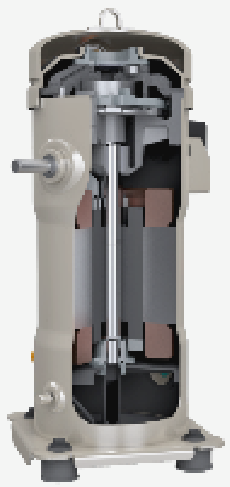


Control based on entering-condenser water temperature

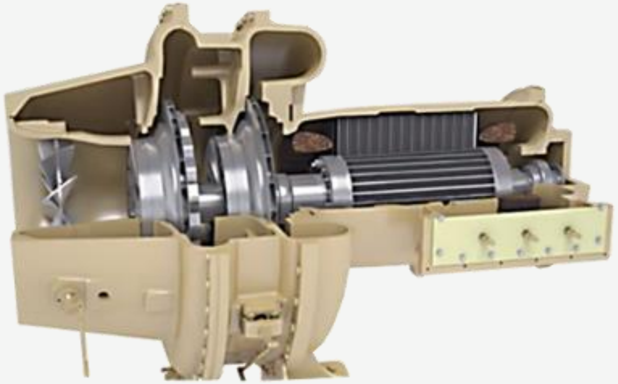
Condenser Water Heat Recovery Applications

All Compressors

Helical-Rotary Compressor



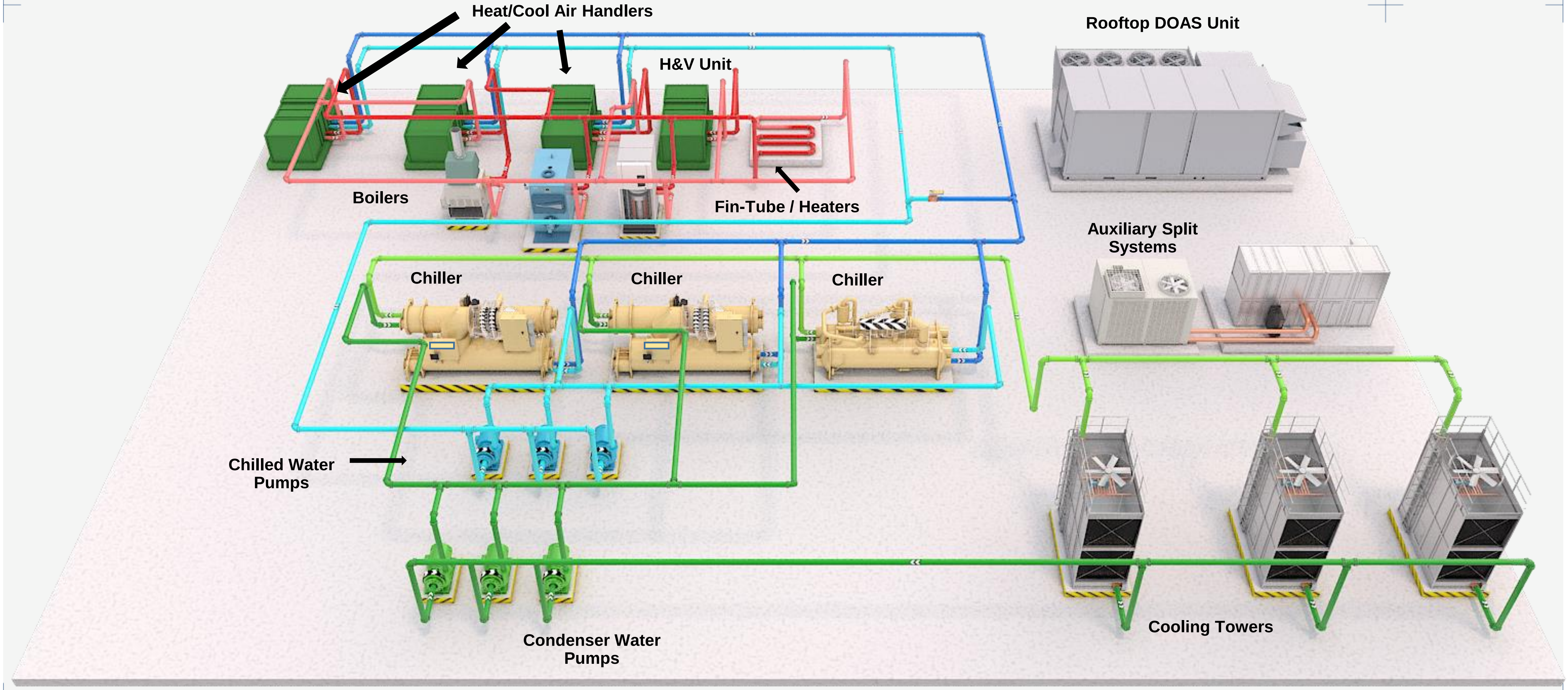
Scroll Compressor



Centrifugal Compressor

Example Systems

Traditional Hydronic



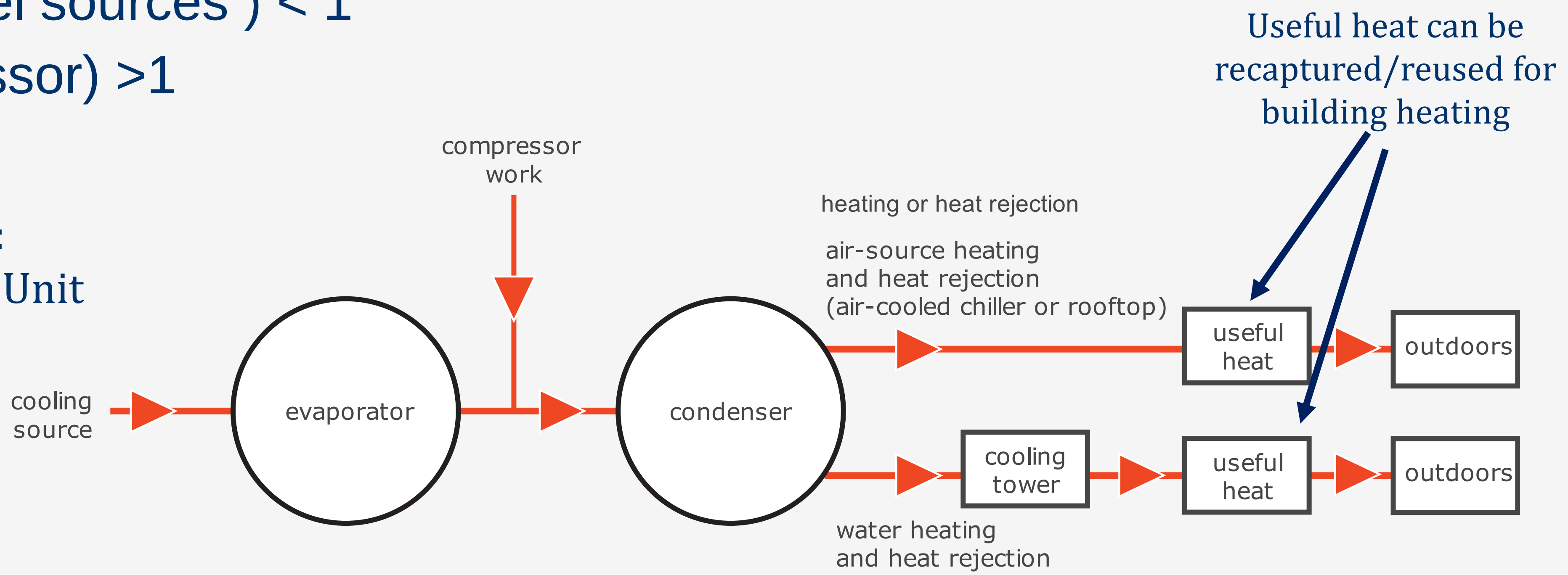
Why Implement Heat Recovery?

Why Implement Heat Recovery?

Coefficient of Performance (COP)

- COP = Useful work out / Power input
- COP (electric resistance heat) = 1.0
- COP (fossil fuel sources) < 1
- COP (compressor) >1

Example:
Cooling Only Unit



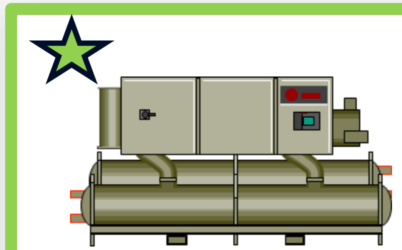
Why Implement Heat Recovery?

- Save money
- Reduce energy use intensity (EUI)
- Comply with codes and standards
- Legislative pressures
- Decrease site emissions compared to burning fossil fuel
- Energy recovery improves sustainability
- Limited natural gas or FF based infrastructure
- Local fees, fines or taxes
- Local grid has significant non-carbon emitting production (wind, solar, etc.)
- Energy Codes are evolving to require Heat Recovery in certain applications which will likely become more stringent over time

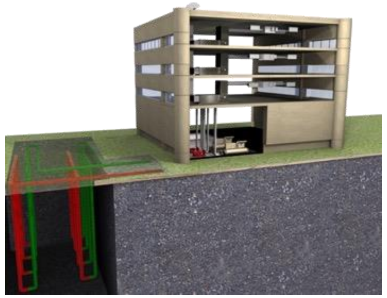
Heat Recovery Applications

Heat Recovery Applications – Heat Sources

Ambient Air



Cooling Load
(Heat Recovery)



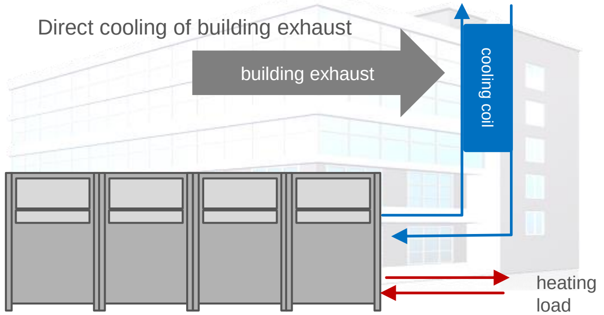
Geothermal loop

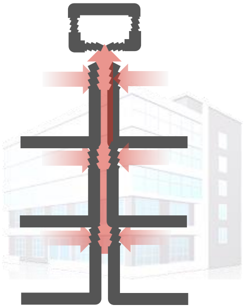
Lake, river, pond

Storm and sewer

Thermal energy storage battery

"Storage Source Heat Pump"





Exhaust air coil

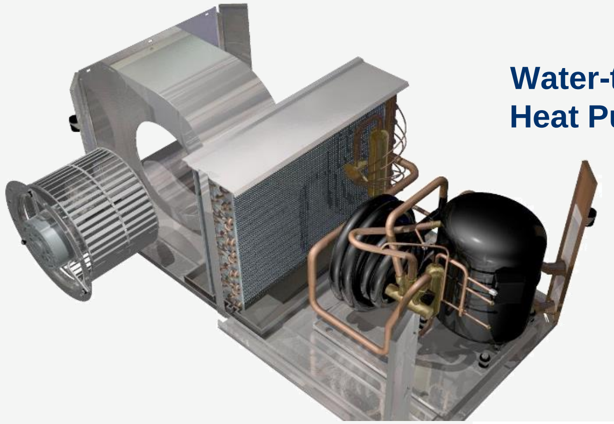
Heating Units Applicable to Condenser Water Heat Recovery

Heat Pump Chillers

Two-pipe
- Cooling or Heating

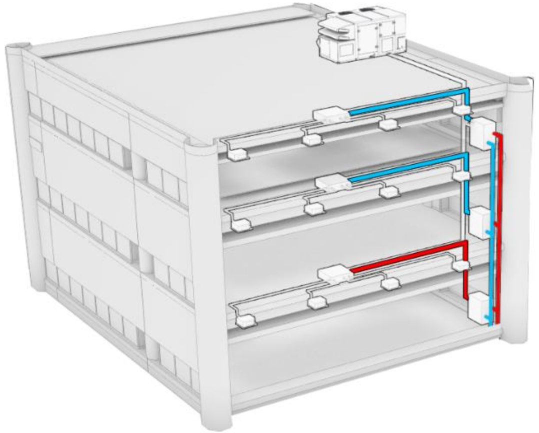
Four-pipe
- Cooling and heating

Six-pipe
- Cooling and heating
- Third set of pipes for heat source / heat sink



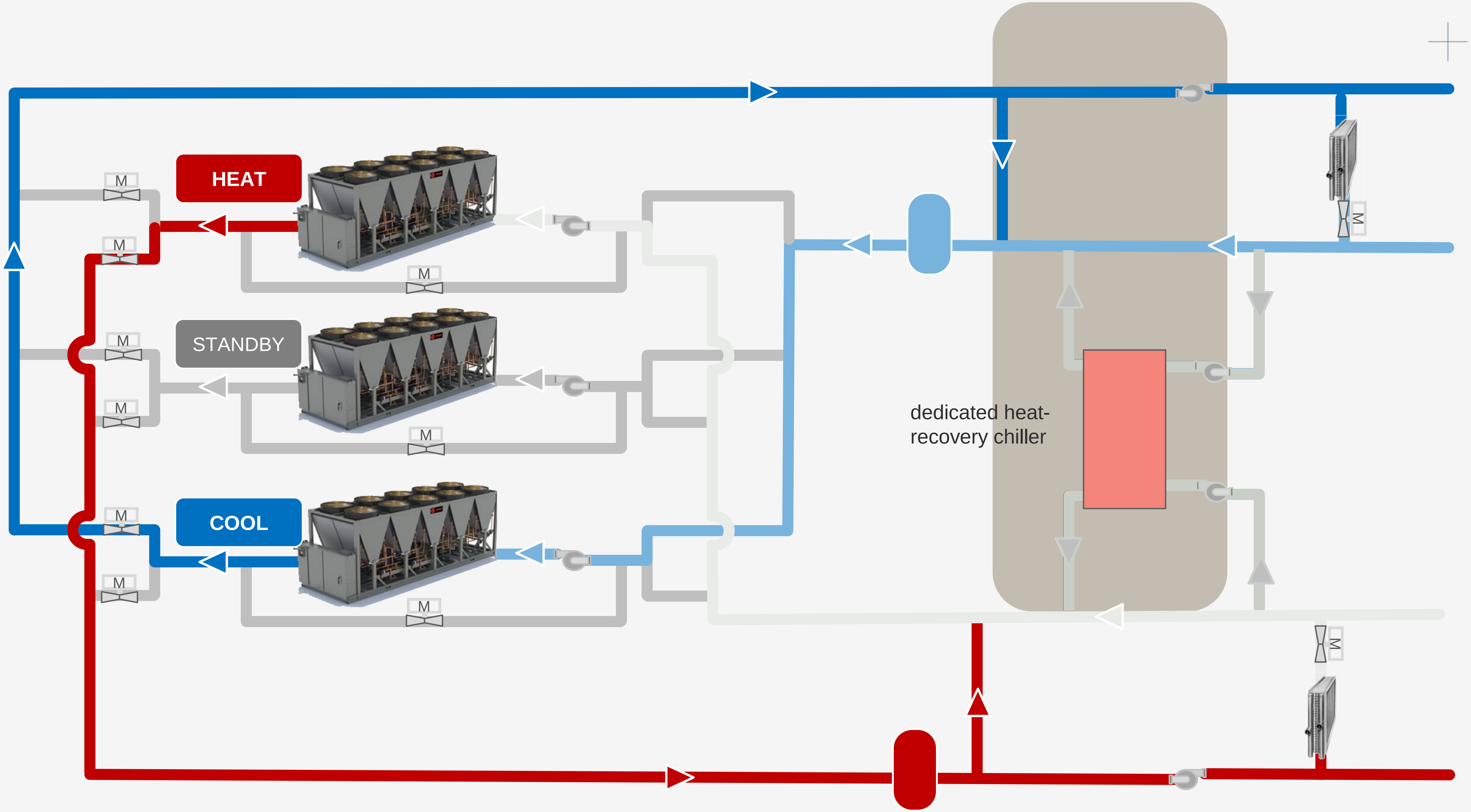
Water-to-Air Heat Pumps

Water-to-Water Heat Pumps

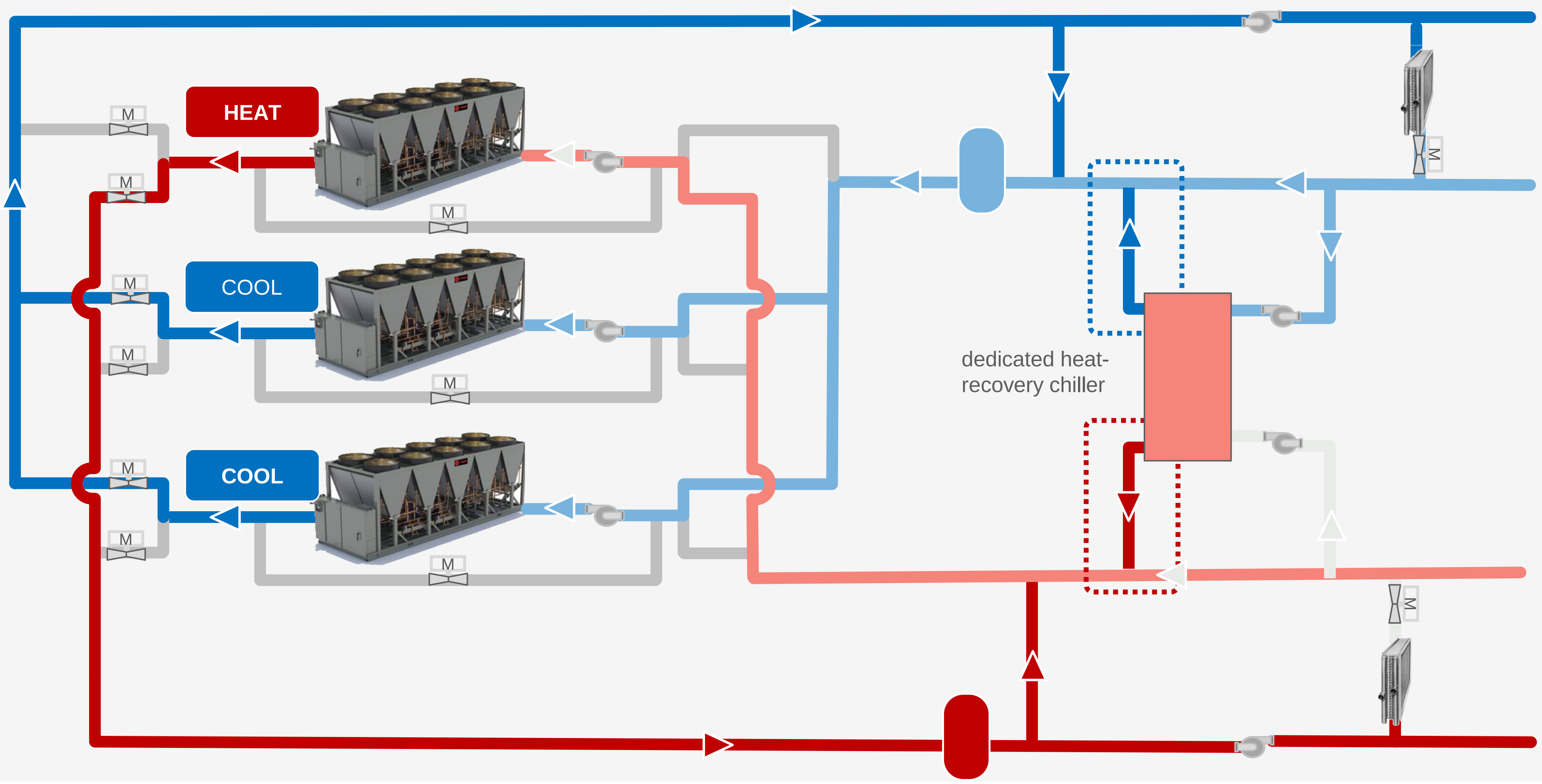


Variable Refrigerant Flow (VRF)

Air-to-Water Heat Pump: Dedicated Heat-Recovery

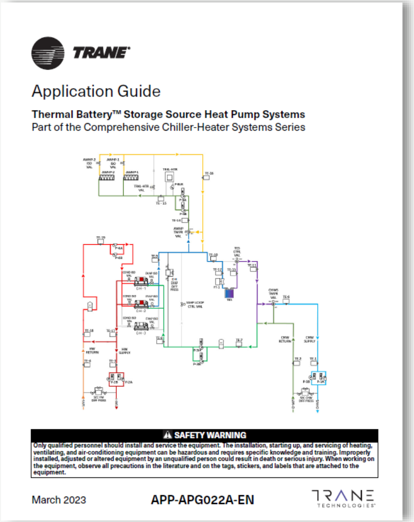


Air-to-Water Heat Pump: Dedicated Heat-Recovery



Storage Source Heat Pump System Overview

A hydronic heating and cooling system including thermal energy storage enabling asynchronous energy transfer and recovery, without typical AWHP constraints.


TRANE

Application Guide

Thermal Battery™ Storage Source Heat Pump Systems

Part of the Comprehensive Chiller-Heater Systems Series

⚠ SAFETY WARNING

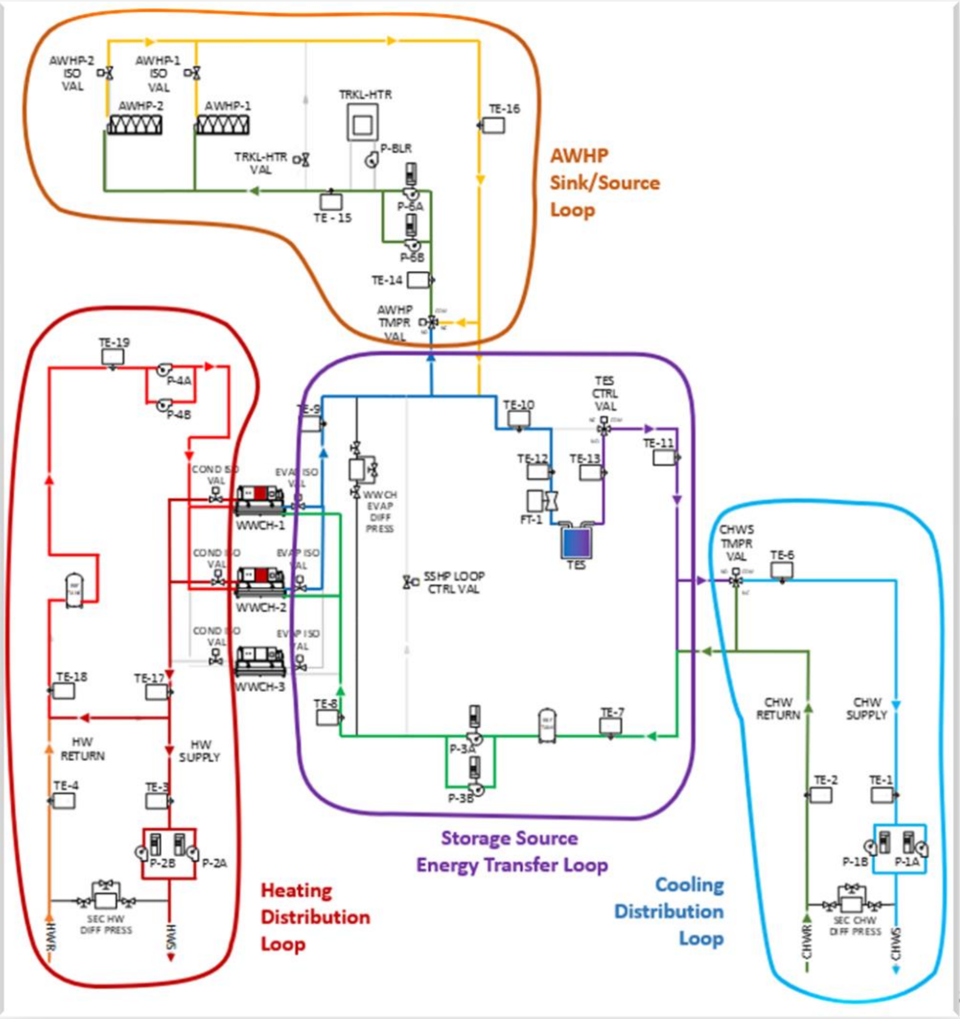
Only qualified personnel should install and service the equipment. The installation, starting up, and servicing of heating, ventilating, and air-conditioning equipment can be hazardous and requires specific knowledge and training. Improperly installed, adjusted or altered equipment by an unqualified person could result in death or serious injury. When working on the equipment, observe all precautions in the literature and on the tags, stickers, and labels that are attached to the equipment.

March 2023 APP-APG022A-EN TRANE TECHNOLOGIES

Key Components

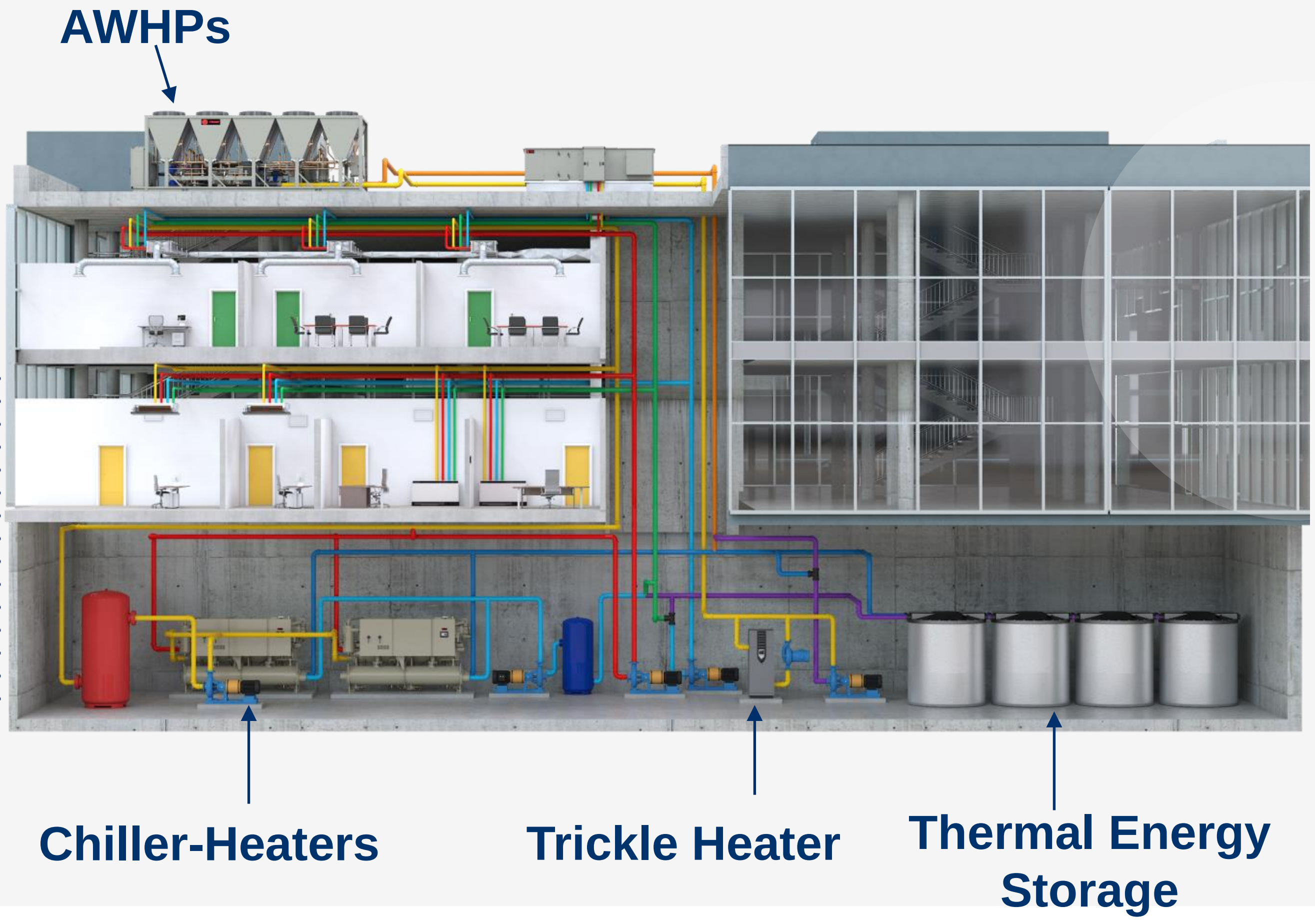
Air to Water Heat Pumps
Chiller-Heaters
Thermal Energy Storage Tanks
Trickle Heater Boiler (if needed)
Buffer Tanks
Controls

Storage Source Energy Transfer Loop
AWHP Sink/Source Loop
Heating Distribution Loop
Cooling Distribution Loop



Storage-Source Heat Pump (SSHP) System

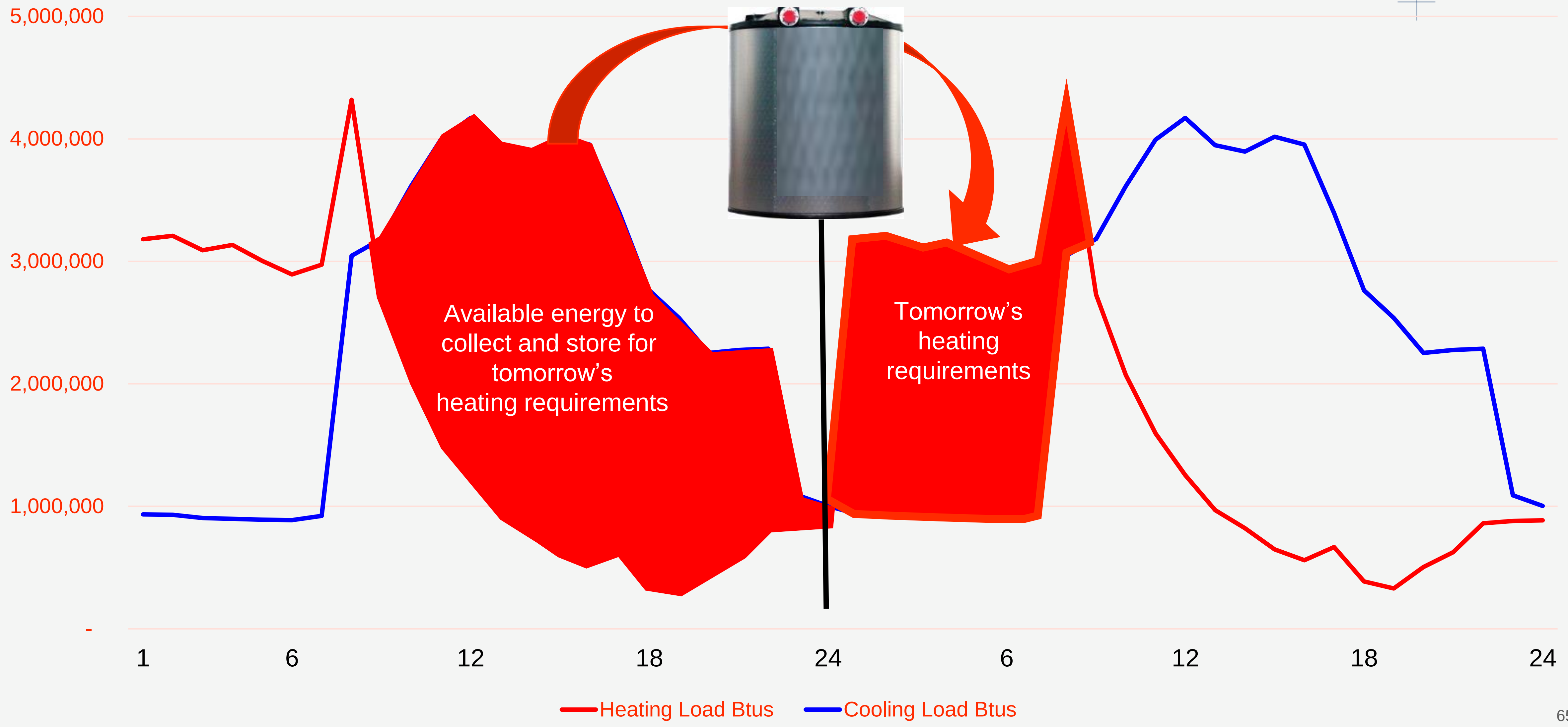
An innovative way to make all-electric heat pump heating possible even in cold climates and dense urban environments where there is limited roof space.



FEATURES:

- **Energy efficient:** Reclaims excess heat from the building using it to heat when needed.
- **Reliable operation:** Collects and stores heat from air-to-water heat pump operation during favorable conditions enabling heating at **all** outdoor conditions including extreme cold.
- **Save roof space:** Collecting and storing heat over 24-hour period for later use, can reduce required air-to-water heat pump capacity and cost.
- **Higher supply water temperatures:** Sourcing energy from a stable thermal energy storage source enables up to 130F.
- **Lowers costs:** Storing thermal energy for later use provides flexibility to use lower-cost electricity. Thermal energy storage can frequently qualify for up to 40% tax credit reducing overall system costs via the IRA which can reduce overall first cost.

Thermal Balancing



Example Case Study

Building Details

- Large Commercial Office Building
  - 24-7 Cooling load from Data Center and other Tenant loads
- Existing Thermal Storage that was used for cooling only application
- Con Ed Steam Heating and Hot water infrastructure

Impacts

- Addition of Heat recovery chillers and Domestic Hot water heat pumps in cascade
- Eliminates Steam for perimeter heating and domestic hot water generation (66% reduction in total steam usage with only a 5% increase in electrical consumption)
  - 17% full building energy reduction
- Qualifies for Clean heat incentives as well as IRA tax credits to offset project costs

Conclusion

Important Aspects

- Heating and cooling loads
  - Heating temperature
  - Outdoor conditions
- Unit capabilities and performance
- System configuration and control
- Analysis
- Detailed design
- Building operator training

High Level Guidance

- Select lowest heating temperature that meets requirements
- Design the system properly
- Select equipment appropriately
- Keep controls as simple as possible
- Ensure operators understand the system

NYSERDA Heat Recovery Roundtable Event
"Exhaust Air Heat Recovery Solutions by HOWATHERM"
January 31st, 2024

Empire Building Challenge
PARTNER
Reimagining Low-carbon Buildings

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Why Energy-Recovery for Ventilation Systems

In today's buildings, energy loss through infiltration and uncontrolled air change (passive ventilation) counts for 50-75% of the total energy consumption. In case of high negative pressure being generated by exhaust air fans (active ventilation), ventilation energy loss may be even higher.

The main purpose of ventilation systems is to supply the occupants with fresh air and to discharge humidity and emissions from inside of the building. Mold protection is a very important issue.

Therefore, ventilation systems should be operated with 100% outside air, and considering energy use, designed for isothermal air distribution (room temperature), not covering heating or cooling loads.

And since future HVAC-systems must be designed for renewable energy supply only, efficient energy-recovery from the exhaust air is inevitable to dramatically reduce the building loads before using e.g., heat pumps.

How this could be implemented for residential buildings, the ventilation retrofit project for 777 6th had been intended to prove as a pilot.

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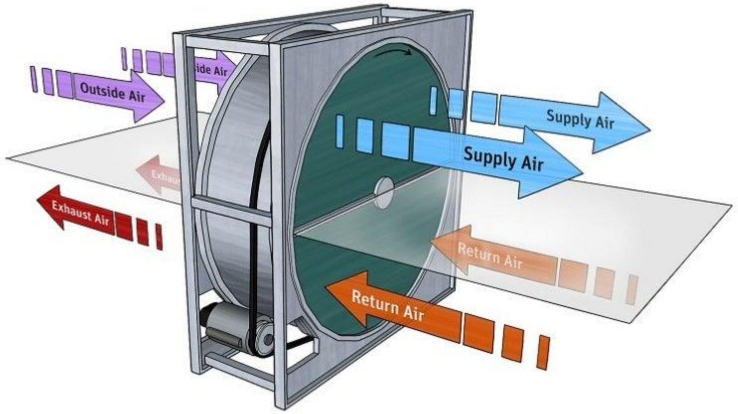
Rotary Wheel Energy Recovery



Reference: https://ecolivingexpert.com

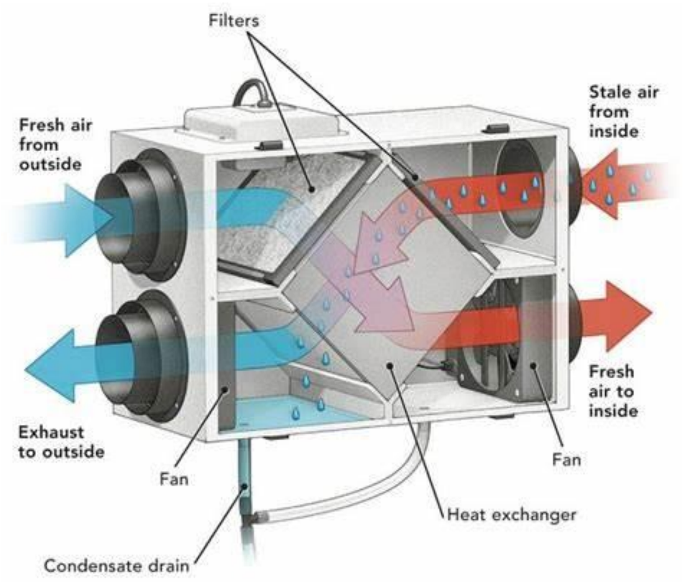
PROS

- + High heat-recovery rate (up to 80%)
- + Re-humidification in wintertime
- + compact design
- + Low risk of freezing

CONS

- – Cross-contamination between supply and exhaust air
- – Risk of mold formation in summertime
- – Demanding installation and commissioning
- – Demanding maintenance
- – High heat-recovery rate may not be achieved in operation

Fixed-Plate (Cross-Flow) Energy Recovery



Reference: https://ecolivingexpert.com

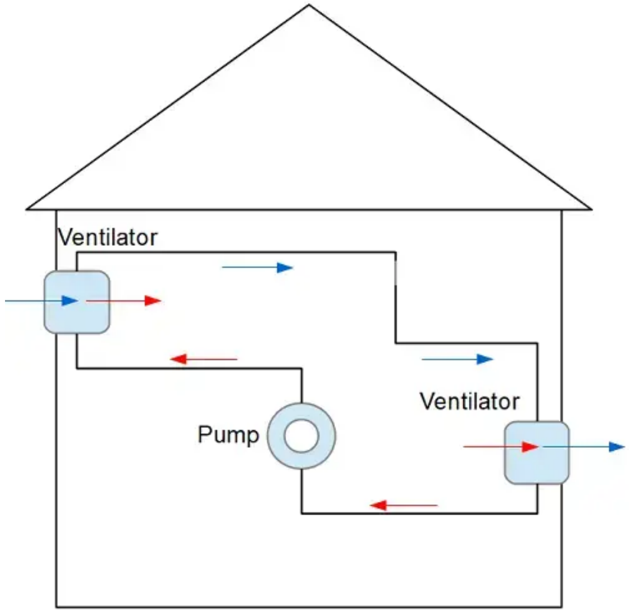
PROS

+ High heat-recovery rate (up to 85%)
+ Low risk of cross-contamination between supply and exhaust air

CONS

– No re-humidification in wintertime
– High space requirements and weight
– Risk of freezing reduces the extend of heat-recovery
– Due to difficult controllability to prevent freezing (bypass "on" or "off") the high heat-recovery rate may not be achieved in operation

Run-Around (Closed Loop) Energy Recovery



PROS

- \+ Highest hygienic standard (no cross-contamination possible)
- \+ Higher flexibility, since supply and exhaust air unit may be installed apart
- \+ Easy coupling to other hydronic systems (e.g. DHW) through the closed loop
- \+ Existing risk of freezing is reduced through good controllability of the loop temperature
- \+ Easy installation and maintenance

CONS

- – Lower heat-recovery rate (45- 65%, but with high performance systems up to 75-80%)
- – No re-humidification in wintertime
- – Risk of freezing reduces the extend of heat-recovery

Reference: https://ecolivingexpert.com

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RUHL

1. Why Energy-Recovery for Ventilation Systems
2. Possible Designs for Energy-Recovery
3. Introducing the HOWATERM Technology
4. 777 6th - Introducing the Pilot Project for Ventilation Heat-Recovery
    a. Redesigning Airflows Rates
    b. Simulation of Summer- and Winter-Operation
    c. Aircon-Unit Design
    d. Balancing of Exhaust- and Supply Airflows
    e. Heat Pump Technology
    f. Hydraulic Design Scheme
    g. Aircon and Heat Pump Installation, Ducting and Piping
    h. Calculations – Baseline, Scenarios & Savings

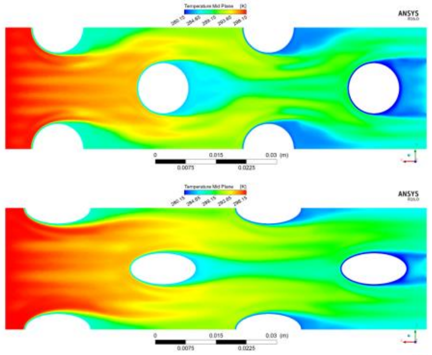
HOWATHERM A family-operated company since 1969

RUHL

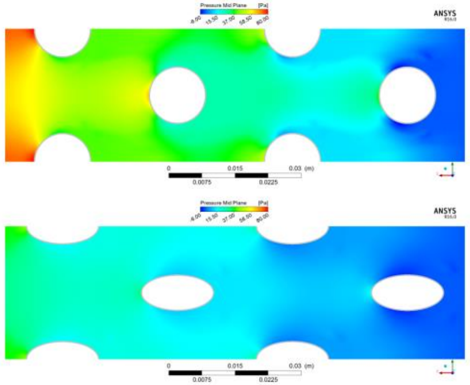
- German family owned manufacturer of energy-optimized aircon systems
- Founded in 1969
- Located in Rhineland-Palatinate, 30 miles away from the US Airbase Ramstein
- CEO Prof. Dr.-Ing. Christoph Kaup
- 180 employees
- Manufacturing base on 168.000 ft²
- Patented energy-recovery technology and designs

RUHL

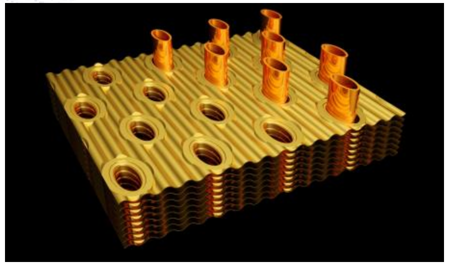
High efficiency ecoFin+



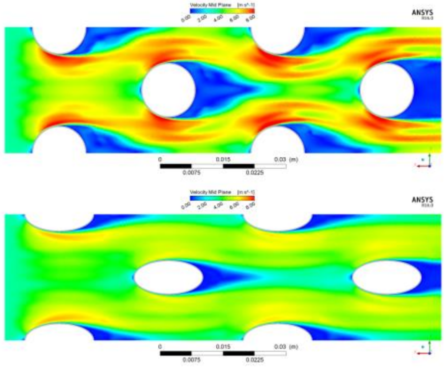
Identic heat transfer



- 45 % pressure loss



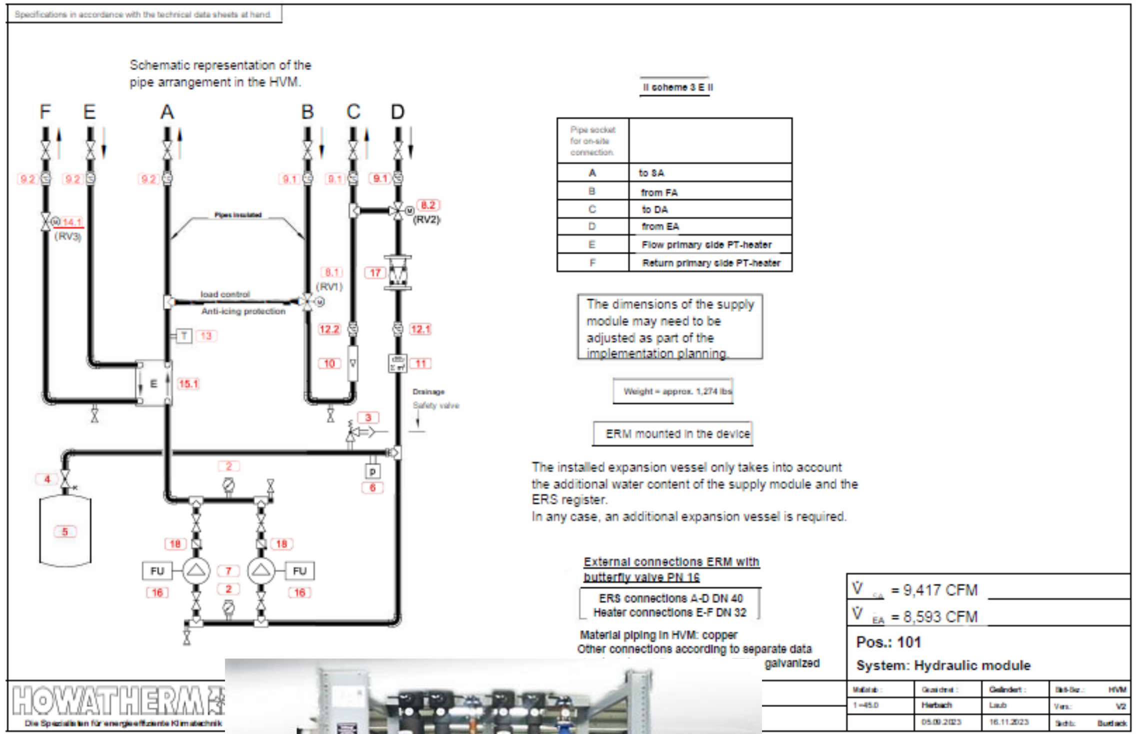
Reduction in pressure loss with oval tubes compared to rounded tubes ~ 45 %

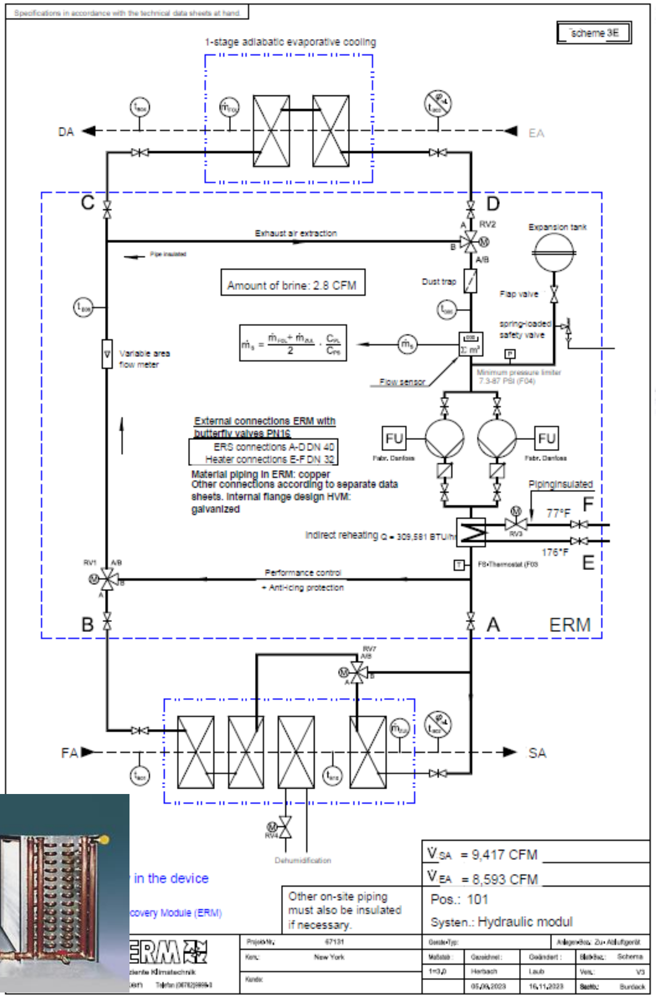


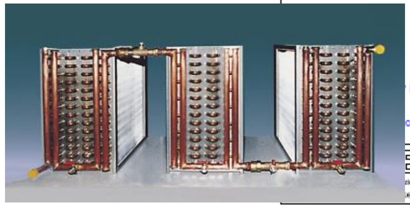
approved air flow dynamics

HOWATHERM

Closed Loop Energy-Recovery with ecoFin+ Heat Exchangers







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Introducing the Pilot Project for Ventilation Heat-Recovery

RUHL

777 6th Avenue, NYC

Equity Residential

Build year:	1999
Number of floors:	32
Number of apartments:	295
Building owner:	Equity Residential (Chicago)

- Pressurizing the hallways with a gas-fired roof top unit
- Discharge of exhaust from bathrooms and kitchens with roof fans
- Steam-coil PTACs for space heating and cooling in apartments
- Base load heat supply for DHW through a gas fired CHP in the basement
- Heat supply for space heating and DHW reheating through gas-fired steam boilers in the basement

Existing Conditions
Exhaust Air Flow Old Design

OLD DESIGN

kitchen exhaust with continuous operation [CFM]| [m³/h]	*100 | 170*
bathroom exhaust with continuous operation [CFM]| [m³/h]	*50 | 85*

RUHL

EXHAUST AIR OLD DESIGN	EXH-1	EXH-2	EXH-3	EXH-4	EXH-5	EXH-6	EXH-7 (kittchen)	EXH-8 (kittchen)	EXH-9	floor	exhaust air flow [CFM]	exhaust air flow [m³/h]
31. floor	100	100	50	100	100	50	200	100	50	31st floor	850	1.444
30. floor	100	100	50	100	100	50	200	100	50	30st floor	850	1.444
29. floor	100	100	50	100	100	50	200	100	50	29st floor	850	1.444
28. floor	100	100	50	100	100	50	200	100	50	28st floor	850	1.444
27. floor	100	100	50	100	100	50	200	100	50	27st floor	850	1.444
26. floor	100	100	50	100	100	50	200	100	50	26st floor	850	1.444
25. floor	100	100	50	100	100	50	200	100	50	25st floor	850	1.444
24. floor	100	100	50	100	100	50	200	100	50	24st floor	850	1.444
23. floor	100	100	50	100	100	50	200	100	50	23st floor	850	1.444
22. floor	100	100	50	100	100	50	200	100	50	22st floor	850	1.444
21. floor	100	100	50	100	100	50	200	100	50	21st floor	850	1.444
20. floor	100	100	50	100	100	50	200	100	50	20st floor	850	1.444
19. floor	100	100	50	100	100	50	200	100	50	19st floor	850	1.444
18. floor	100	100	50	100	100	50	200	100	50	18st floor	850	1.444
17. floor	100	100	50	100	100	50	200	100	50	17st floor	850	1.444
16. floor	100	100	50	100	100	50	200	100	50	16st floor	850	1.444
15. floor	100	100	50	100	100	50	200	100	50	15st floor	850	1.444
14. floor	100	100	50	100	100	50	200	100	50	14st floor	850	1.444
13. floor	100	100	50	100	100	50	200	100	50	13st floor	850	1.444
12. floor	100	100	50	100	100	50	200	100	50	12st floor	850	1.444
11. floor	100	100	50	100	100	50	200	100	50	11st floor	850	1.444
10. floor	100	100	50	100	100	50	200	100	50	10st floor	850	1.444
9. floor	100	100	50	100	100	50	200	100	50	9st floor	850	1.444
8. floor	100	100	50	100	100	50	200	100	50	8st floor	850	1.444
7. floor	100	100	50	100	100	50	200	100	50	7st floor	850	1.444
6. floor	100	100	50	100	100	50	200	100	50	6st floor	850	1.444
5. floor	50	100	100	100	100	50	300		100	5st floor	900	1.529
4. floor	50	100	100	100	100	50	300		100	4st floor	900	1.529
3. floor	50	100	100	100	100	50	300		100	3st floor	900	1.529
2. floor	100	50		100			150			2st floor	400	680
1. floor										1st floor	0	0
basement					75					basement	75	127
total exhaust	**2850**	**2950**	**1600**	**3000**	**2975**	**1450**	**6250**	**2600**	**1600**		**25.275**	**42.942**

Redesigning Airflow Rates
Exhaust Air Flow New Design

NEW DESIGN

kitchen exhaust with continuous operation [CFM] | [m³/h]	*25 | 43*
bathroom exhaust with continuous operation [CFM]| [m³/h]	*20 | 34*

RUHL

EXHAUST AIR NEW DESIGN	EXH-1	EXH-2	EXH-3	EXH-4	EXH-5	EXH-6	EXH-7 (kittchen)	EXH-8 (kittchen)	EXH-9	floor	exhaust air flow [CFM]	exhaust air flow [m³/h]
31. floor	40	40	20	40	40	20	50	25	20	31st floor	295	501
30. floor	40	40	20	40	40	20	50	25	20	30st floor	295	501
29. floor	40	40	20	40	40	20	50	25	20	29st floor	295	501
28. floor	40	40	20	40	40	20	50	25	20	28st floor	295	501
27. floor	40	40	20	40	40	20	50	25	20	27st floor	295	501
26. floor	40	40	20	40	40	20	50	25	20	26st floor	295	501
25. floor	40	40	20	40	40	20	50	25	20	25st floor	295	501
24. floor	40	40	20	40	40	20	50	25	20	24st floor	295	501
23. floor	40	40	20	40	40	20	50	25	20	23st floor	295	501
22. floor	40	40	20	40	40	20	50	25	20	22st floor	295	501
21. floor	40	40	20	40	40	20	50	25	20	21st floor	295	501
20. floor	40	40	20	40	40	20	50	25	20	20st floor	295	501
19. floor	40	40	20	40	40	20	50	25	20	19st floor	295	501
18. floor	40	40	20	40	40	20	50	25	20	18st floor	295	501
17. floor	40	40	20	40	40	20	50	25	20	17st floor	295	501
16. floor	40	40	20	40	40	20	50	25	20	16st floor	295	501
15. floor	40	40	20	40	40	20	50	25	20	15st floor	295	501
14. floor	40	40	20	40	40	20	50	25	20	14st floor	295	501
13. floor	40	40	20	40	40	20	50	25	20	13st floor	295	501
12. floor	40	40	20	40	40	20	50	25	20	12st floor	295	501
11. floor	40	40	20	40	40	20	50	25	20	11st floor	295	501
10. floor	40	40	20	40	40	20	50	25	20	10st floor	295	501
9. floor	40	40	20	40	40	20	50	25	20	9st floor	295	501
8. floor	40	40	20	40	40	20	50	25	20	8st floor	295	501
7. floor	40	40	20	40	40	20	50	25	20	7st floor	295	501
6. floor	40	40	20	40	40	20	50	25	20	6st floor	295	501
5. floor	20	40	40	40	40	20	75		40	5st floor	315	535
4. floor	20	40	40	40	40	20	75		40	4st floor	315	535
3. floor	20	40	40	40	40	20	75		40	3rd floor	315	535
2. floor	40	20		80			37,5			2nd floor	177,5	302
1. floor										1st floor	0	0
basement					60					basement	60	102
total exhaust	**1140**	**1180**	**640**	**1240**	**1220**	**580**	**1562,5**	**650**	**640**		**8.853**	**15.040**

Redesigning Airflow Rates
Supply Air Flow New Design

Reduction of exhaust air: 66%
Pressure conditions changed to “positive”

RUHL

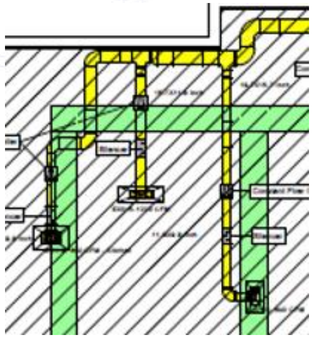
SUPPLY AIR NEW DESIGN	supply air flow according ventilation riser diagram [CFM]	needed supply air flow for exhaust air balance [CFM]	supply air flow according to exhaust air balance +10% [CFM]	supply air flow according to exhaust air balance +10% [m³/h]	total supply air flow at this point [m³/h]	dimension width [inch]	dimension length [inch]	dimension width [m]	dimension length [m]	duct surface [m²]	air flow speed [m/s]
31st floor	250	295	325	551	16.000	71	12	1,80	0,30	0,55	8,1
30st floor	250	295	325	551	15.449	71	12	1,80	0,30	0,55	7,8
29st floor	250	295	325	551	14.897	71	12	1,80	0,30	0,55	7,6
28st floor	250	295	325	551	14.346	71	12	1,80	0,30	0,55	7,2
27st floor	250	295	325	551	13.795	71	12	1,80	0,30	0,55	6,8
26st floor	250	295	325	551	13.243	71	12	1,80	0,30	0,55	6,6
25st floor	250	295	325	551	12.692	68	12	1,73	0,30	0,53	6,6
24st floor	250	295	325	551	12.141	68	12	1,73	0,30	0,53	6,2
23st floor	250	295	325	551	11.589	68	12	1,73	0,30	0,53	6,0
22st floor	250	295	325	551	11.038	66	12	1,68	0,30	0,51	6,0
21st floor	250	295	325	551	10.487	66	12	1,68	0,30	0,51	5,7
20st floor	250	295	325	551	9.935	66	12	1,68	0,30	0,51	5,4
19st floor	250	295	325	551	9.384	64	12	1,63	0,30	0,50	5,2
17st floor	250	295	325	551	8.833	64	12	1,63	0,30	0,50	4.8
16st floor	250	295	325	551	8.281	60	12	1,52	0,30	0,46	5.0
15st floor	250	295	325	551	7.730	60	12	1,52	0,30	0,46	4
14st floor	250	295	325	551	7.179	60	12	1,52	0,30	0,46	4.4
13st floor	250	295	325	551	6.627	48	12	1,22	0,30	0,37	4.8
12st floor	250	295	325	551	6.076	48	12	1,22	0,30	0,37	4.5
11st floor	250	295	325	551	5.525	48	12	1,22	0,30	0,37	4.3
10st floor	250	295	325	551	4.973	36	12	0,91	0,30	0,28	5.0
9st floor	250	295	325	551	4.422	36	12	0,91	0,30	0,28	4.4
8st floor	250	295	325	551	3.871	36	12	0,91	0,30	0,28	3.9
7st floor	250	295	325	551	3.320	26	12	0,66	0,30	0,20	4.4
6st floor	250	295	325	551	2.768	26	12	0,66	0,30	0,20	3.3
5st floor	300	315	347	589	2.217	26	12	0,66	0,30	0,20	2.9
4st floor	300	315	347	589	1.628	16	12	0,41	0,30	0,12	3.8
3st floor	300	315	347	589	1.039	16	12	0,41	0,30	0,12	2.4
2st floor	400	178	195	332	451	16	12	0,41	0,30	0,12	1.3
1st floor	0	0	0	0	119						
basement	0	60	66	112	119						
total supply	**7.550**	**8.558**	**9.413**	**15.993**							

Balancing of Exhaust- and Supply Airflows

To guarantee stable and pressure-conditions in the building (= overpressure to reduce energy loss caused by infiltration) through balanced airflows, of each single air outlet and inlet must be adjusted.

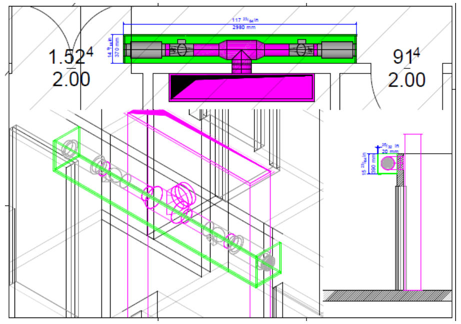
Therefore, airflow-controllers or -limiters are used for

- **exhaust air risers on the roof**

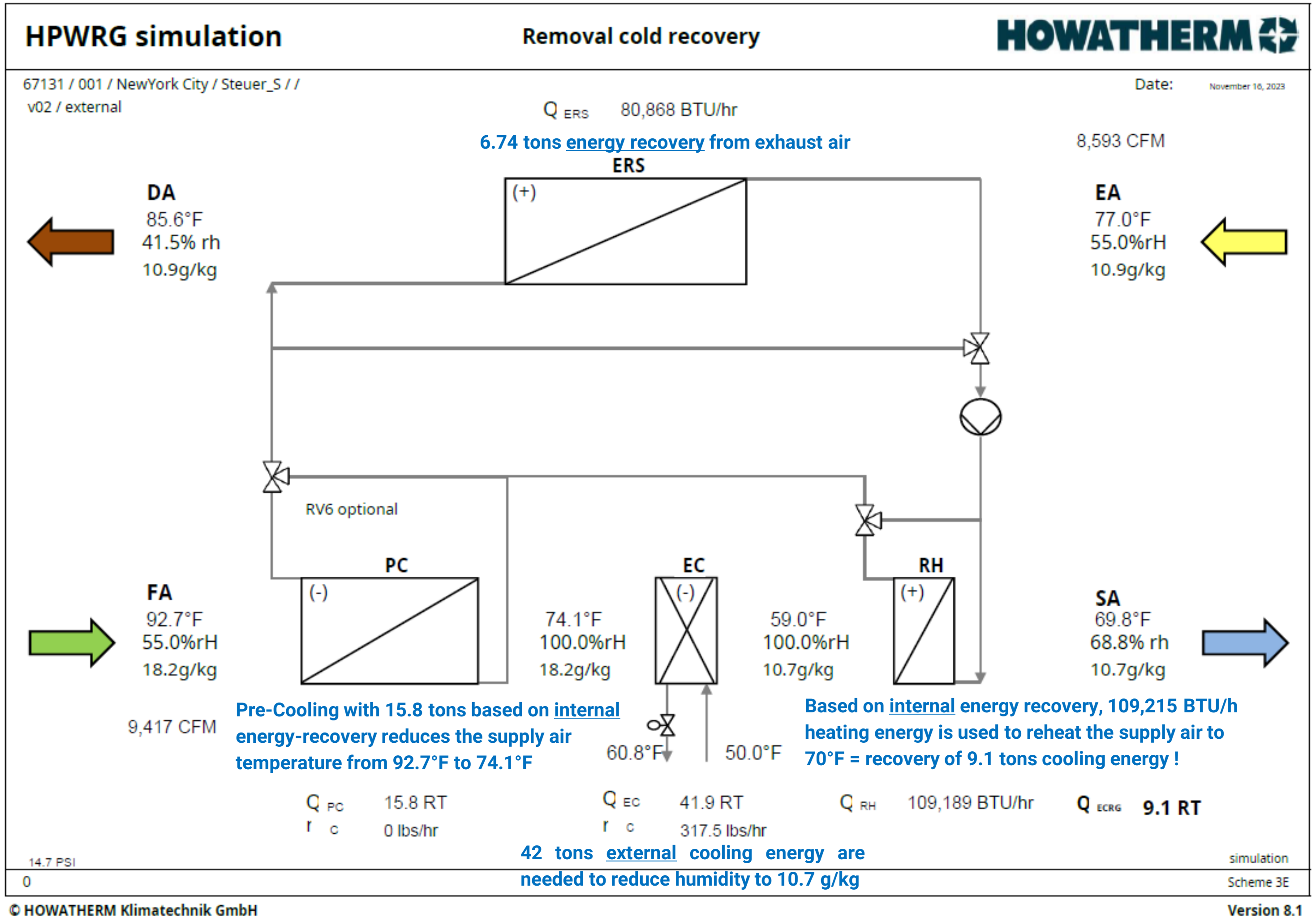


- **Exhaust air inlets in bathrooms and kitchens**

- **Supply air outlets in hallways**



Simulation of Summer-Operation with 92.7°F and 55% r.H.



Winter-Operation Scenario 1: Outside air with 5.0°F

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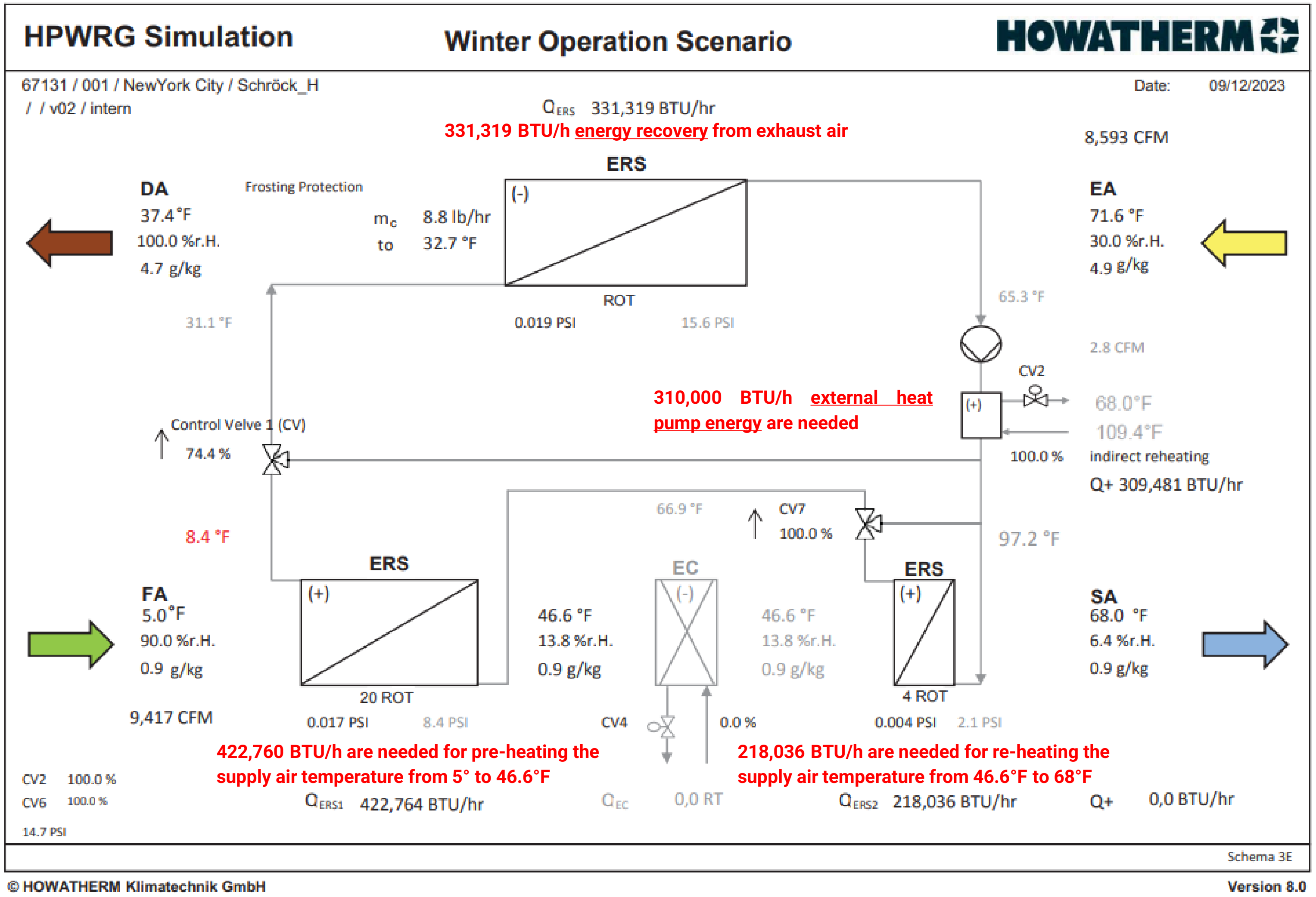
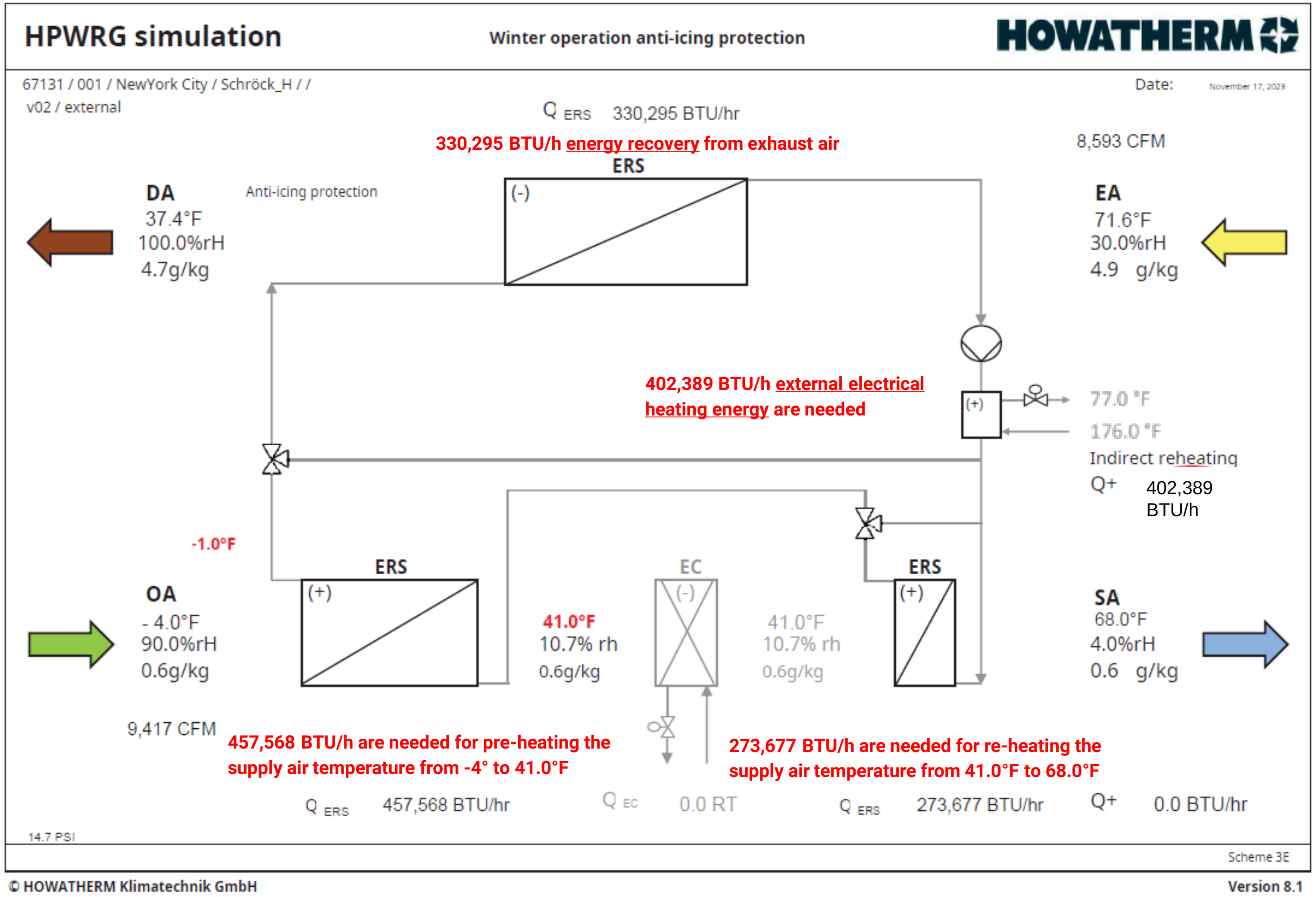
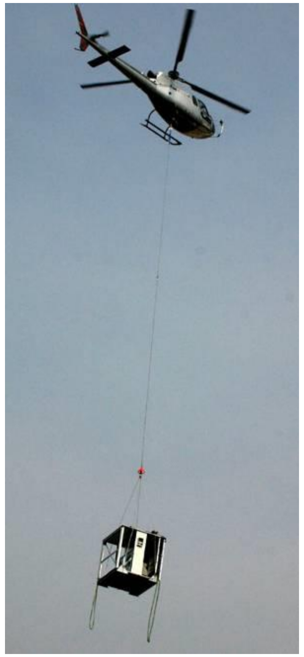


Winter-Operation Scenario 2: Outside air with -4.0°F



Aircon-Unit Design

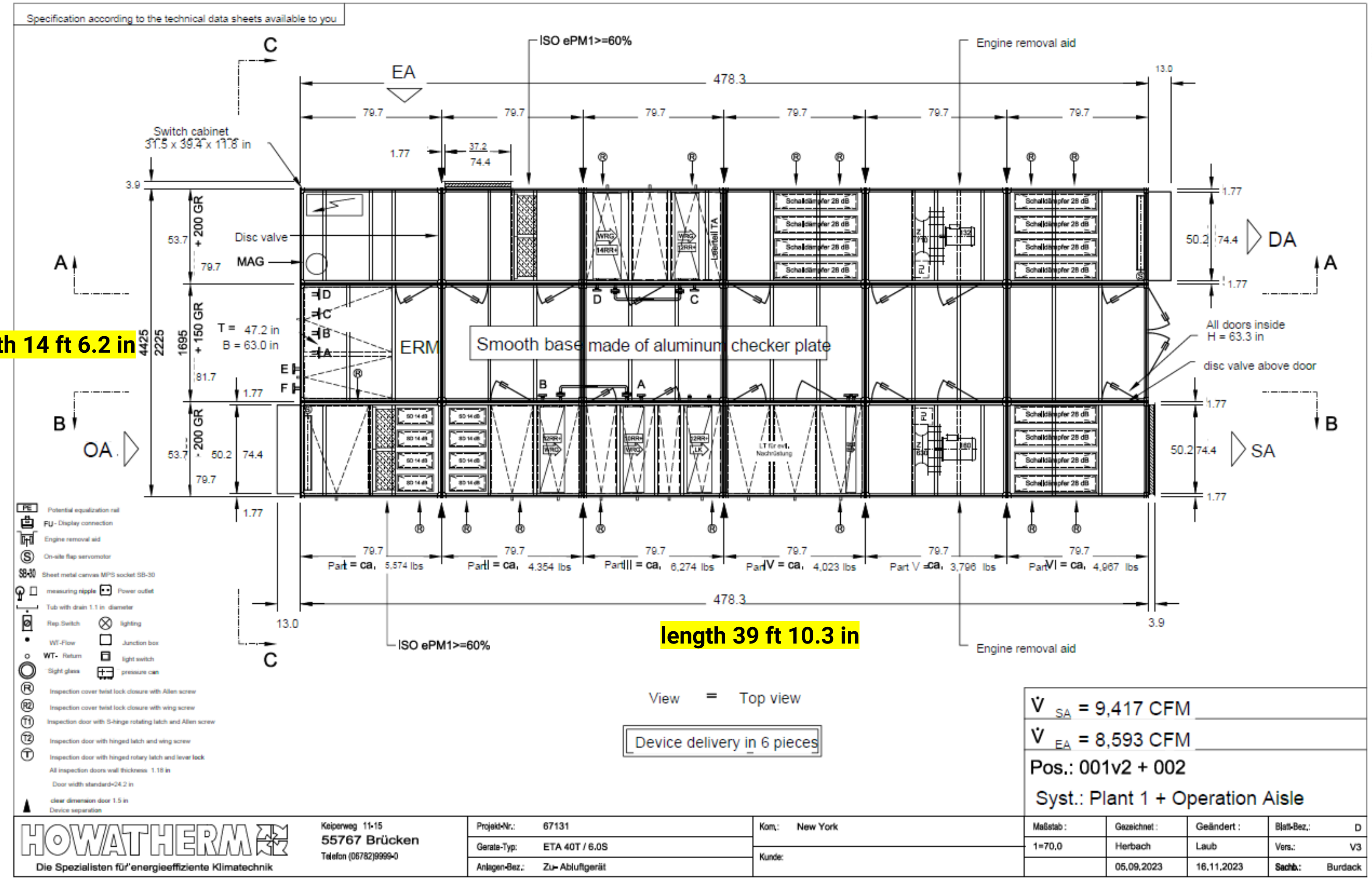
RUHL



- Roof mounted unit pressurizes the corridors with 100% outside air.
- Supply- and return-air unit are connected through a maintenance space as weather protection for the equipment and to maximize pre-installation.
- Highly efficient closed loop heat-recovery with ecoFin+ heat exchangers.
- Hydronic heat exchangers to feed in heat pump-based energy for heating and cooling.

Aircon-Unit Design

RUHL

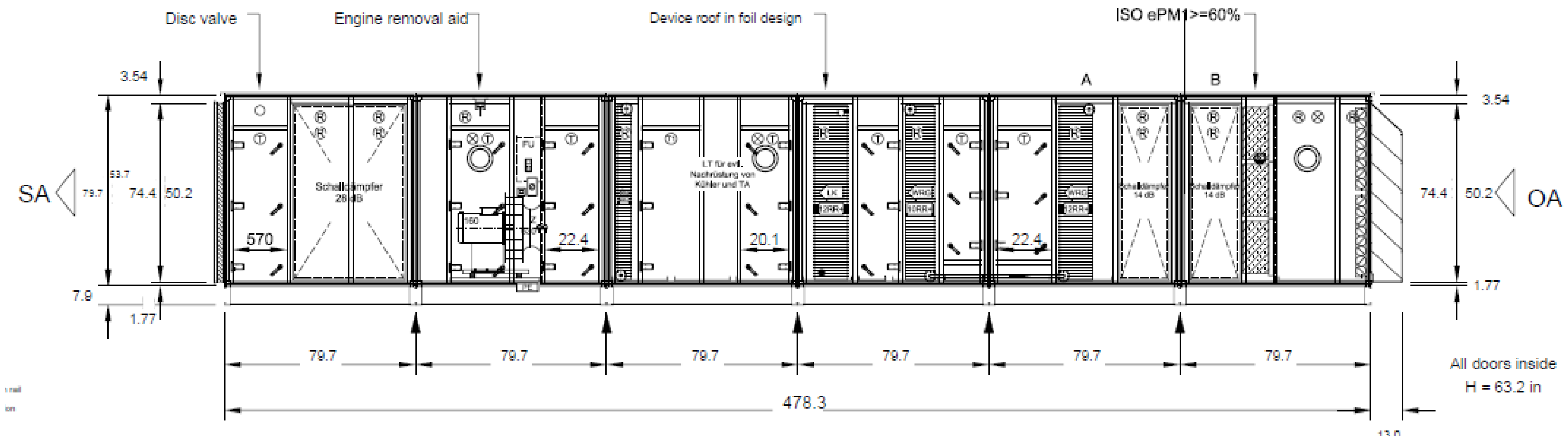


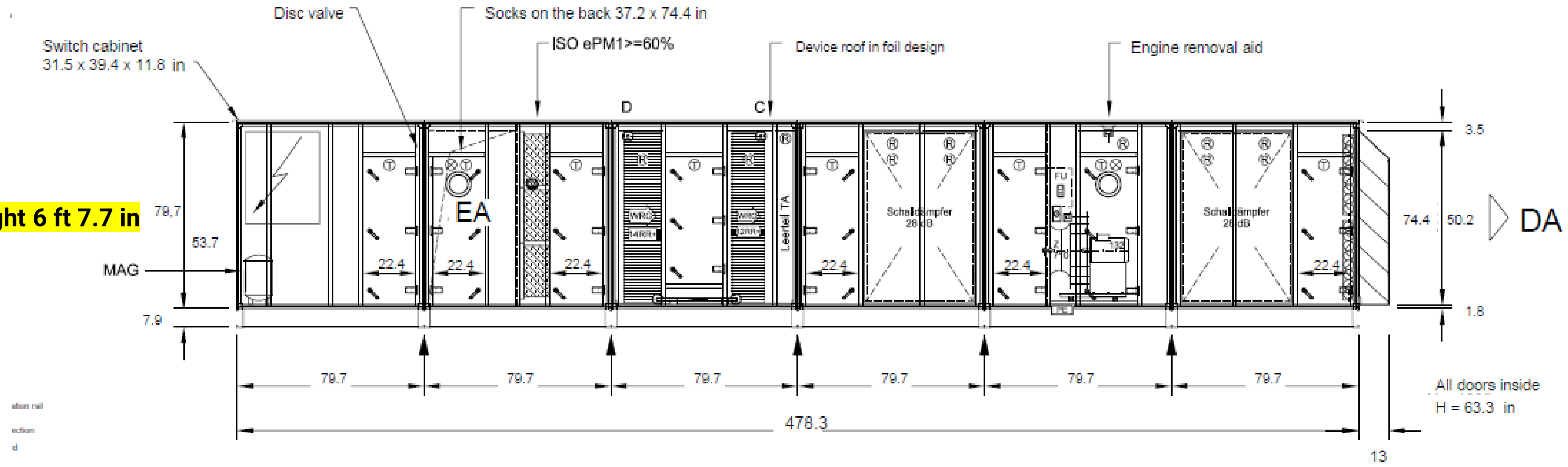
width 14 ft 6.2 in

length 39 ft 10.3 in

Aircon-Unit Design

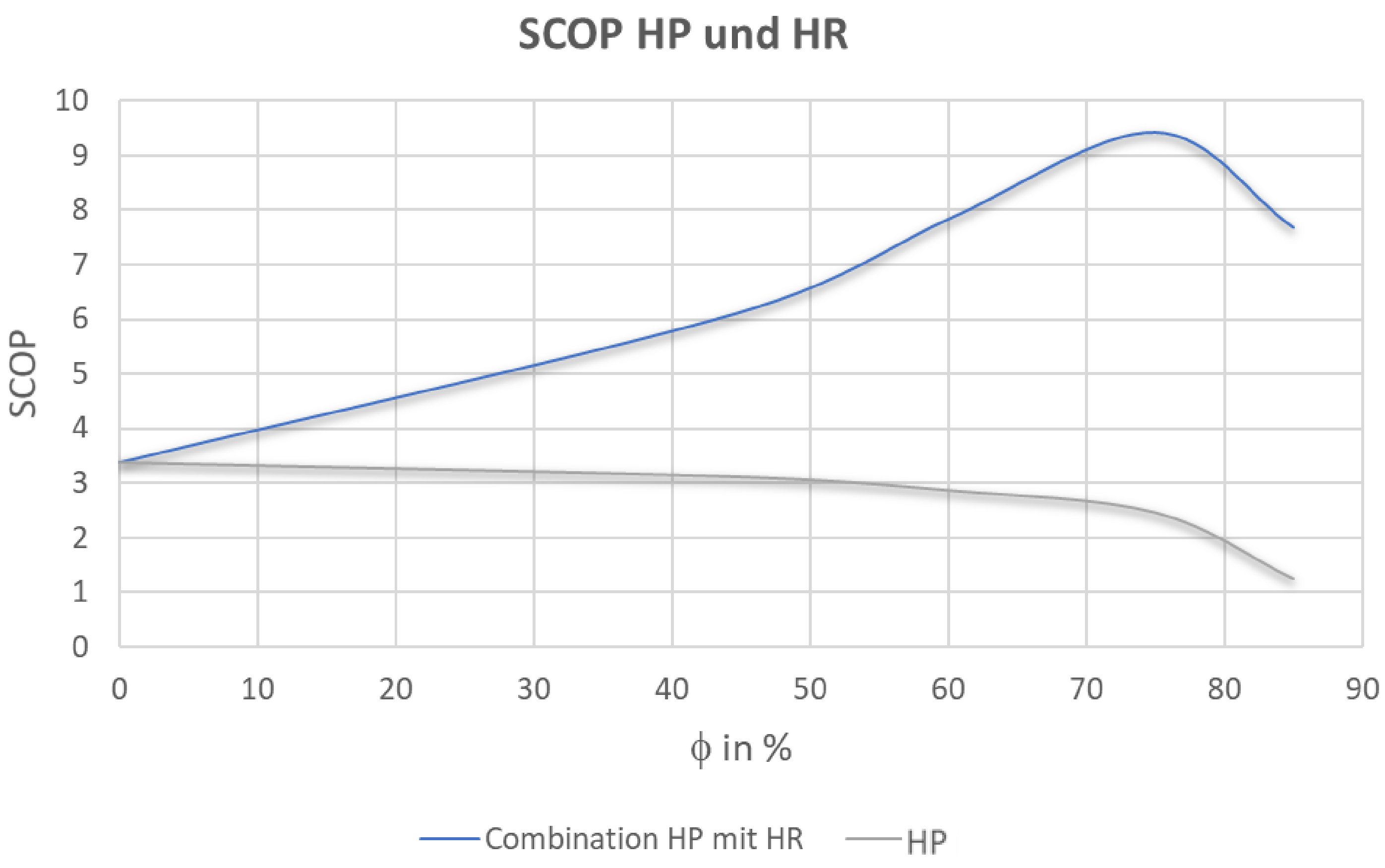
RUHL





height 6 ft 7.7 in

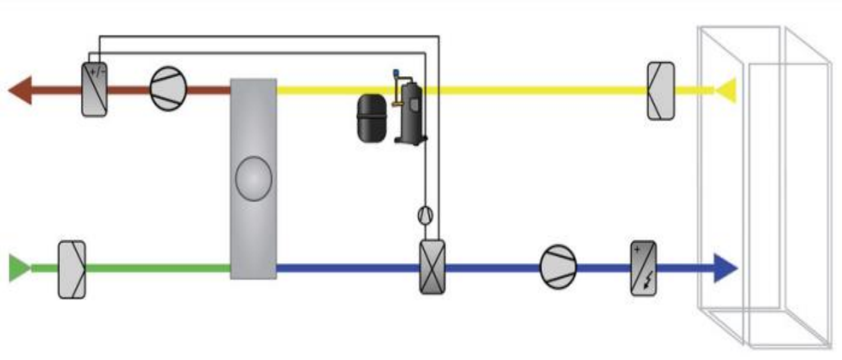
Why Combination of Heat Pump and Heat-Recovery?



Reference: HOWATHERM

Heat Pump Technology

<u>Integrated</u> reversible heat pump for heating and cooling operation



The refrigeration circuit is completely integrated into the ventilation unit.

The reversal of the refrigerant flow allows cooling and heating operation, because the coils are used alternately as a condenser or as an evaporator.

The design of an integrated reversible heat pump is very compact, and the on-site installation effort is low.

In <u>cooling mode</u>, the evaporator coil extracts heat from the supply air and releases it as waste heat to the exhaust air via the integrated condenser coil. This means that only as much cooling capacity can be generated as the exhaust flow can discharge in the form of waste heat. Therefore, the required cooling capacity for dehumidification operation in summer can only be provided to a limited extent, which makes additional external cooling energy supply necessary.

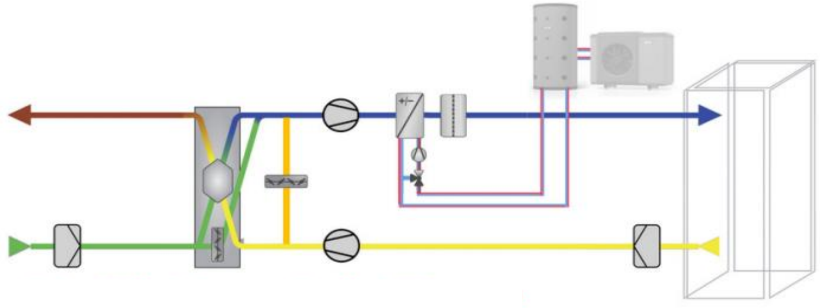
In <u>heating mode</u>, the heat pump's capacity is limited by the heat energy content of the exhaust air after energy-recovery – energy may only be recovered once.

However, during defrosting operation, no "heat pump heating energy" is available for heating the supply air, which means that a sufficiently dimensioned "backup heating system" must be available for reasons of operation safety.

Reference: Peter Hofstetter (WOLF GmbH), TGA-Fachplaner 08.2023

External reversible heat pump for heating and cooling operation

Since in ventilation units with an integrated heat pump, additional systems for dehumidification and backup-heating must be installed anyhow, it seems to be cost efficient to use only one energy source for heating and cooling energy supply only.



An external reversible air-source heat pump is using a hydronic loop to feed in both heating- and cooling-energy. An energy storage tank with electric-heating-device is used to cover peak-loads and as back-up for defrosting and very low ambient temperatures.

2 pcs. reversible air-source heat pumps

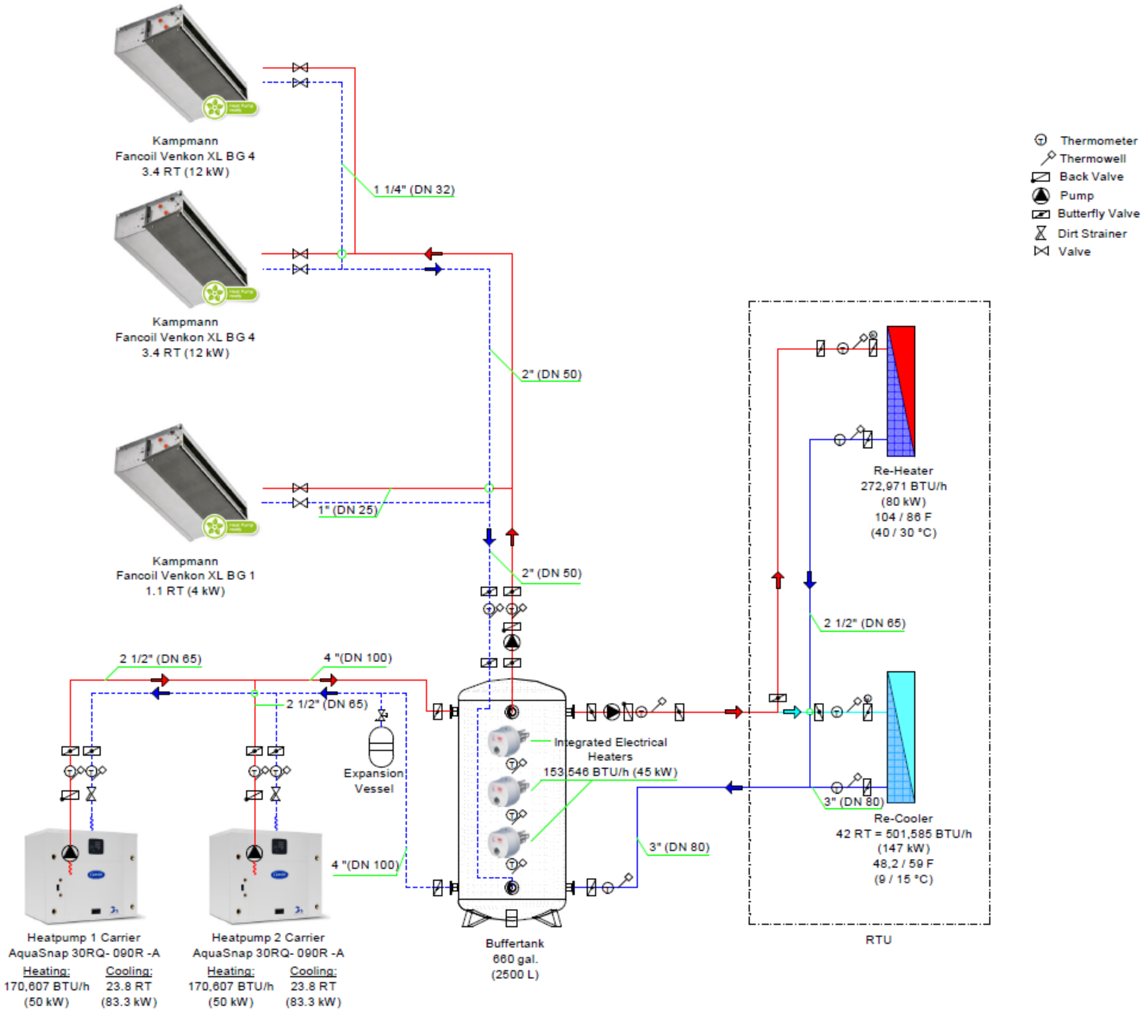
Cooling capacity at 92.7°F with 55% r.H. (18,2 g/kg):	2 x 23.8 RT (2 x 83.3 kW)
Heating capacity at 5°F:	2 x 170,648 BTU/h (2 x 50 kW)

Heat-Source air: 5°F (-15°C)(dry bulb temperature)
Heat-Source air: 4.6°F (wet bulb temperature)
Heat-Sink: 104/87°F (40/30.5°C)
COP = about 1.99 (at 5°F)
SCOP = about 3.90

Electrical heating in the energy storage tank: 3 x 153,583 BTU/h (3 x 45 KW)

Reference: Peter Hofstetter (WOLF GmbH), TGA-Fachplaner 08.2023, CARRIER AquaSnap 30RQ-090R-A

Heat Pump Technology
Schematic design for hydraulic integration



Equipment Installation on the Roof Top (2D)

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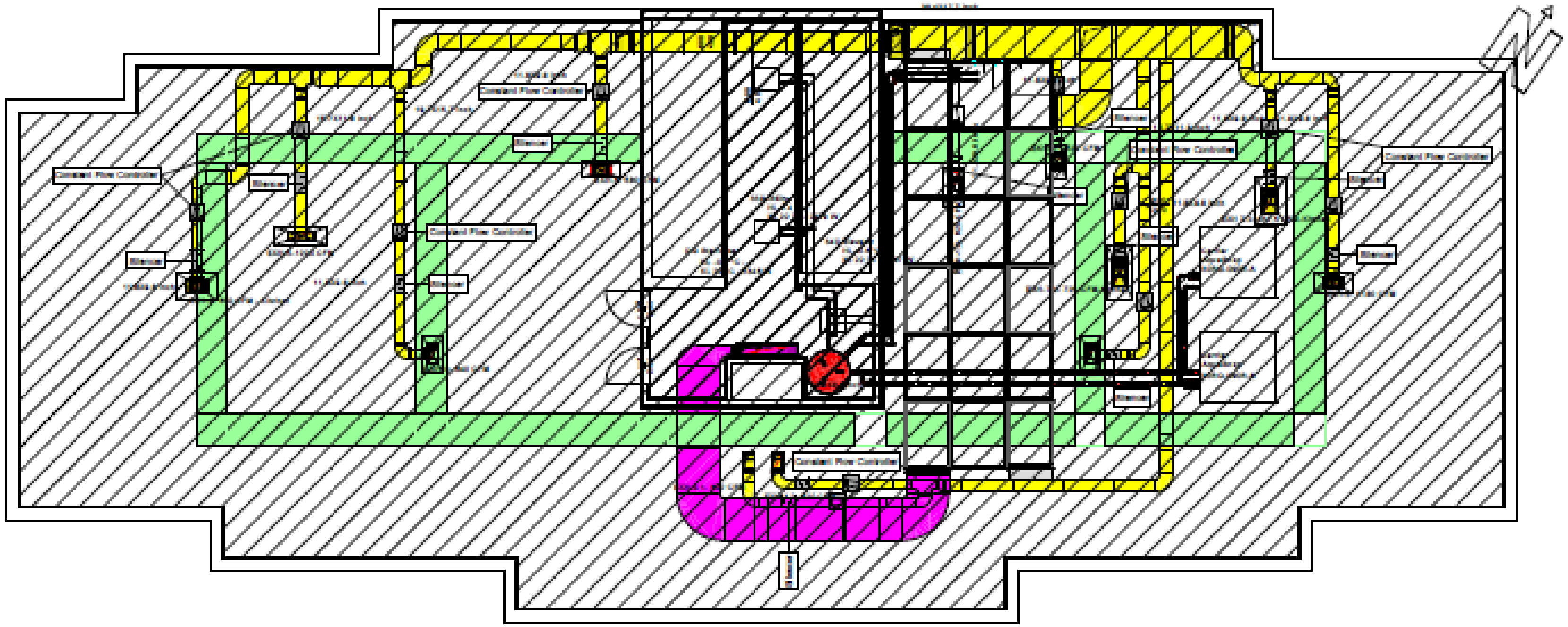
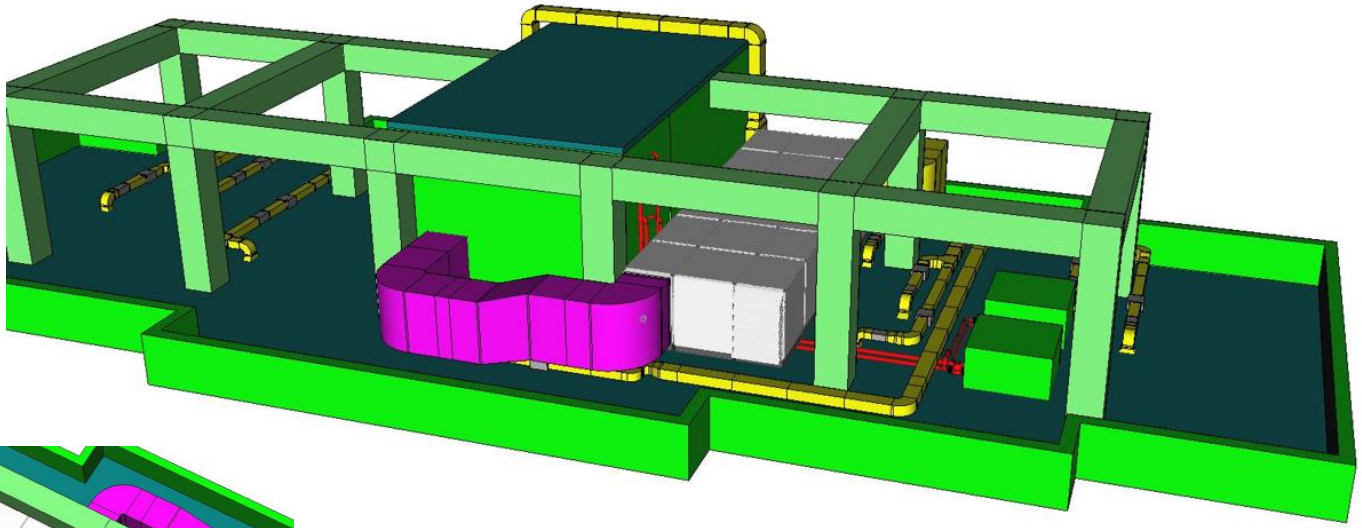
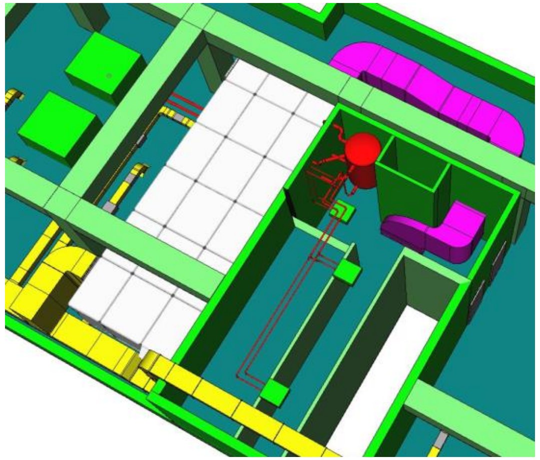


Equipment Installation on the Roof Top (3D)





Electrical Load Evaluation
Required electrical power for the new roof equipment (in kW)

Power availability with three elevators in use: 106.7 KW

Heat pump heating operation at 5°F (-15°C)
Total electrical power consumption in regular operation: 65.0 KW OK
Total electrical power consumption in defrosting operation: 83.1 KW OK

Electrical heating operation at -4°F (-20°C)
Total electrical power consumption in regular operation: 135 KW *but:* mostly at night

Heat pump cooling operation at 92.7°F, 55% r.H. (18,2 g/kg)
Total electrical power consumption in regular operation: 78 KW OK

The elevators will be supplied with priority in any case, which means other equipment's supply will be reduced if necessary.

Therefore, a load management system will constantly monitor the available load for the equipment by measuring the actual power consumption of the elevators.

If it comes to a peak demand of the elevators, the load management system will switch off the electrical heating devices in the energy storage tank, that can be controlled in 9 stages, stepwise.

During this (short) period, the energy storage tank will cover the heat supply.

Calculations – Baseline, Scenarios & Savings
Definition of the Baseline

- The total exhaust air flow of 25,275 CFM must be re-heated/-cooled to the required room temperature, either through the gas-fired RTU or the steam-coil PTACs.
- RTU operation: hallway air flow to be treated: 7,550 CFM
  - The RTU's supply air temperature in winter is 75°F (23.9°C) and the efficiency of the gas-firing will be estimated with 80%. In cooling operation, the supply air temperature is 68°F (20°C) and the integrated a/c's EER is about 8.5 (related to unit RT).
  - There is no controlled dehumidification, the supply air is only cooled down to the setpoint temperature (saturation).
  - There is a change-over-operation according to the actual outside temperature (heating operation, if ambient temperature < 68°F/20°C and cooling operation, if ambient temperature > 75°F/24°C).
- PTAC operation: infiltrated air flow to be treated: 17,725 CFM
  - In addition to the transmission loads for space heating and cooling, that are not considered here, the PTACs must condition the infiltrated air to the required room temperature.
  - The room temperature is estimated to be set to 72°F (22.2°C) in winter and 74°F (23.3°C) in summer.
  - The efficiency of the steam-based heating is estimated to be 60% (incl. gas-firing and steam transmission) and the integrated a/c's EER is about 7.7 (related to unit RT).
  - There is no controlled dehumidification, the supply air is only cooled down to the setpoint temperature (saturation).

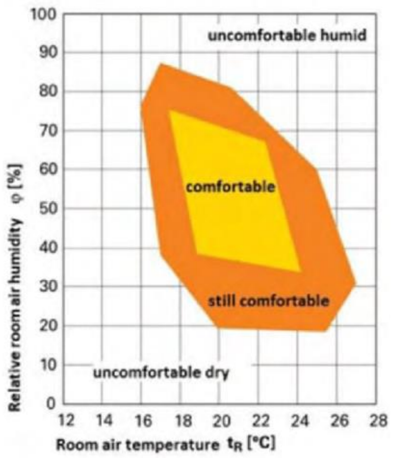
Calculations – Baseline, Scenarios & Savings

Definition of Scenario 1

- The new aircon unit with energy recovery and heat pump-based heating and cooling energy supply with be operated with reduced air rates. To enable comparison with the baseline scenario, there is no controlled dehumidification, the supply air is only cooled down to the setpoint temperature (saturation).
- The total exhaust air flow will be balanced with air flow limiters to 8,620 CFM.
- To stop infiltration through the façade, there will be a roughly 10% over pressure being supplied by the new aircon unit to the hallways with 9,424 CFM.
- The RTU's supply air temperature in winter is 75°F (22°C). In heating operation, the reversible heat pumps SCOP is 3.26 (related to unit kW).
- In cooling operation, the supply air temperature is 70°F (21°C). In cooling operation, the reversible heat pumps SEER is 4.29 (related to unit kW).
- Control strategy
    - Heating operation will be released only, if the actual ambient temperature is < 68°F (20°C), and during the last 4 days, heating had been required for at least 48 hours.
    - Cooling operation will be released only, if no heating operation is required, the actual ambient temperature is > 75°F (24°C) and during the last 4 days, cooling had been required for at least 48 hours.
    - If the RTU isn't in heating or cooling operation, the heat pumps will be switched off. As soon as either heating or cooling operation is released for the RTU, the heat pumps will be switched on in the respective operation mode (response time about 1 hour).

Calculations – Baseline, Scenarios & Savings
Definition of Scenario 2

- Exhaust and supply air flows are set according to scenario 1.
- In addition to scenario 1, cooling operation will be combined with controlled dehumidification of the supply air.
- Control strategy
    - Heating operation will be released only, if the actual ambient temperature is < 68°F (20°C), and during the last 4 days, heating had been required for at least 48 hours.
    - Cooling operation will be released only, if no heating operation is required, the actual ambient temperature is > 75°F (24°C) and during the last 4 days, cooling had been required for at least 48 hours.



- Cooling operation with <u>controlled dehumidification</u> will be released only, if the absolute humidity is > 12.0 g/kg (upper limit of the "still comfortable zone"). In this case absolute humidity of the supply air will be reduced to 10.7 g/kg (70°F, 68.8% r.H., "comfort zone").
- If the RTU isn't in heating or cooling operation, the heat pumps will be switched off. As soon as either heating or cooling operation is released for the RTU, the heat pumps will be switched on in the respective operation mode (response time about 1 hour).

Calculations - Baseline & Savings

Simulation of Energy Consumption, Savings and CO_2-Emissions

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results	baseline	scenario 1	scenario 2
energy cost	$156.838,17	$51.669,81	$54.349,40
annual tons C02	499,27 t CO2	79,23 t CO2	83,3 t CO2
annual energy use	2.041.064,65 kWh	215.290,87 kWh	226.455,85 kWh
% saving kwh	0%	89,45%	88,91%
% saving CO2	0%	84,13%	83,31%
% saving USD	0%	67,06%	65,35%

Total savings: 105,168.36 USD [100.0%]

Savings for building owner: 93,416.27 USD [88.9%]

Savings for tenants (PTAC cooling): 11,752.09 USD [11.1%]

Sustainable solutions
for a
world worth
living

RUHL

RUHL TecDesign LLC is a New York based MEP engineering and design company with a German background, being focused on the development of low carbon footprint projects using renewable energy and energy efficient building technology.

With the experience of over 65 years in business and being specialised in commercial buildings, production facilities and large housing projects in Europe, the Americas, Asia and Africa, RUHL achieved growing success developing carbon-neutral projects, being realised needless of fossil energy.

In 2022, RUHL successfully took part in the NYSERDA Empire Building Challenge, designing a steam-to-heat-pump retrofit for a residential high rise in NYC.

Empire Building Challenge
PARTNER
Reimagining Low-carbon Buildings

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BRIEFING REPORT

Heat reuse: a management primer

Jacqueline Davis, Research Analyst

Presented to NYSERDA Heat Recovery Roundtable
January 31, 2024

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- On heat recovery:

Max Smolaks

Research Analyst

Heat reuse: a management primer (2023)

Jacqueline Davis

Research Analyst

Data center cooling, 2021-present

Data center heat recovery, 2024

Accessing Uptime's report


UII REPORT 114M • OCTOBER 2023
ENVIRONMENT & SUSTAINABILITY

BRIEFING REPORT

Heat reuse:
a management primer

Max Smolaks, Research Analyst mamolaks@uptimeinstitute.com

Almost all the energy consumed by data centers is converted into heat, which is typically rejected into the environment. Technologies that enable data center operators to capture and recycle this "waste heat" are well understood but rarely used. This report investigates the current state of data center heat recovery projects and looks at the factors that are likely to influence the development of this field in the next three to four years.

KEY POINTS
- A cold climate and widespread use of district heating networks have made Northern Europe the global leader in waste heat recovery, with nearly 60 documented projects across hyperscale, enterprise, colocation, high-performance computing (HPC) and edge facilities.
- The EU's Energy Efficiency Directive (EED) recast will require member states to ensure that data centers with a total energy consumption of 1 megawatt (MW) and above utilize waste heat recovery, or show that such recovery is technically or economically unfeasible.
- Quantifying the commercial value of waste heat is difficult: both the heat output of the data center and the price of heat delivered to the customer are variable, with demand often driven by the season.
- Advances in district heating networks, growth in IT equipment density and greater adoption of liquid cooling will improve the viability of data center waste heat recapture projects.

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The briefing report **Heat reuse: a management primer** is available for download from the Uptime Institute website:

uptimeinstitute.com/resources

Uptime's report in summary

What is waste heat recovery?

The difficult business case of waste heat recovery

The countries taking the lead in heat recovery

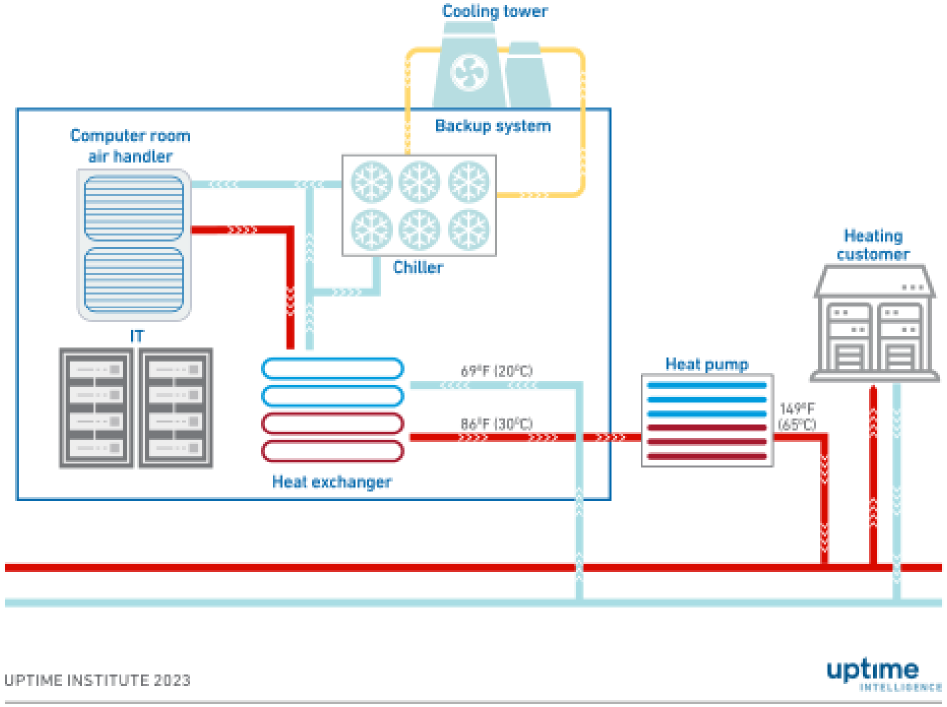
How waste heat is captured and transported

What is a heat pump?

Growing policy interest in waste heat recovery

Advances in district heating networks

Applications for waste heat



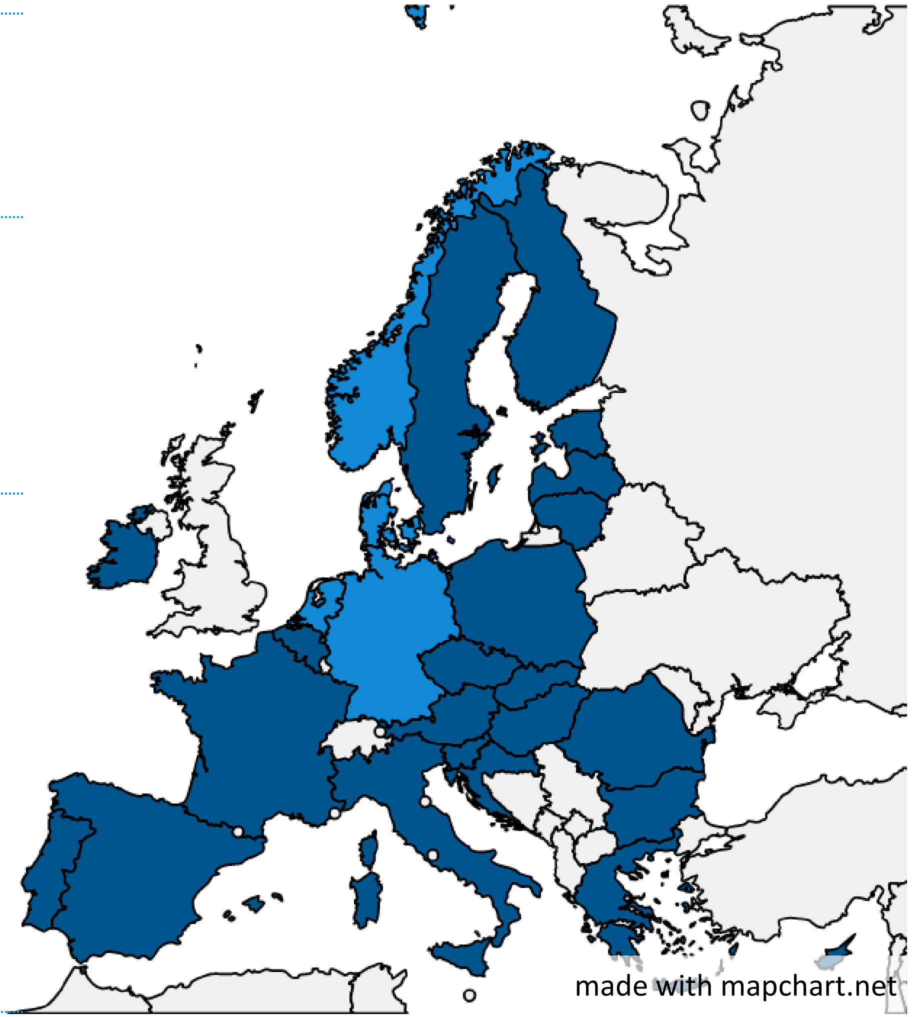
Growing policy interest in waste heat recovery

Governments are starting to take more interest in waste heat recovery schemes.

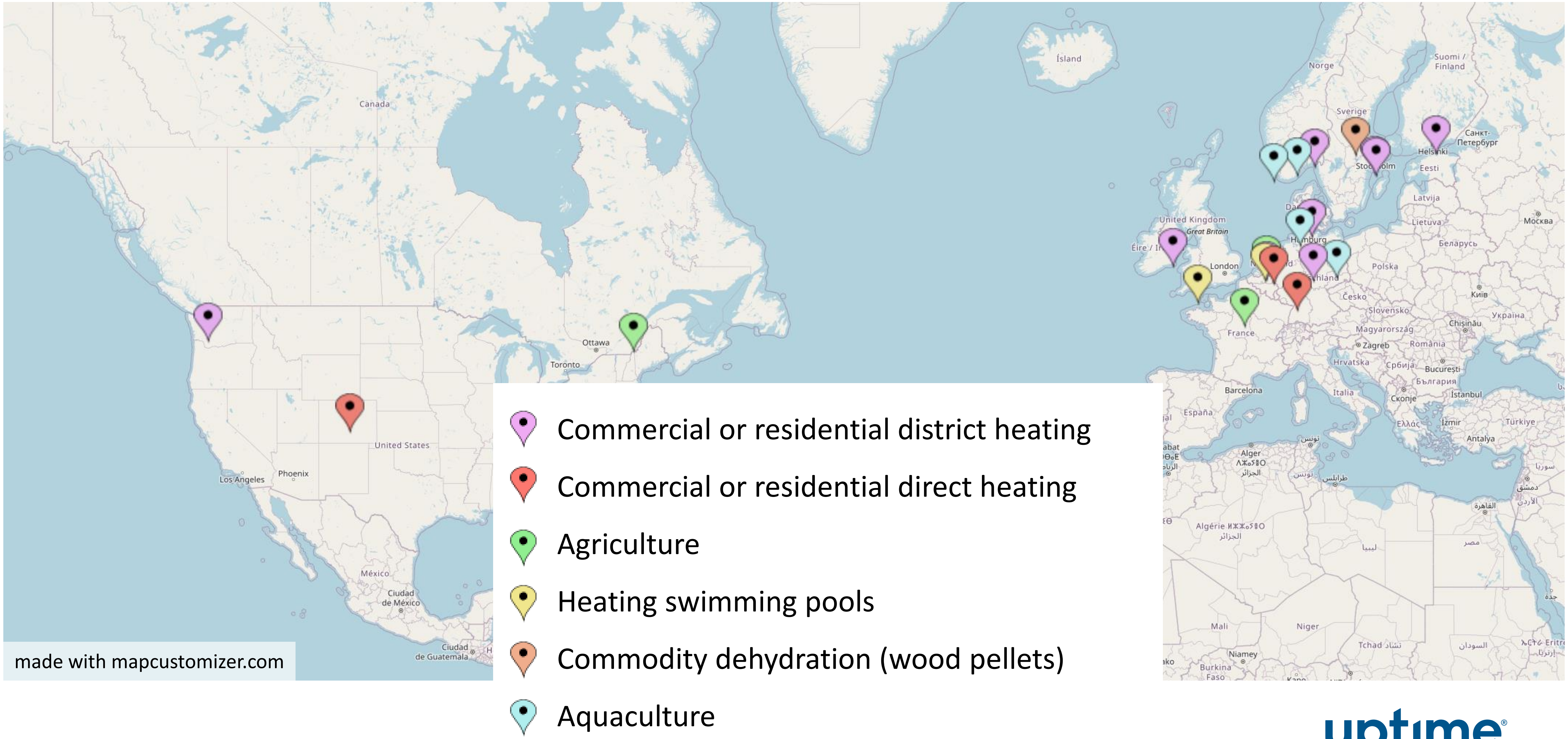
EU Energy Efficiency Directive (EED) Recast:
Data centers ≥1MW must recover waste heat, or else show that heat recovery is not feasible

Additional heat reuse legislation in Europe, present or pending:

Germany
Denmark
Netherlands
Norway



Applications for waste heat



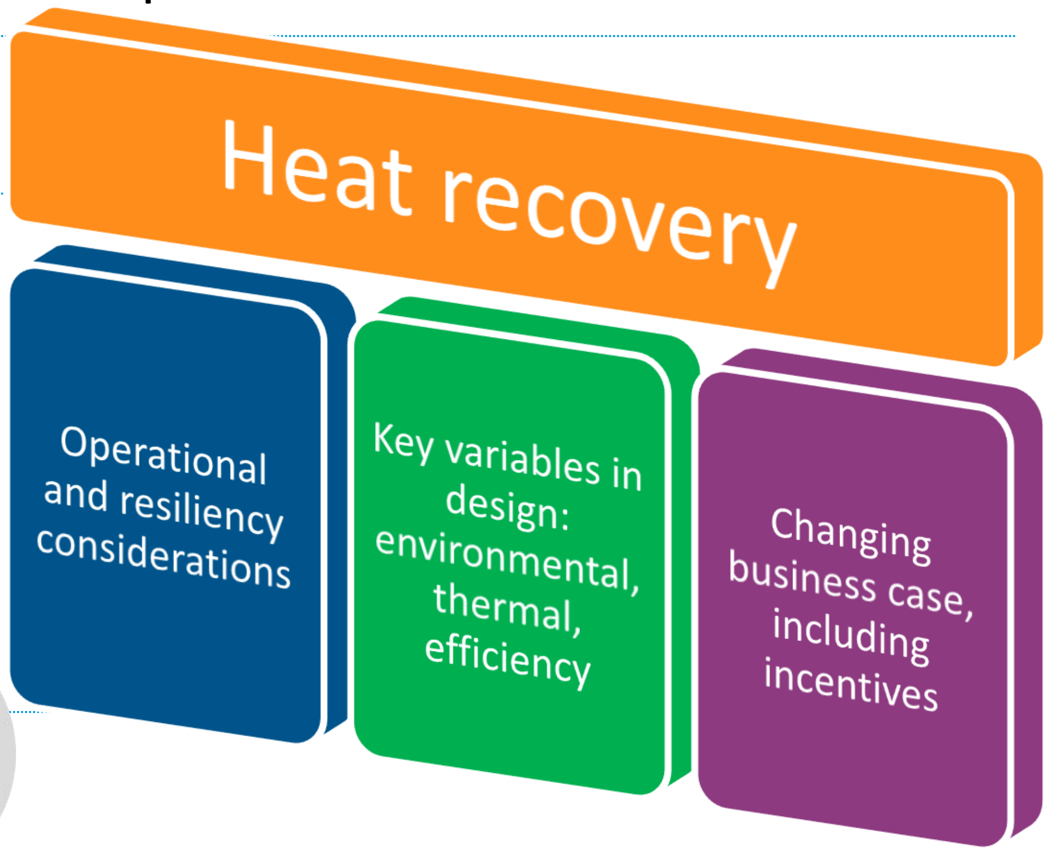
Uptime's research continues

Uptime's reports help data center owners, operators, equipment suppliers, and other stakeholders explore new opportunities and reduce exposure to risk.

2024 research focus:

First report will come out Q1 2024.

If you are knowledgeable in any of the waste heat recovery topics here, or have more to add – I would love to speak with you!



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ENVIRONMENT & SUSTAINABILITY

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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.