ELC + SME CONSORTIUM

Decarbonizing Industry:

Opportunities for Heat Recovery

April 14th, 2022

Toronto and Region Conservation Authority

We respectfully acknowledge that we are situated on the Traditional Territories and Treaty Lands, in particular those of the Mississaugas of the Credit First Nation, as well as the Anishinaabe of the Williams Treaty First Nations, the Huron Wendat, the Haudenosaunee, and the Metis Nation.

As stewards of land and water resources within the Greater Toronto Region, Toronto and Region Conservation Authority appreciates and respects the history and diversity of the land and is grateful to have the opportunity to work and meet on this territory.

native-land.ca

- Where you are from
- Whose lands you are on/What lands know you
- Your intentions

Check out these resources:
www.yrnature.ca/acknowledging_land

https://edgeofthebush.ca/about/
www.native-land.ca

Text 1-855-917-5263 your City and Province to learn whose traditional territory you're on
(standard text messaging rates may apply)

Today's Agenda

TIME	ACTIVITY
1:00 – 1:10 PM	**Updates, Reminders, & Intro** • Matt Brunette, Partners in Project Green
1:10 – 1:45 PM	**Decarbonizing Industry: Opportunities for Heat Recovery** • Stephen Condie, Noventa Energy • Lukas Glaspell, Trane Technologies Toronto
1:45 – 2:00 PM	**Question & Answer Period**
2:00 – 2:45 PM	**ELC Member Roundtable (Members Only)**

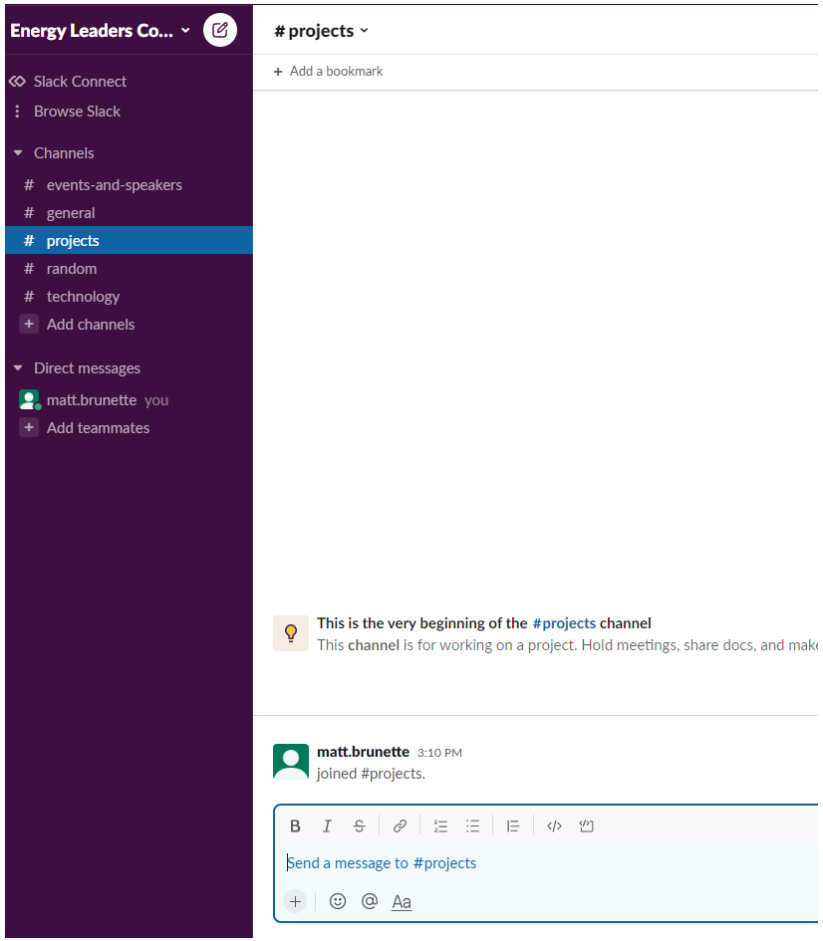
Upcoming ELC Sessions

Date	Topic
April 28th	**Solar for Large Commercial and Industrial Facilities** *With Demand Renewables & Phoenix Solar Thermal*
May 3rd	**Building Controls** *With Siemens*
May 19th	**Deep Energy Retrofits** *With Entuitive*
TBD	*ELC Site Visit***

**Please contact Matt Brunette if you are interested in hosting an ELC Site Visits this year

ELC Slack Account

- Slack is a free, platform for collaboration (online or via app)
- Workspace set up for Energy Leaders Consortium. ***All ELC members will receive an invite to Slack after this meeting***
- Several channel have been set up for topic-related discussions and resources
  - Events and speakers
  - General
  - Random
  - Projects
  - Technology
- We will pilot Slack over the next 6-weeks to determine how useful it is for the ELC



Other News & Reminders!

PPG New Website Launch coming up April 22!

- Launch will be a part of our Earth Day event (more details to come)
- Event registration now open: https://partnersinprojectgreen.com/events/powered-by-purpose-investing-in-our-planets-future/

Membership Renewal Emails

- Please confirm with Matt if membership renewal due in April
- Reminder to please provide updated logos (.eps or .png) if it has changed recently

E'nergys visiting from France on May 3-5, looking for organizations to meet with

Partners in Project Green

A Program of Toronto and Region Conservation Authority

Introduction

Stephen Condie, Noventa Energy

Stephen Condie, CTO & Head of Operations, Noventa Energy Steve began his career at Enwave in 2003 as a Project Manager. In 2008, he was promoted to Manager of System Operations with responsibility for the steam and chilled water systems. He went on to hold progressively senior positions, culminating in Vice President of Engineering and Innovation, where he oversaw all capital projects from the research and budgeting phase through to construction and commissioning.

Stephen.Condie@noventaenergy.com

Lukas Glaspell, Trane Technologies Toronto

Lukas is an account executive with the Trane Technologies Toronto team working closely with clients to achieve their sustainability and energy goals by leveraging their BAS, supplying equipment, and optimizing HVAC performance. Through his leadership in low carbon and high efficiency HVAC strategies, Lukas supports clients to create and design HVAC solutions and follows them through manufacturing, installation, and optimal operation.

Lukas.Glaspell@trane.com

Decarbonizing Industry:
Opportunities for Heat Recovery

Toronto and Region Conservation Authority

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Wastewater Energy Transfer

Executive Summary

- Buildings are one of largest contributors to global warming accounting for almost **30% of all CO_{2e}** emissions in North America
- Noventa Energy has partnered with Huber Technology, a **187-year-old** wastewater company to bring this environmentally friendly solution to market
- The Huber ThermWin® System coupled with Trane Heat Pumps has many applications including:
  - Extracting heat from sewers for heating or rejecting heat to sewers for cooling
  - Using a buildings own sewage
  - Extracting energy from condensate in district steam buildings
  - Industrial processes with high % dissolved solids
  - High temperature process loads

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2 Noventa Energy Corporation

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Noventa Energy Partners

- *Noventa Energy is a provider of proven, fully-engineered technology alternatives for heating and cooling buildings. From wastewater energy transfer to thermal energy storage and energy sharing, we draw on our portfolio of exclusively licensed technologies and internally created IP to develop customized renewable energy solutions that reduce carbon emissions and manage energy costs for clients.*
- **Our Competencies:**
  - Identifying and conceptualizing projects
  - Developing energy master plans and the corresponding business cases
  - Securing approvals, permitting and stakeholder support
  - Detailed design and budgeting
  - Contract negotiations
  - Financing
  - Project management
  - Operations
- Noventa's projects are typically subject to long-term agreements, with credit-worthy counterparties, that will include provisions for accretive growth and continuous efficiency improvements to enhance value for the customer and our investors

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Industry Leading Partners

Development Partners

MCW Consultants Ltd.

Stantec

BIRD

TRANE

arva

SPRINT MECHANICAL

JACOBS

THERMENEX

Regional Design Partners

GEOSOURCE ENERGY INC

MULVEY&BANANI INTERNATIONAL INC.

FVB

HHAngus

TMP Consulting Engineers

JBB JAROS BAUM & BOLLES

DOHERTY ENGINEERING INC.

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3 Wastewater Energy Transfer

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Wastewater Energy Transfer Potential ("WET")

168 Billion Liters
wastewater per day

350 Billion
kWh per Day

Enough energy to supply US for 1.5 months

Over 90% of heat used for domestic hot water goes down the drain

See Appendix E

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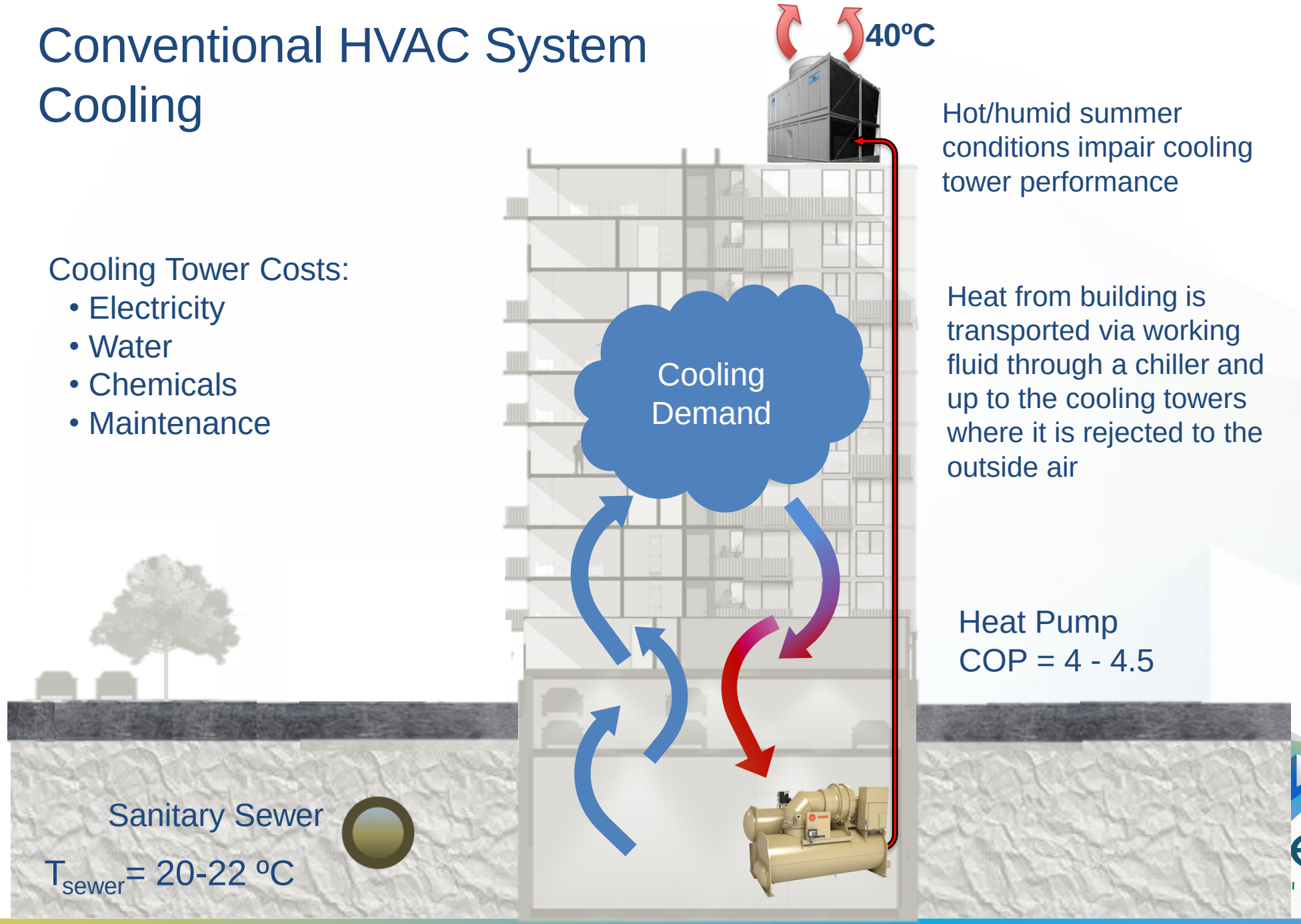
Conventional HVAC System Cooling



Cooling Tower Costs:

- Electricity
- Water
- Chemicals
- Maintenance

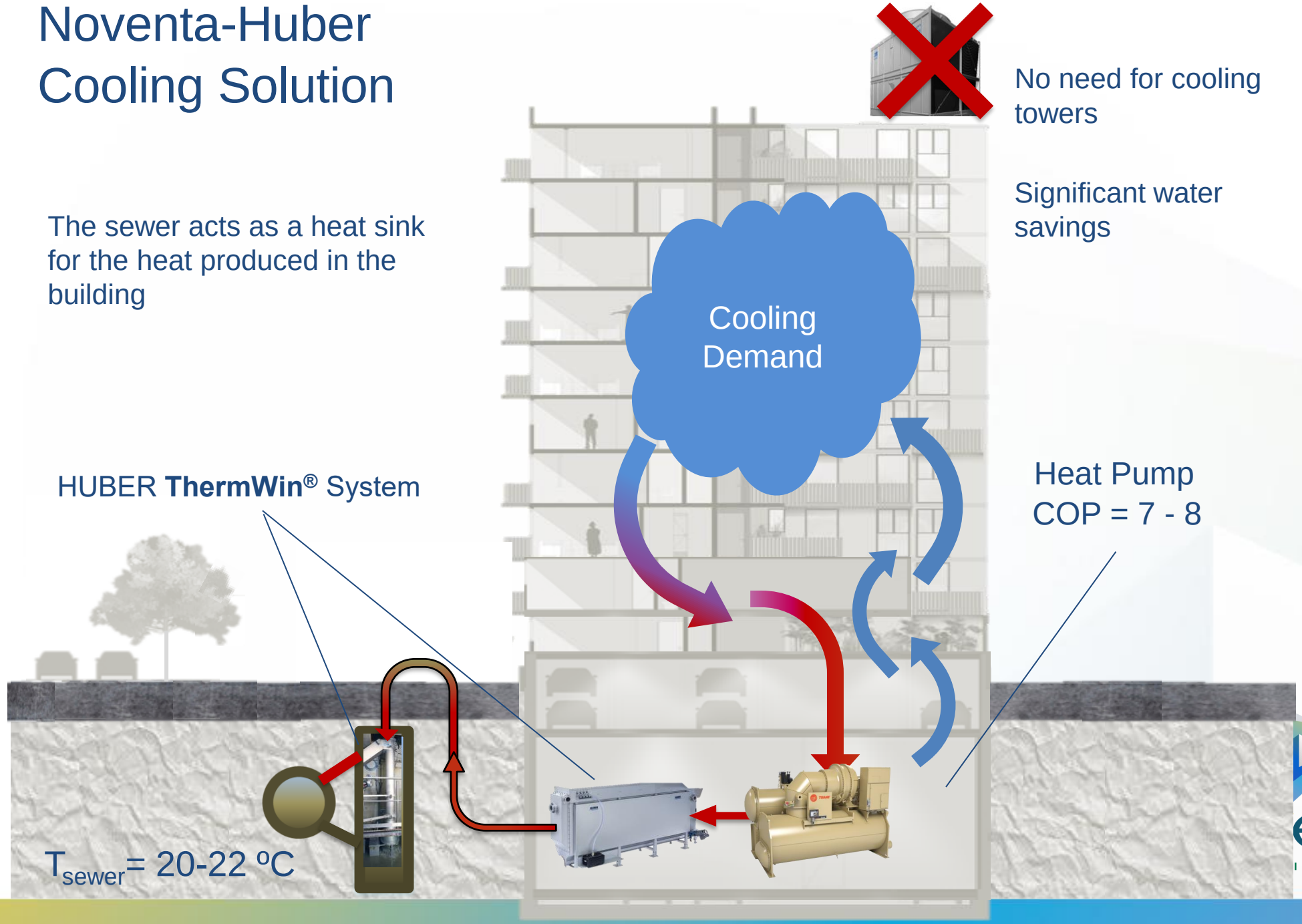
Hot/humid summer conditions impair cooling tower performance

Heat from building is transported via working fluid through a chiller and up to the cooling towers where it is rejected to the outside air

Heat Pump
COP = 4 - 4.5

Noventa-Huber Cooling Solution

The sewer acts as a heat sink for the heat produced in the building



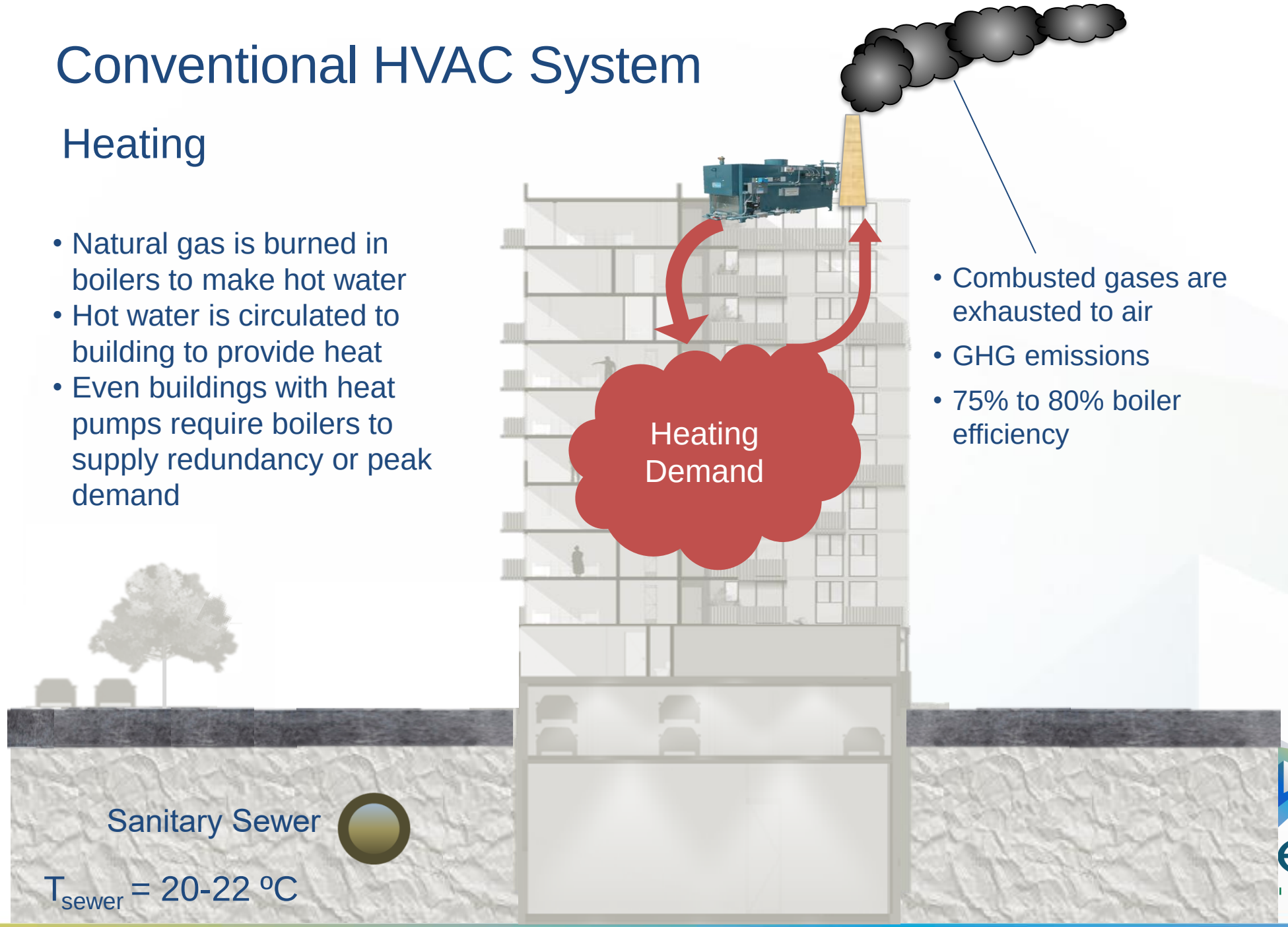
No need for cooling towers

Significant water savings

Conventional HVAC System

Heating

- Natural gas is burned in boilers to make hot water
- Hot water is circulated to building to provide heat
- Even buildings with heat pumps require boilers to supply redundancy or peak demand



- Combusted gases are exhausted to air
- GHG emissions
- 75% to 80% boiler efficiency

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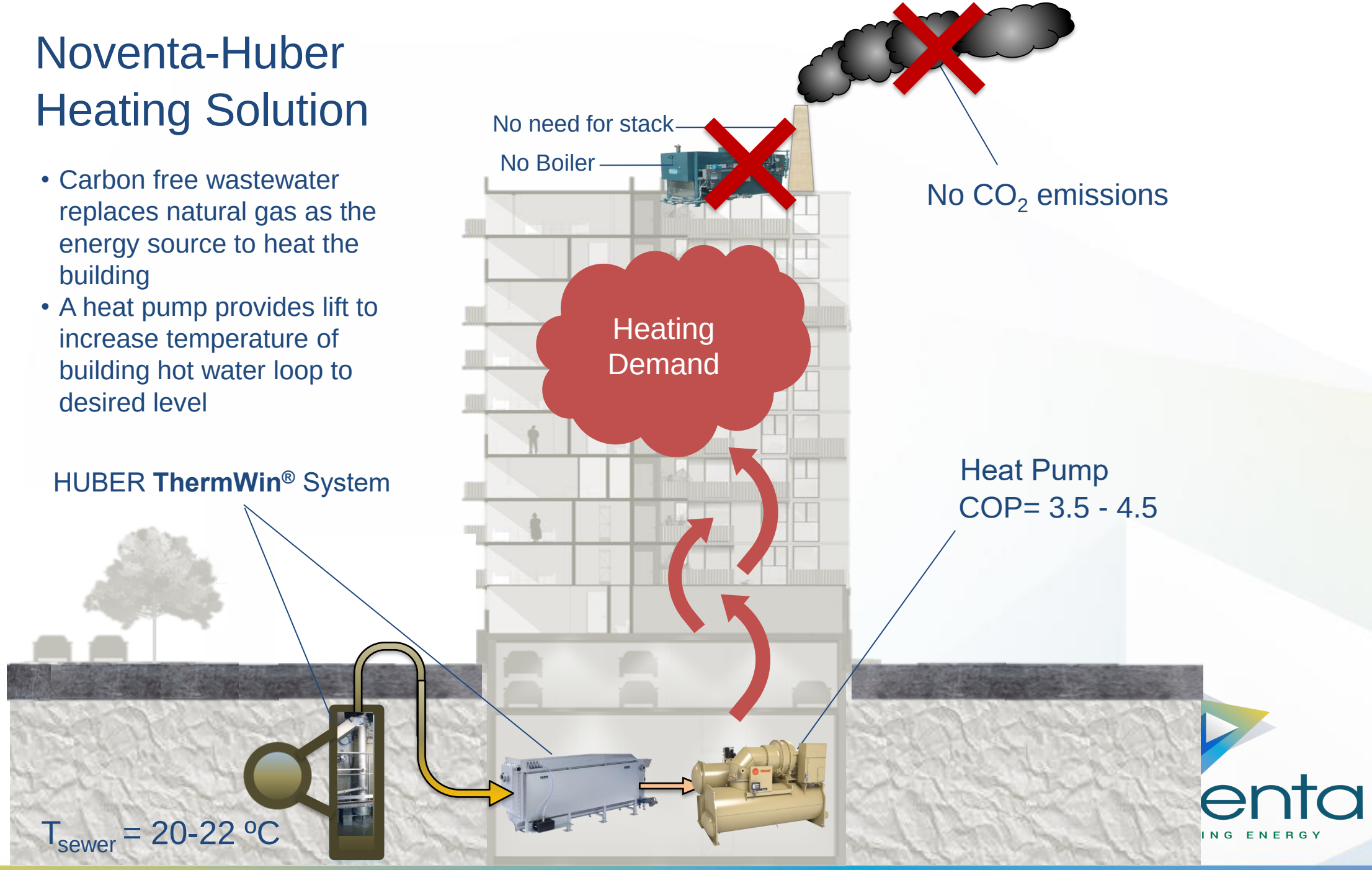
Noventa-Huber Heating Solution

- Carbon free wastewater replaces natural gas as the energy source to heat the building
- A heat pump provides lift to increase temperature of building hot water loop to desired level



4 Wastewater Energy Transfer - Challenges

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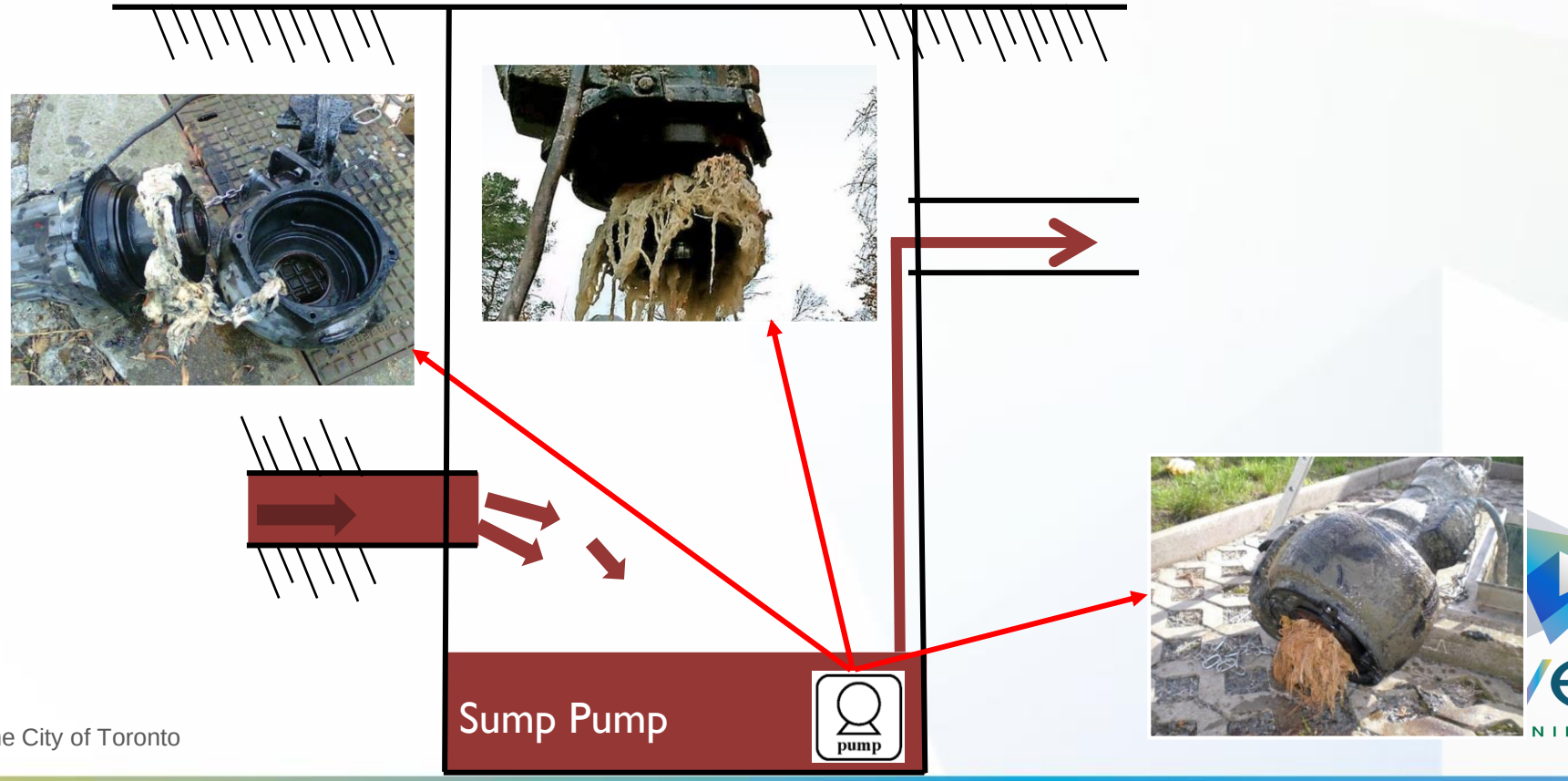
Solids Handling

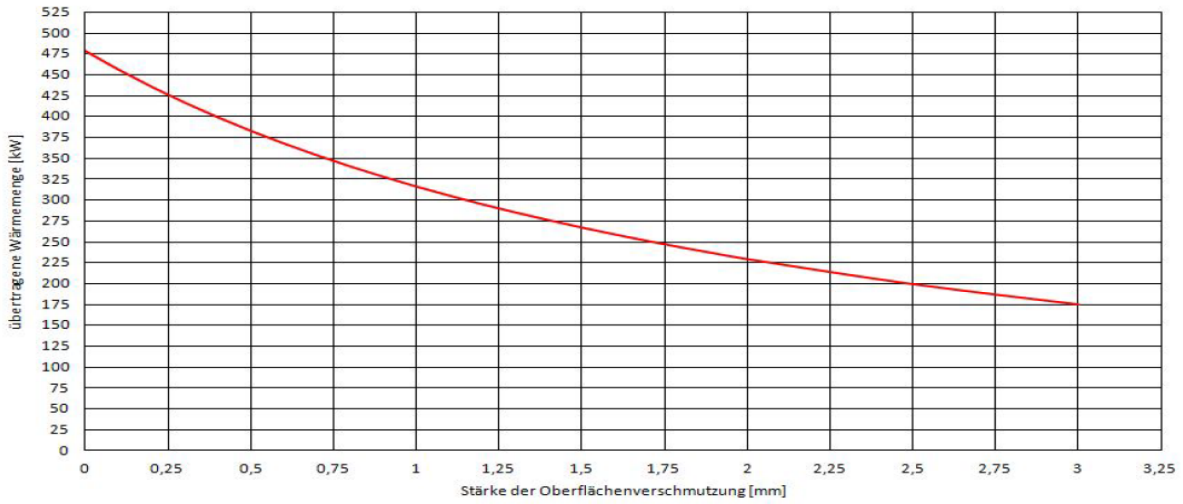
- Large sewers tend to transport larger pieces of debris and have high TDS
- Sump pumps, even equipped with grinders, require costly maintenance and are subject to replacement every 3-5 years[1] when pumping unscreened wastewater



1 As Per the City of Toronto

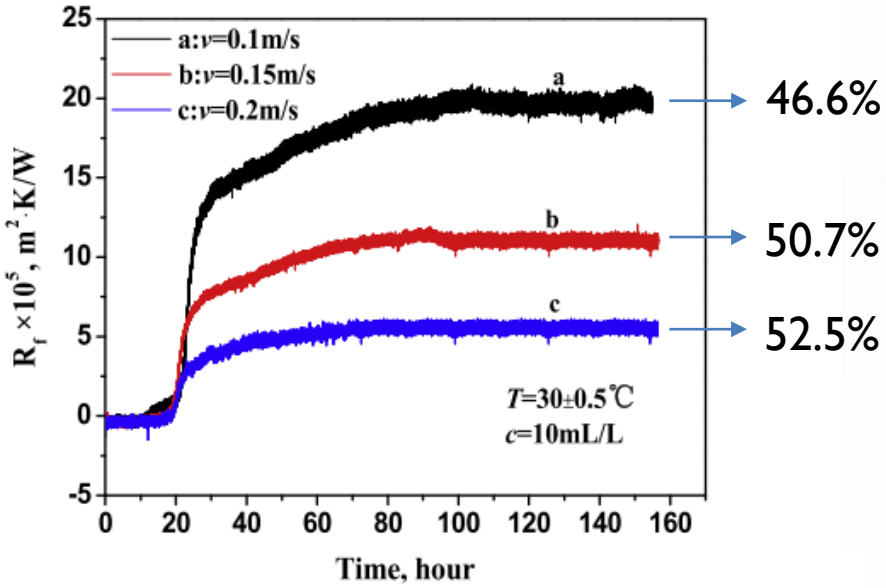
Biofouling[1]

- Biofouling is the greatest challenge for Wastewater systems – 1mm thick biofilm reduces the effectiveness by **over 45%**
- Conventional heat exchangers, including wide gap plate frame HX need to be chemically cleaned and disassembled frequently to restore performance
  - Opening heat exchangers, expose people to odors and unsanitary conditions creating health concerns within the building



1 Biofouling data provided by Toronto Water and *Experimental Study on Microbial Fouling Characteristics of the Plate Heat Exchanger* by Zhiming Xu a, Jingtao Wanga,⇑, Yuting Jia b, Xiaoya Geng a, Zuodong Liu a

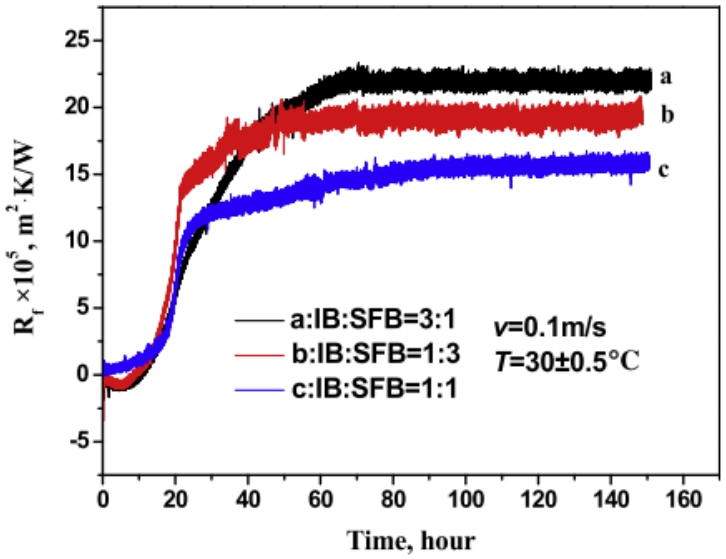
Biofouling[1] (cont.)



46.6%

50.7%

52.5%



- Biofouling of an organic stream occurs in as little as **20 hours**
- Based on organic concentrations the effectiveness of energy transfer can be reduced by as much as **22%** within 20 hours
- This study does not include particulate flow

1 *Experimental Study on Microbial Fouling Characteristics of the Plate Heat Exchanger*
Zhiming Xu a, Jingtao Wanga, Yuting Jia b, Xiaoya Geng a, Zuodong Liu a

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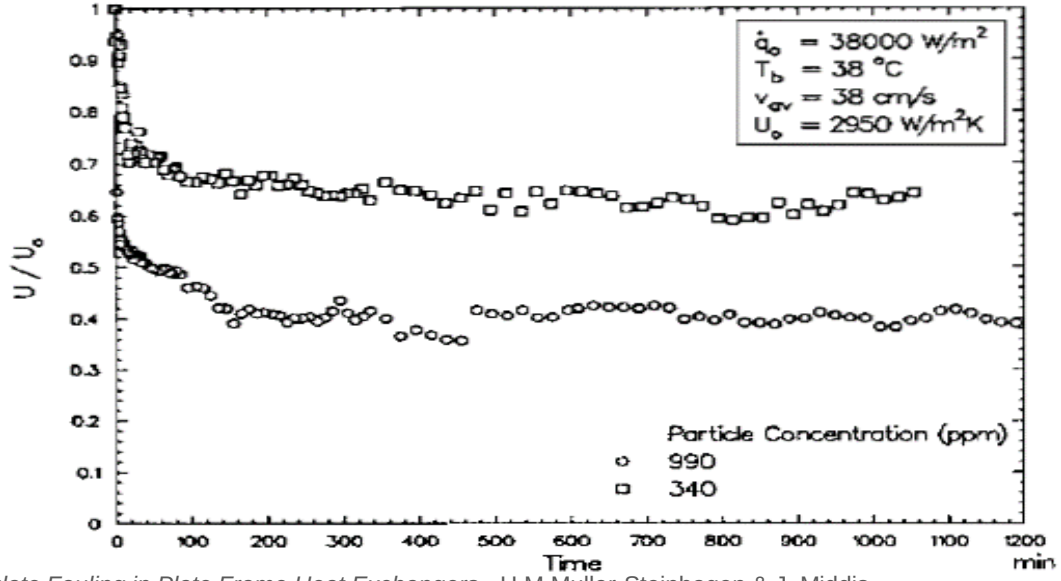
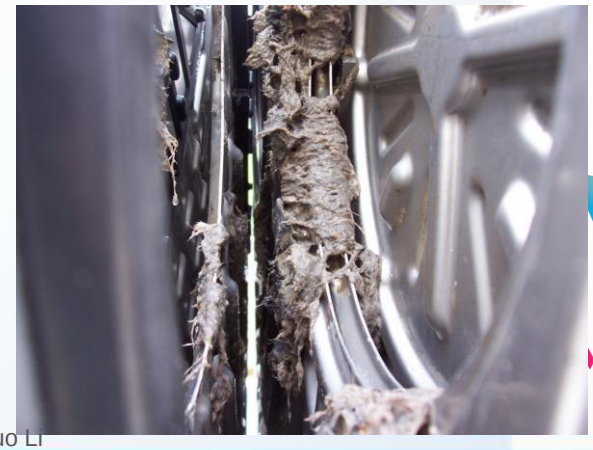
Wastewater and Sedimentary Flows

- Energy transfer is further reduced by sediment and particulate found in wastewater
- Conventional heat exchangers, including wide-gap plate frame HX, will need a high-pressure backflush to attempt dislodging particulate
  - Not all particulate can be flushed out resulting in decreased flows and reduced capacity
  - **60% Reduction** of Overall Heat Transfer Coefficient at 990ppm (wastewater is typically 6,400-7,800ppm)





Particulate Fouling in Plate Frame Heat Exchangers - H.M Muller-Steinhagen & J. Middis

Sewage Particulate Concentration Measurement Based on Image Processing Technology – Hui Lui, Shigan Yu, Linguo Li

5 HUBER ThermWin® System

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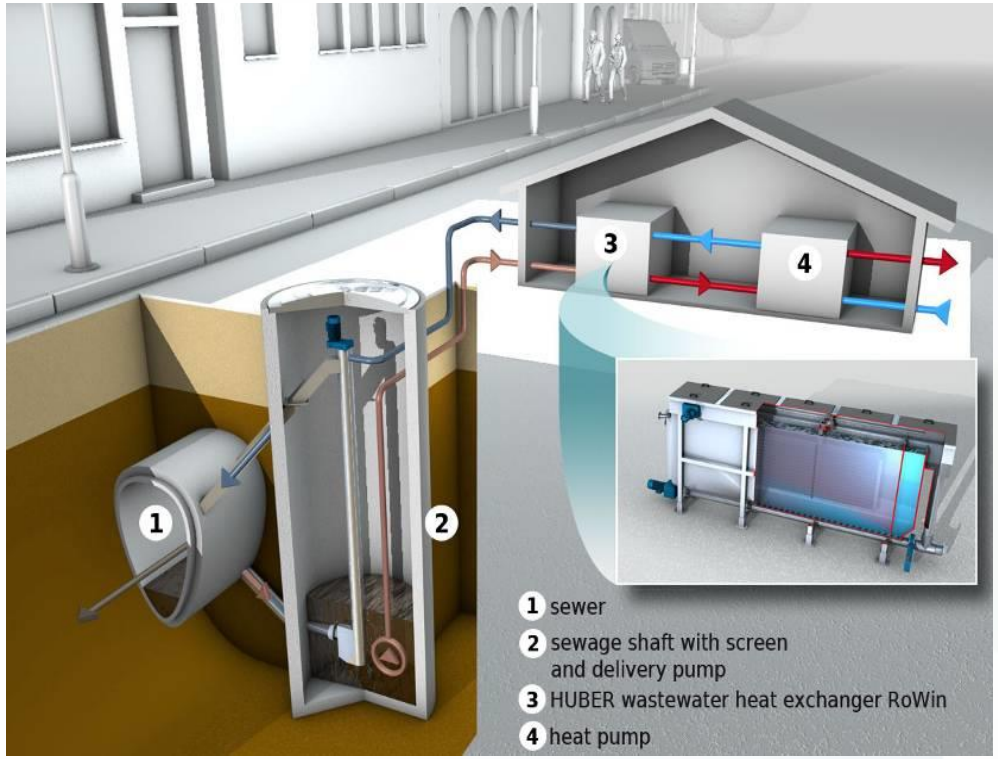
ThermWin® - How it Works

The utilization of energy from wastewater is accomplished with the HUBER ThermWin® system.



1. A portion of the raw sewage flows via gravity through an intake structure from the sewer into the wet well and the HUBER Pumping Station Screen, ROTAMAT® RoK4 that retains the coarse solids.
2. The solids retained by the screen are transported vertically upwards and returned to the sewer system.
3. The screened wastewater is lifted by a pump installed in the inlet structure and flows by gravity through the RoWin® heat exchanger installed above ground. This creates continuously stable hydraulic conditions and ensures a controlled heat transfer. In the HUBER RoWin® Heat Exchanger the heat energy is transferred to a cooling medium (normally water) which transports the energy to a heat pump.
4. The cooled wastewater flows back to the sewer taking along the screenings separated by the HUBER Pumping Stations Screen ROTAMAT® RoK4.

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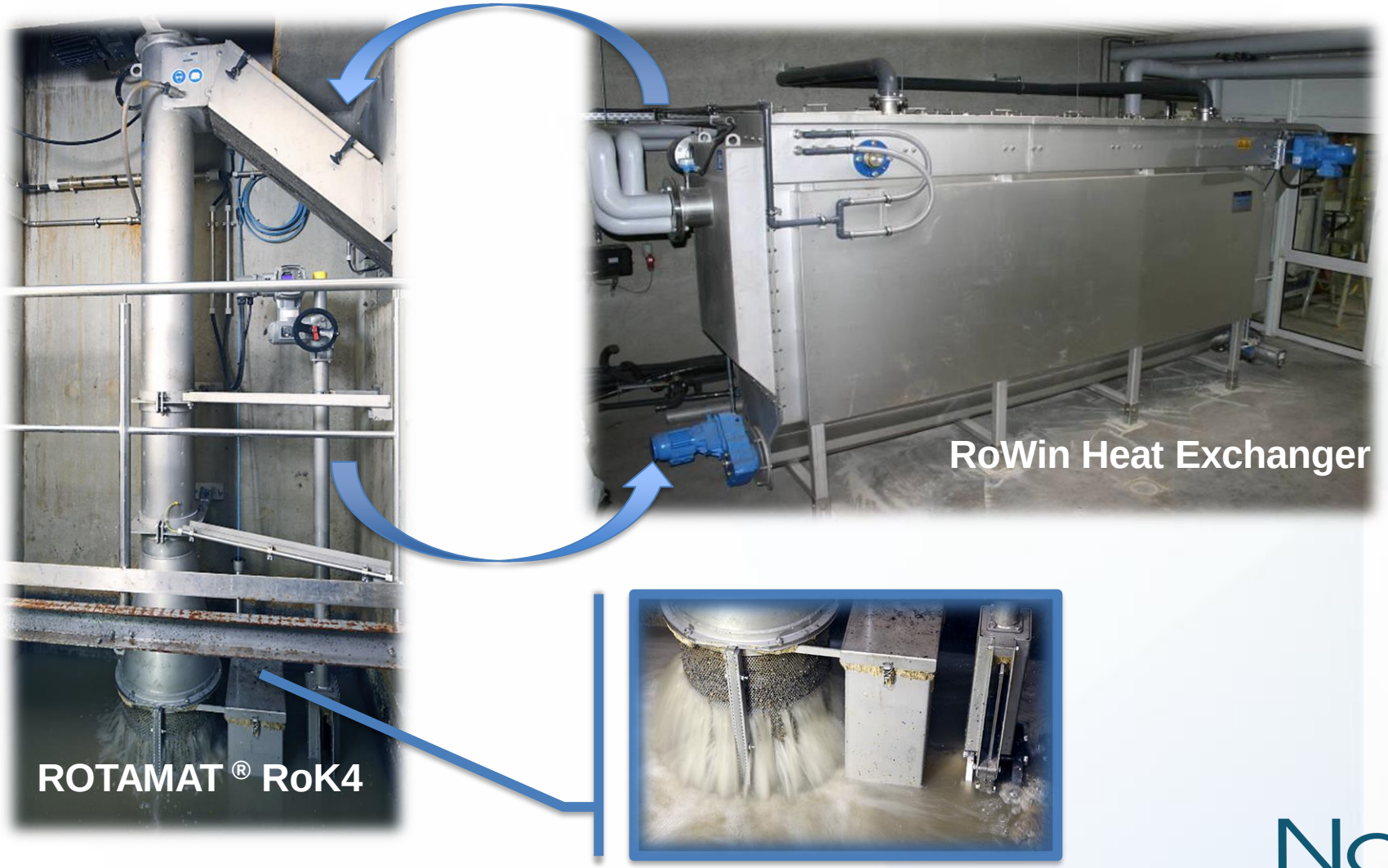
HUBER ThermWin® System



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- Vide

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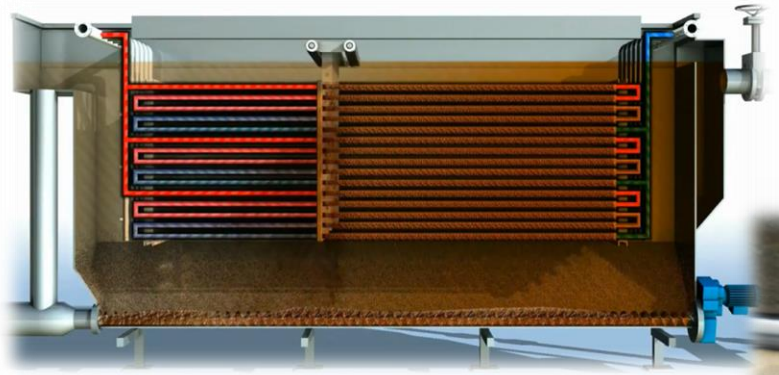
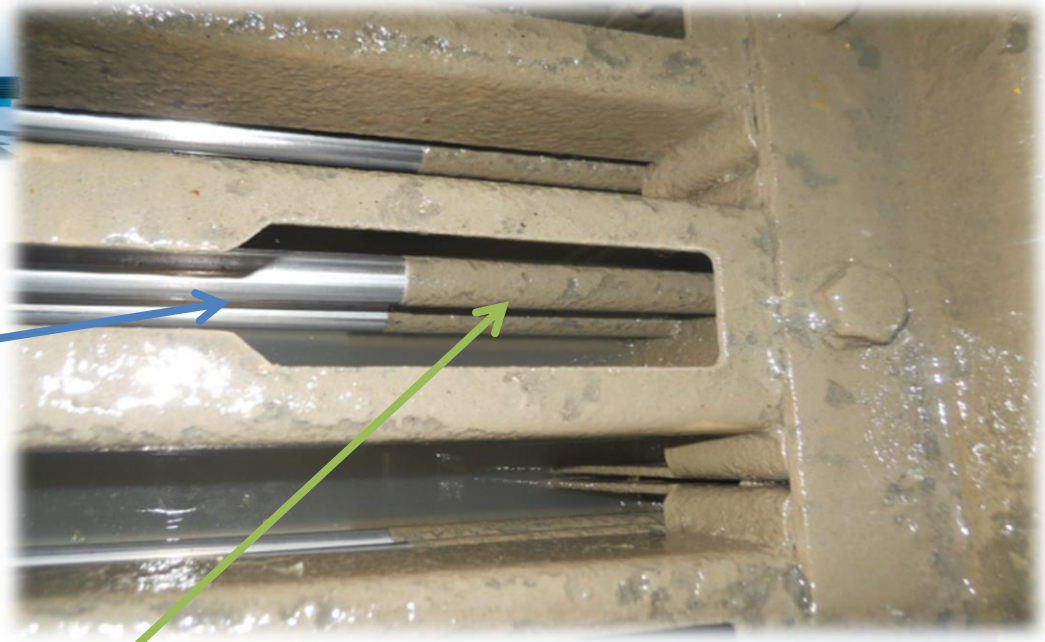
Patented Self-Cleaning System





Clean heat exchanger surface

Dirty heat exchanger surface

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6 TRANE Heat Pumps

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Lukas Glaspell

Trane Account Executive

Specialize in sustainable and efficient designs and solutions

Personal:

I get outside and explore Nature

Cross Country skiing

Hockey

Hiking

Canoe trips

Positioned to Meet Global Challenges

We are addressing: Carbon Emissions, Food Loss, and Achieving Diversity

Our 2030 Commitments

Gigaton Challenge

Reduce customer carbon footprint by **1 gigaton***

- ✓ Accelerate clean technologies that heat and cool buildings in sustainable ways
- ✓ Increase energy efficiency in buildings, homes and transport environments
- ✓ Reduce food loss in the global cold chain
- ✓ Transition out of high-Global Warming Potential Refrigerants by 2030 – ahead of regulation
- • Design systems for circularity
- • Increase access to cooling and fresh food

*1B metric tons of CO_2e

Leading by Example

- • Achieve carbon neutral operations
- • Deliver zero waste to landfills
- • Become net positive with water use
- • Reduce absolute energy consumption by 10%†

†Compared to 2019 baseline

Opportunity for All

- • Achieve workforce diversity reflective of our communities
- • Achieve gender parity in leadership roles
- • Maintain world-class safety metrics
- • Provide market-competitive wages, benefits and leading wellness offerings for workforce
- • Invest $100 million in building sustainable futures for under-represented students
- • Dedicate 500,000 employee volunteer hours in our communities

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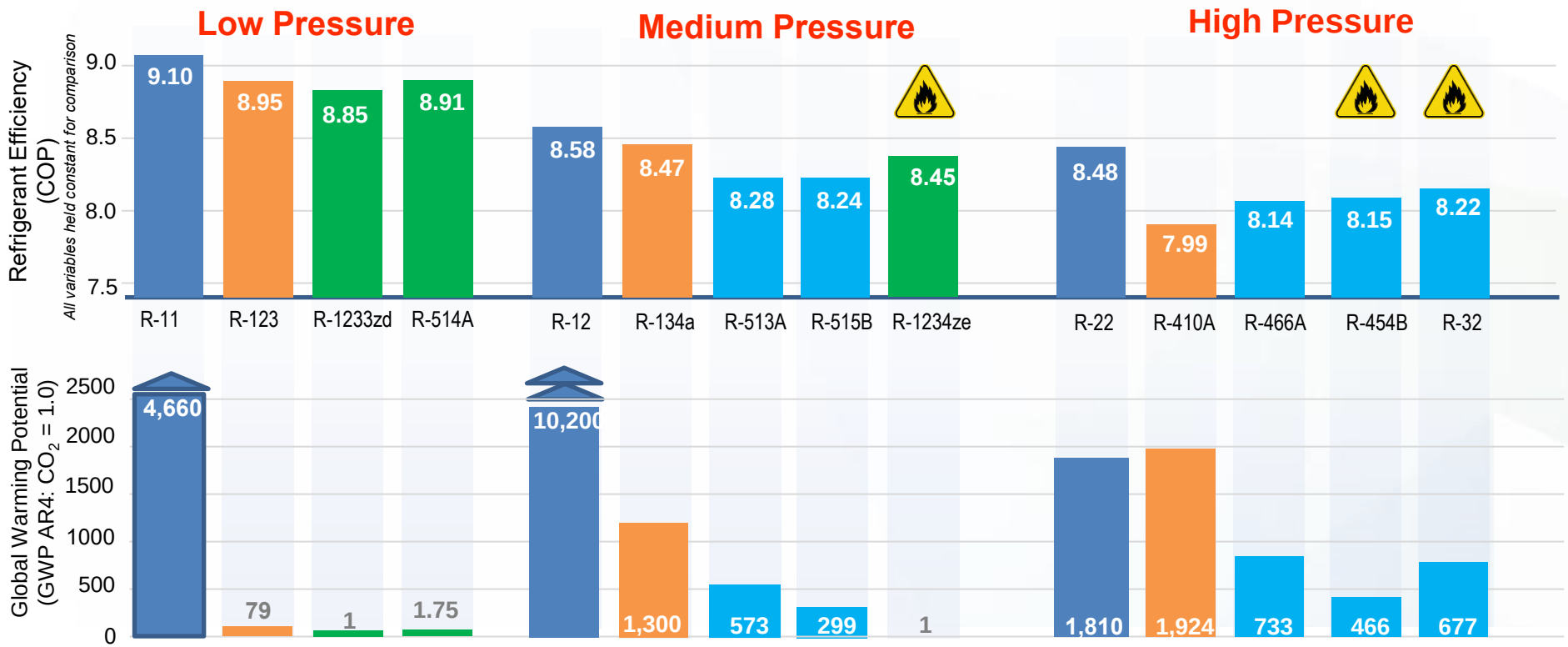
Efficiency and GWP Comparison

Past | Transitional | Lower GWP | Ultra-Low GWP



Industry choices offer options & trade-offs; New options evolving

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Existing Sites need Hotter water

- Designed around Higher water temperatures

- Reduce loop temperatures

Or

- Provide Higher temperature Heat pumps

- 180F (82C) Hot water supply

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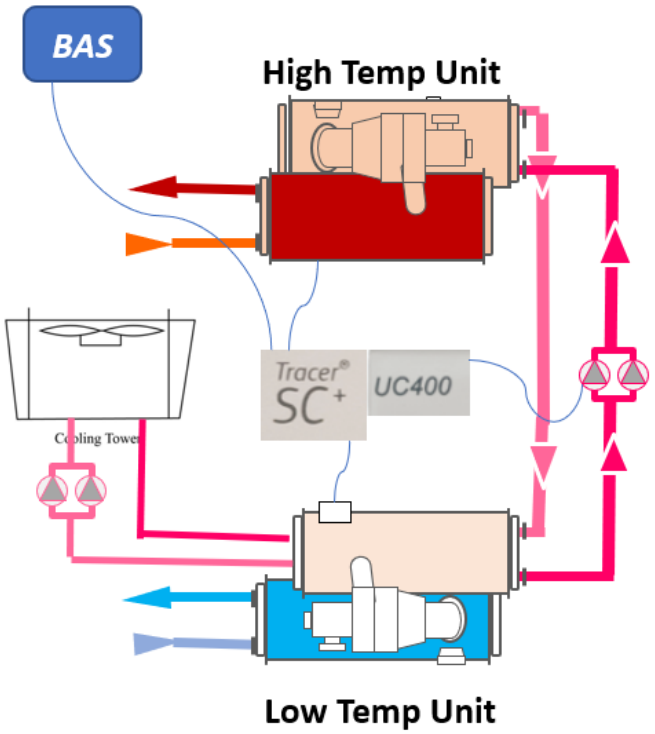
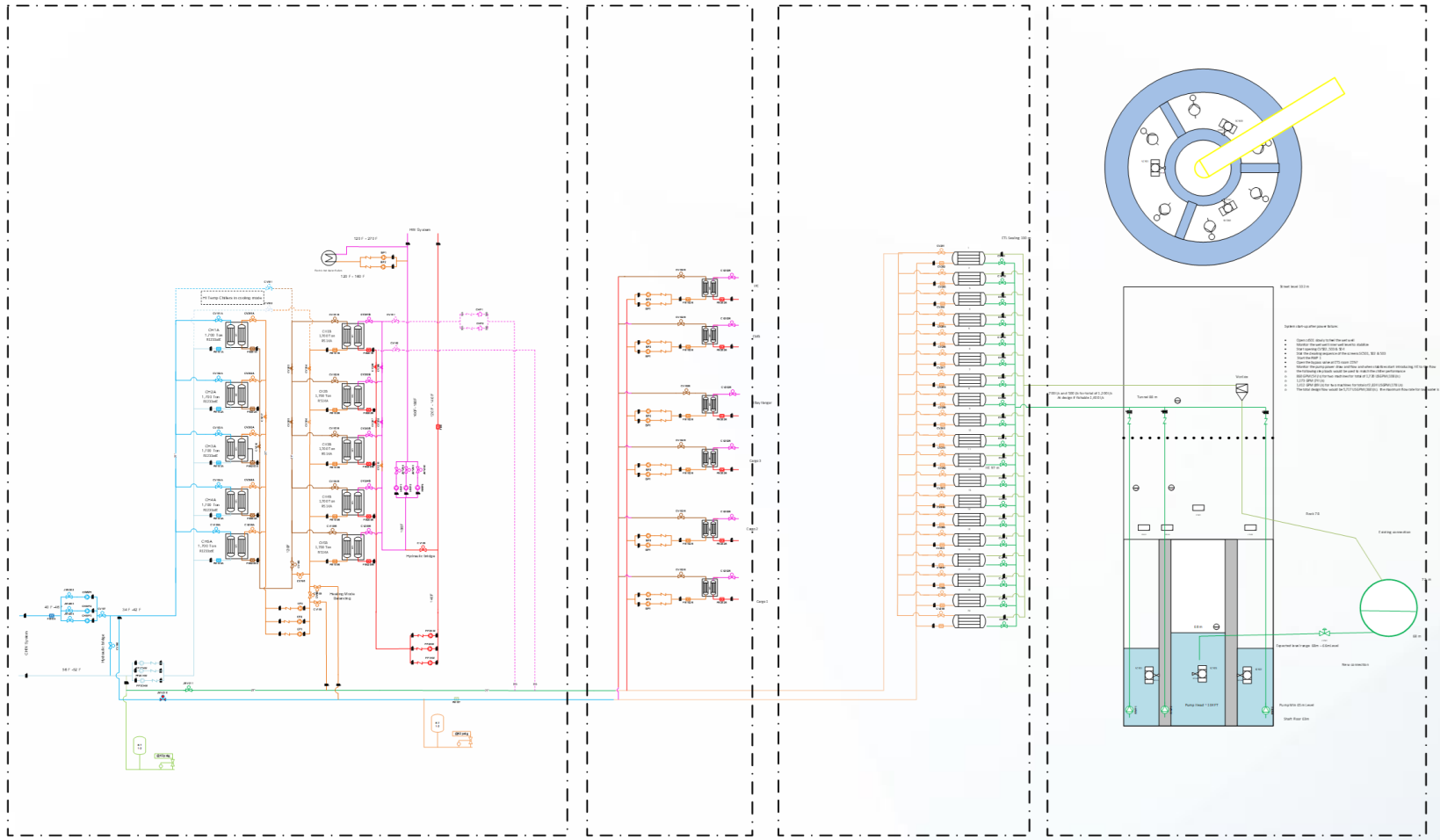
Water Sourced Heat Pump Cascade

- **WSHP Description**
  - **180F (82C) with a rejection chilled water loop as low as 35F (1.7C).**
  - Two Trane model CVHH heat pumps cascaded
  - Total heating supply of 2275 Tons (27,300 MBH) per system
- **Technology**
  - Low pressure and low GWP refrigerants R1233zd(E) and R514A,
    - 1 for LT Unit: R1233zdE
    - 2 for HT Unit: R514A
  - Each unit can be used as a regular **high efficiency** chiller during summer.
  - Some of the Highest efficiencies and temperatures on the market



High Temperature Plant Design Example



Central Plant

HTS

Wet Well

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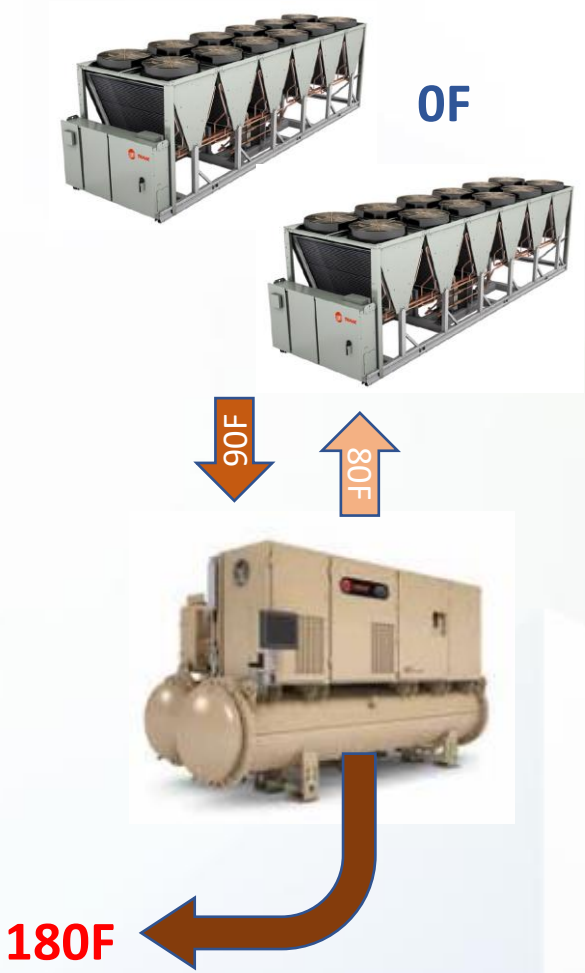
Air Sourced Heat Pump Cascade

- **ASHP Description**
  - **Produce 180F (82C) Hot Water when Ambient is 0F (-18C)**
  - Two ACX230 ASHP units with one HDWA400 booster.
  - R410A in ACX230 low temperature unit
  - R515B in HDWA high temperature unit
  - Total heating supply of 315 Tons (3780 MBH) per system
- **Technology**
  - Our market survey indicates no example of ASHP installation for 0F ambient to 180F hot water.
  - System integration flexibility into existing buildings with water side cascade
  - Each unit can be used as a regular **high efficiency** chiller during summer.



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What is coming in the Next 5 years?

- Extreme Higher temperature Heat pumps
  - Directly replace steam produced by conventional steam plants
  - Meet the demand of existing steam designed buildings that require steam for Humidification and heating loads

- Extreme Low temperature Ambient Heat pump compressors

- Noventa/Trane Wastewater Energy Transfer - more projects with Higher combined COP and high temperatures

- No need for carbon based fuels and boilers
  - With transition to high efficiency Hot Water Heat Pumps

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TRANE®

REDUCING THE ENERGY INTENSITY OF THE WORLD™

TRANE TECHNOLOGIES

"One company can change an industry and an industry can change the world."

– Mike Lamach, Executive Chairman

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7 Projects & Applications

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Applications

Hotels and Apartments

Public Institutions

Industrial / Breweries & Food Processing

Wastewater Treatment Plants

Hospitals

Swimming Pools

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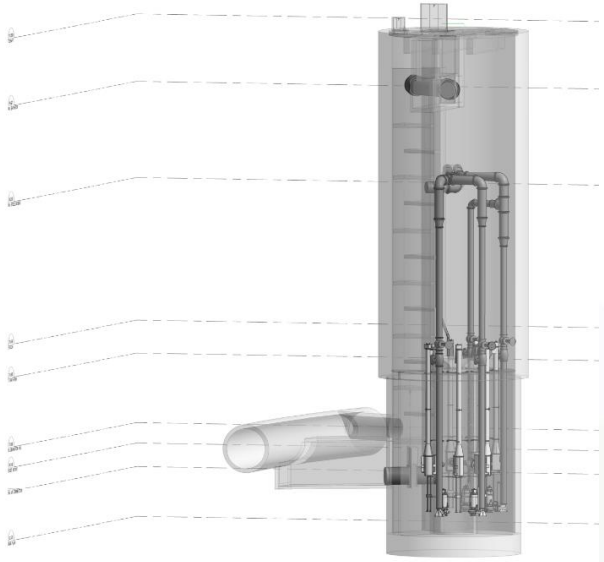
Toronto Western Hospital

Project	Description
Location	• Ontario Based Hospital
Project	• Multi-Phased Hospital - 1,500,000 sq.ft. • Over 120,000 MBH of Boiler Capacity • Over 6,800 Tons of Chiller Capacity
Description	• Integrate Low-Temperature Hot Water Loop while Maintaining Existing Infrastructure • Provide >90% of Annual Heating and Cooling Demand • Over 9.5MW of Heating and 9.5MW of Cooling from Wastewater
Energy Savings **GHG Reduction** **Water Saving**	• Approximately $485,000 Per Year • Over 8,400 Tonnes/year • Over 43,000 m^3/year



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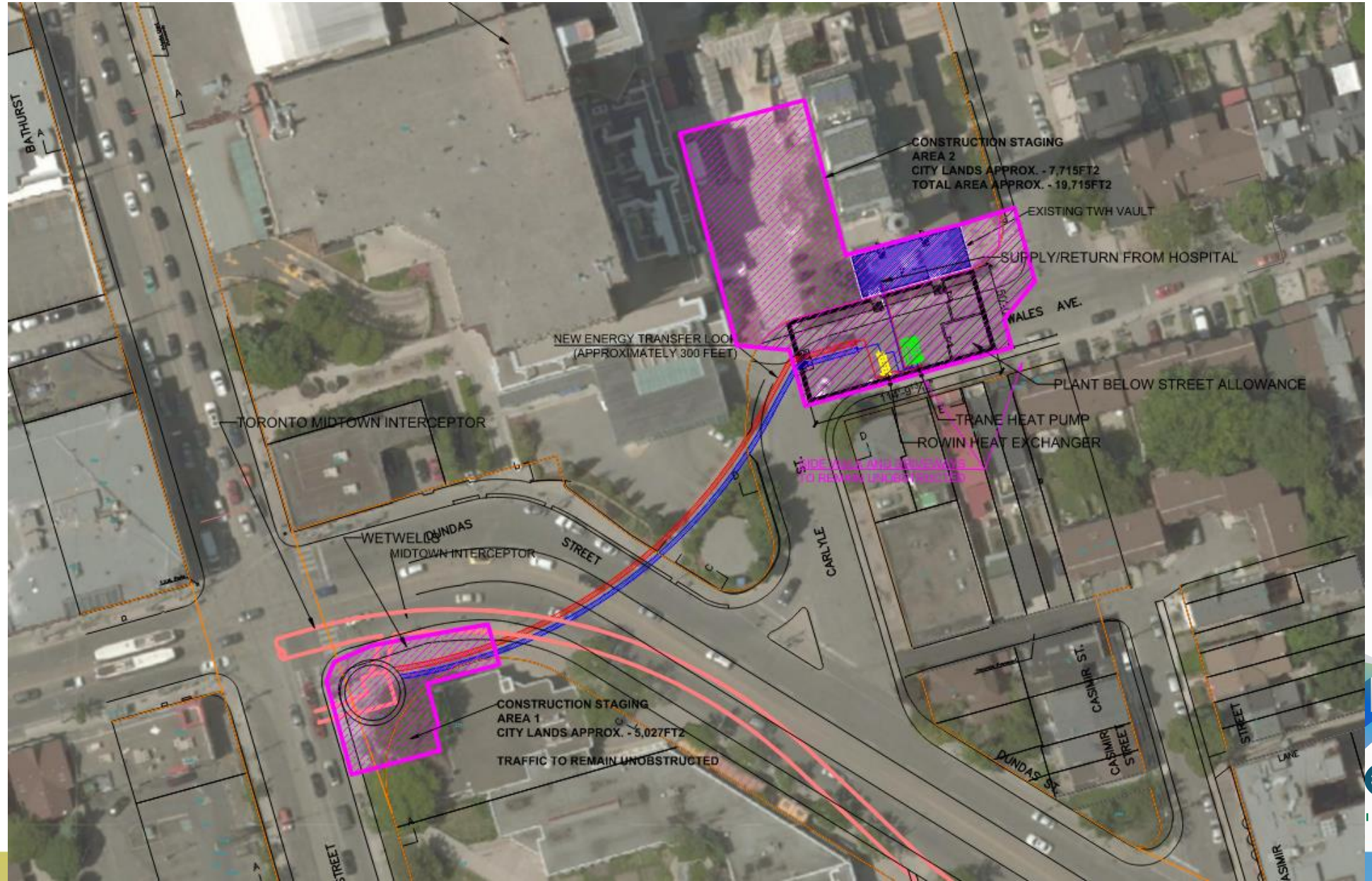
TWH – Project Overview



American Geophysical Union (AGU)

Project	Description
Location	• Washington D.C. • Operational since May 2018 • AGU has 60,000 members, 130 Countries
Project	• 7 storey structure and 62,000ft^2 of refurbished office space • Certified Net-Zero Building by the U.S. Green Building Council
Description	• RoK4-700 fine screen pumping station inserted in a shaft beside the sewer next to building (Sewer flow rate is 6,400 GPM) • 1 RoWin® BG 8 heat exchanger installed in building basement.
Energy Savings	• The system provides 480kW of heating & 840kW of cooling • Coefficient of Performance

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Residential Apartment Complex

Project	Description
Location	• Straubing, Germany
Project	• Low-rise apartment complex comprised of 11 buildings • Total units: 102 • In operation since 2010
Description	• A partial flow of wastewater (20 L/s) is taken from a main sewer running outside the apartment buildings. • 2x HUBER RoWin® Heat Exchanger extract up to 210 kW of thermal energy from the wastewater. • With Heat Pump COP of 5.0 we provide a heat output of approx. 260 kW.
Energy Savings	• Almost 386,000 kWh/a

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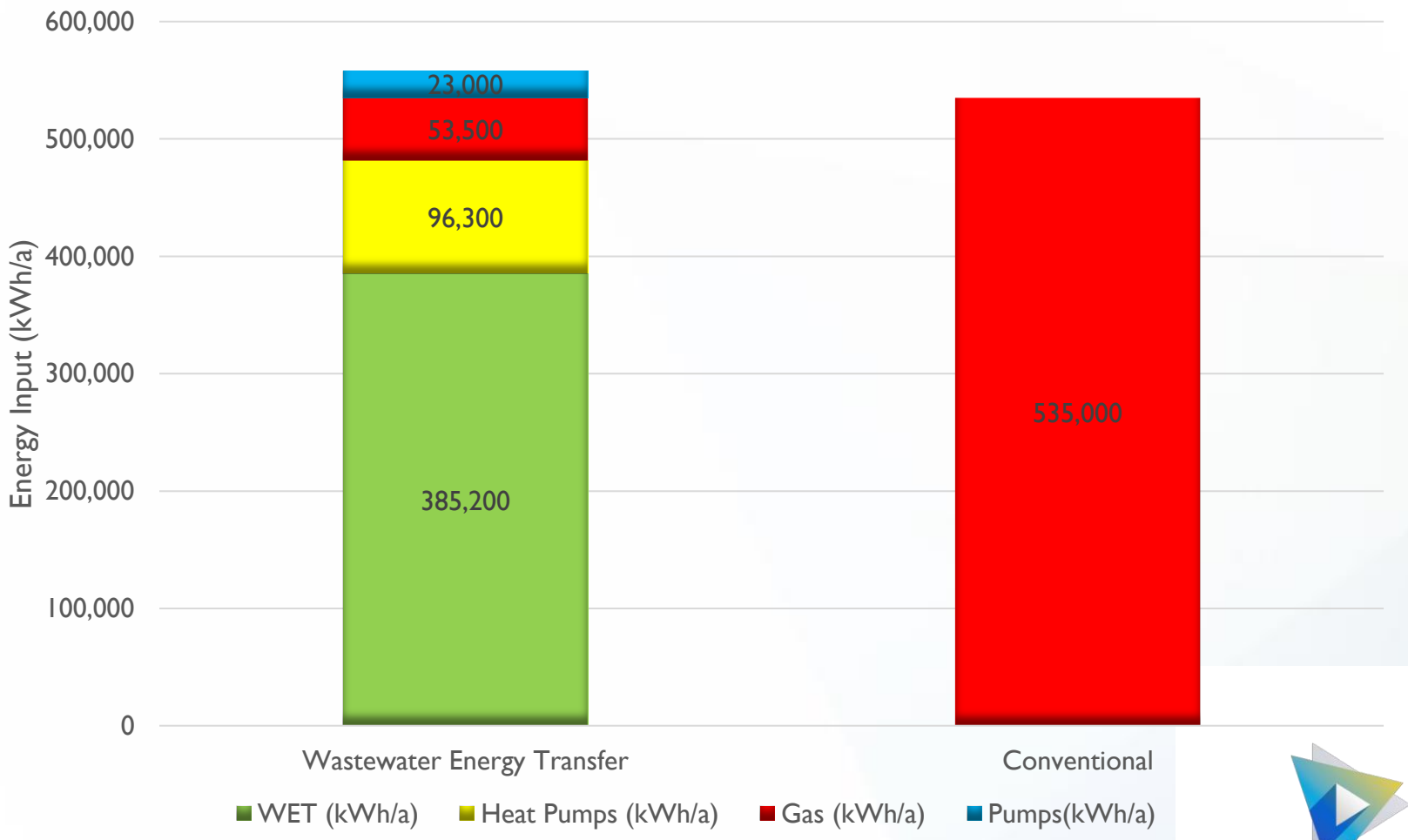
Straubing - Germany



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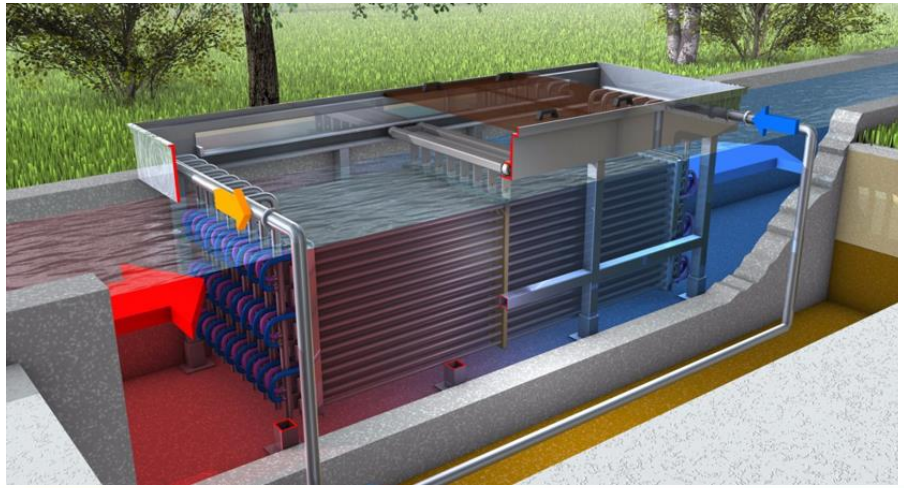
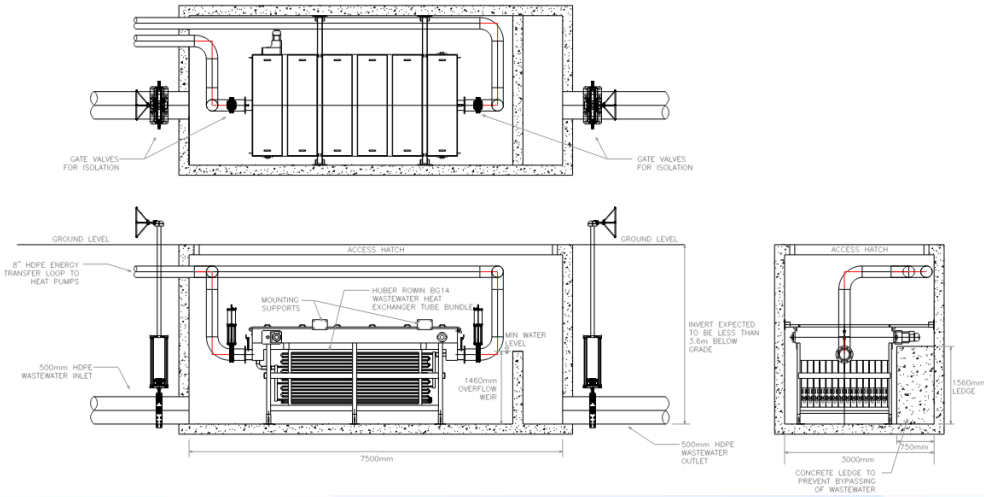
In-Channel Options

- The In-Channel options provides the same robust cleaning mechanism and manufactured for the harshest conditions
- Easy deployment in wastewater treatment plants or waterways
- Available in 4 different sizes





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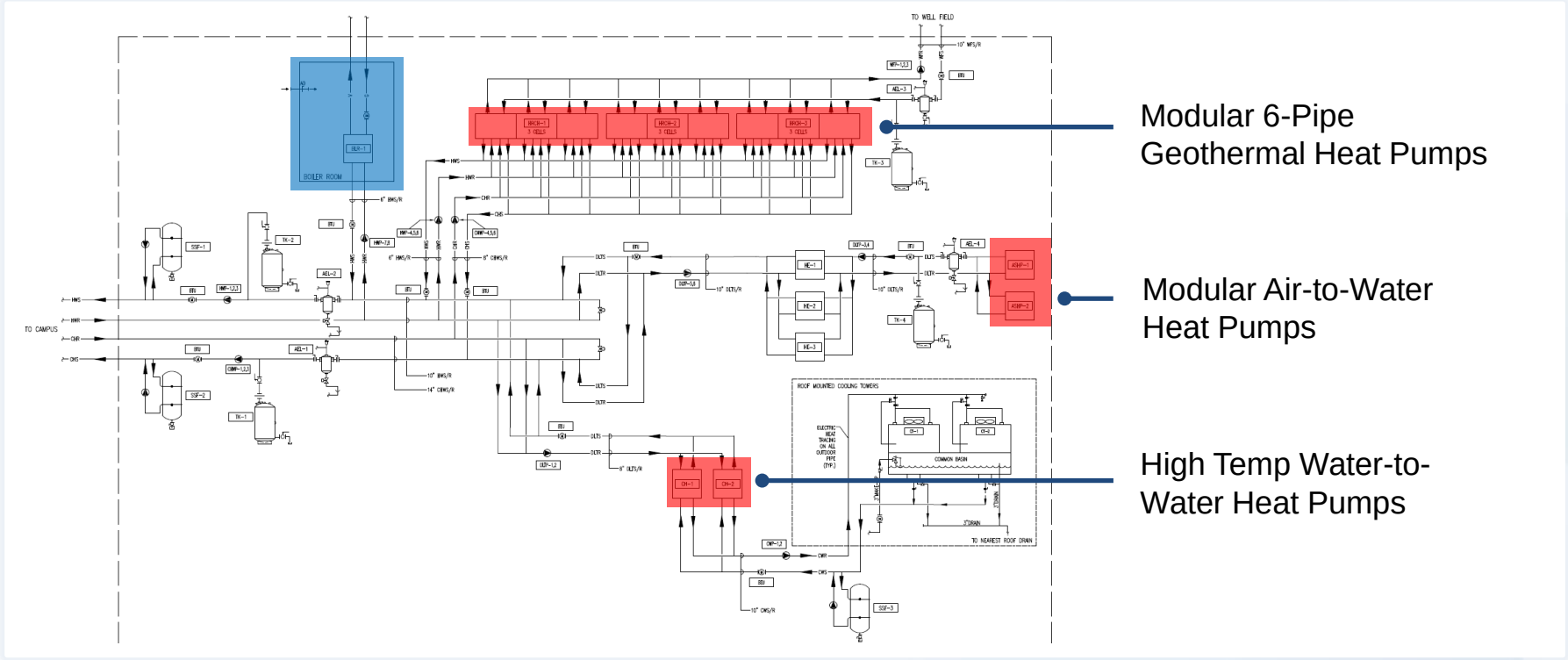
Design Example



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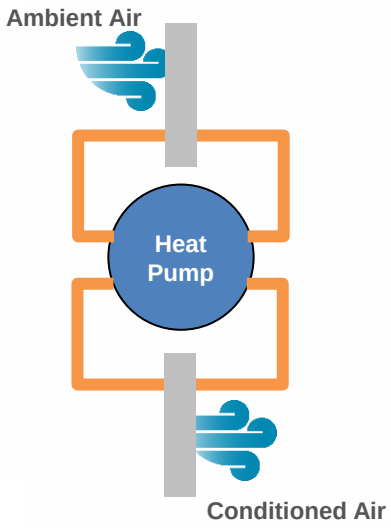
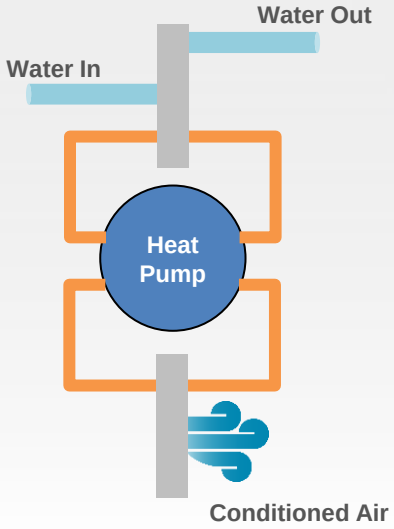
Heat Pump types

Air to Air



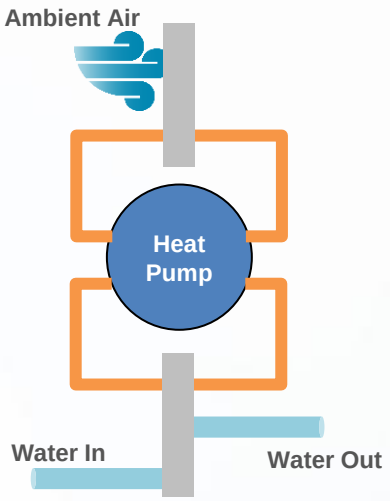
Example:
Rooftop Units
VRF

Water to Air



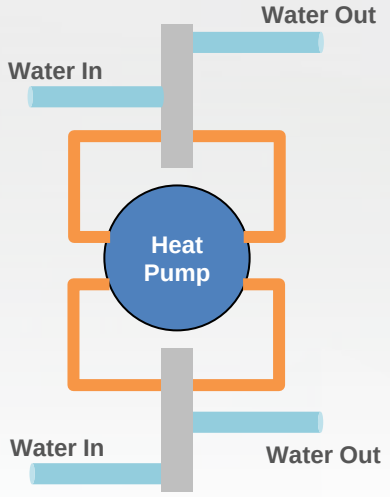
Example:
WSHP

Air to Water



Example:
Air-Source
Heat Pump Chiller

Water to Water



Example:
Water-Source
Chiller

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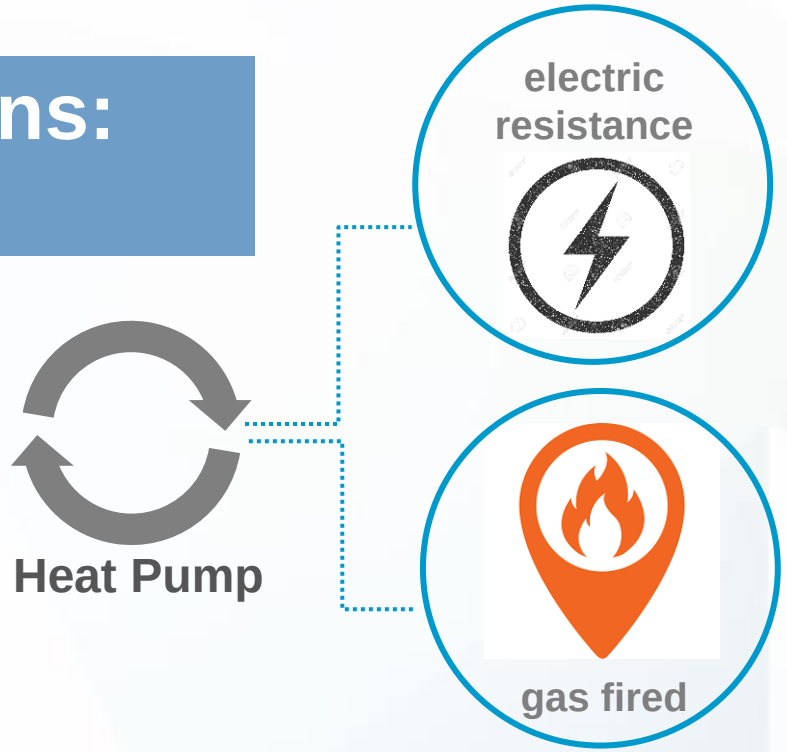
Heat Pump Considerations: Dual/Auxiliary Fuel



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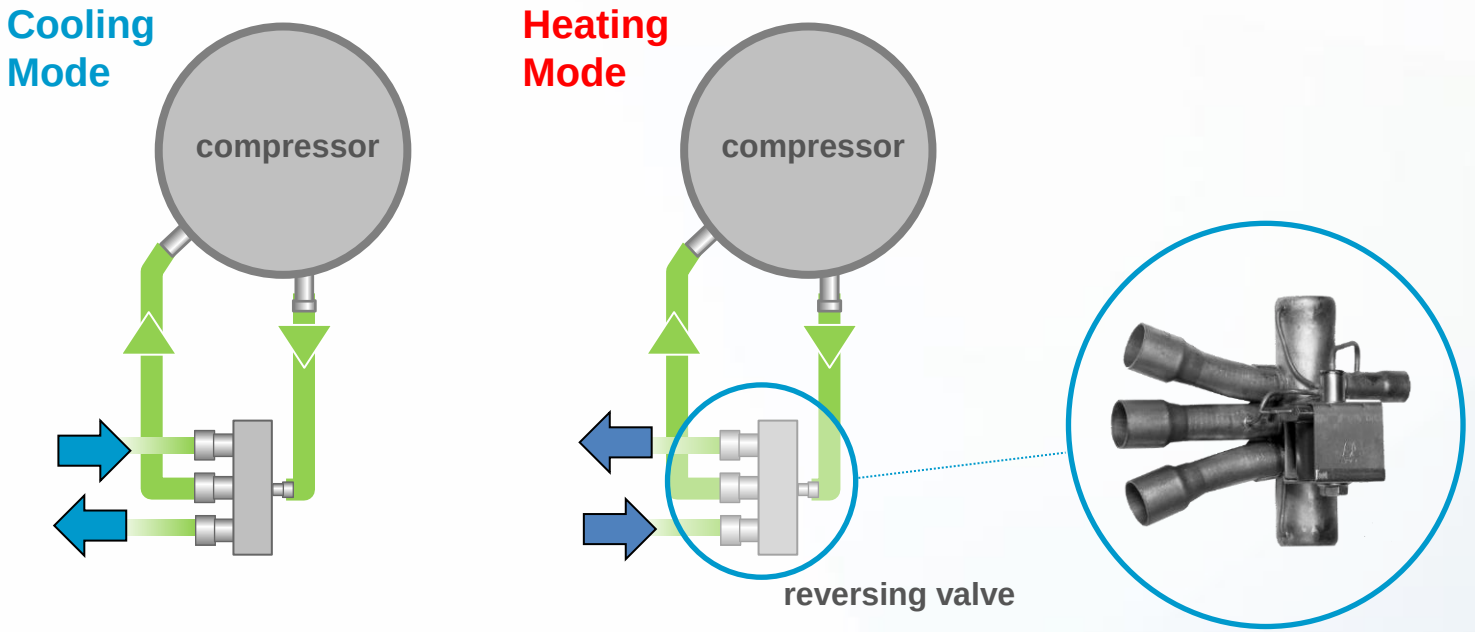
Heat Pumps



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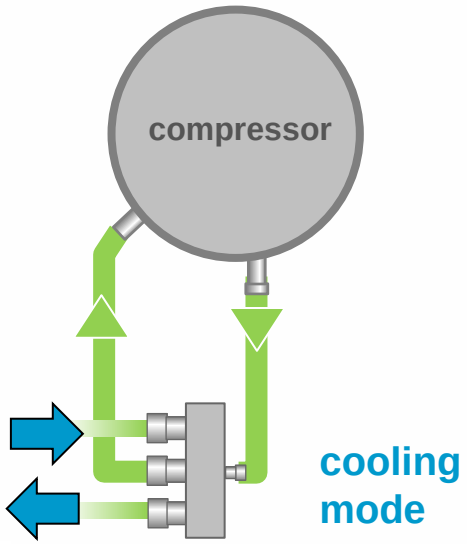
Heat Pump

Reversing valve (4-way)

- Heating or cooling
- Changeover



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Heat Pump

Reversing valve (4-way)

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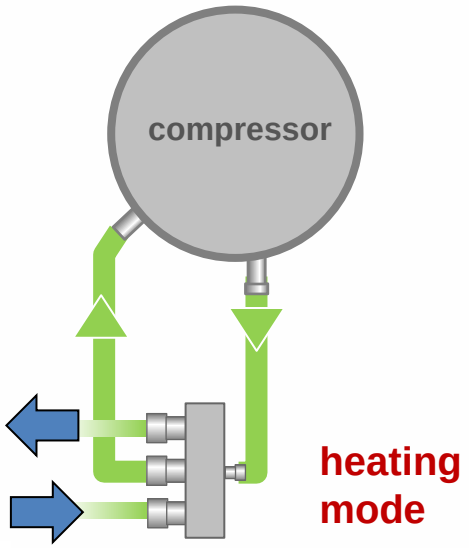

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Questions?

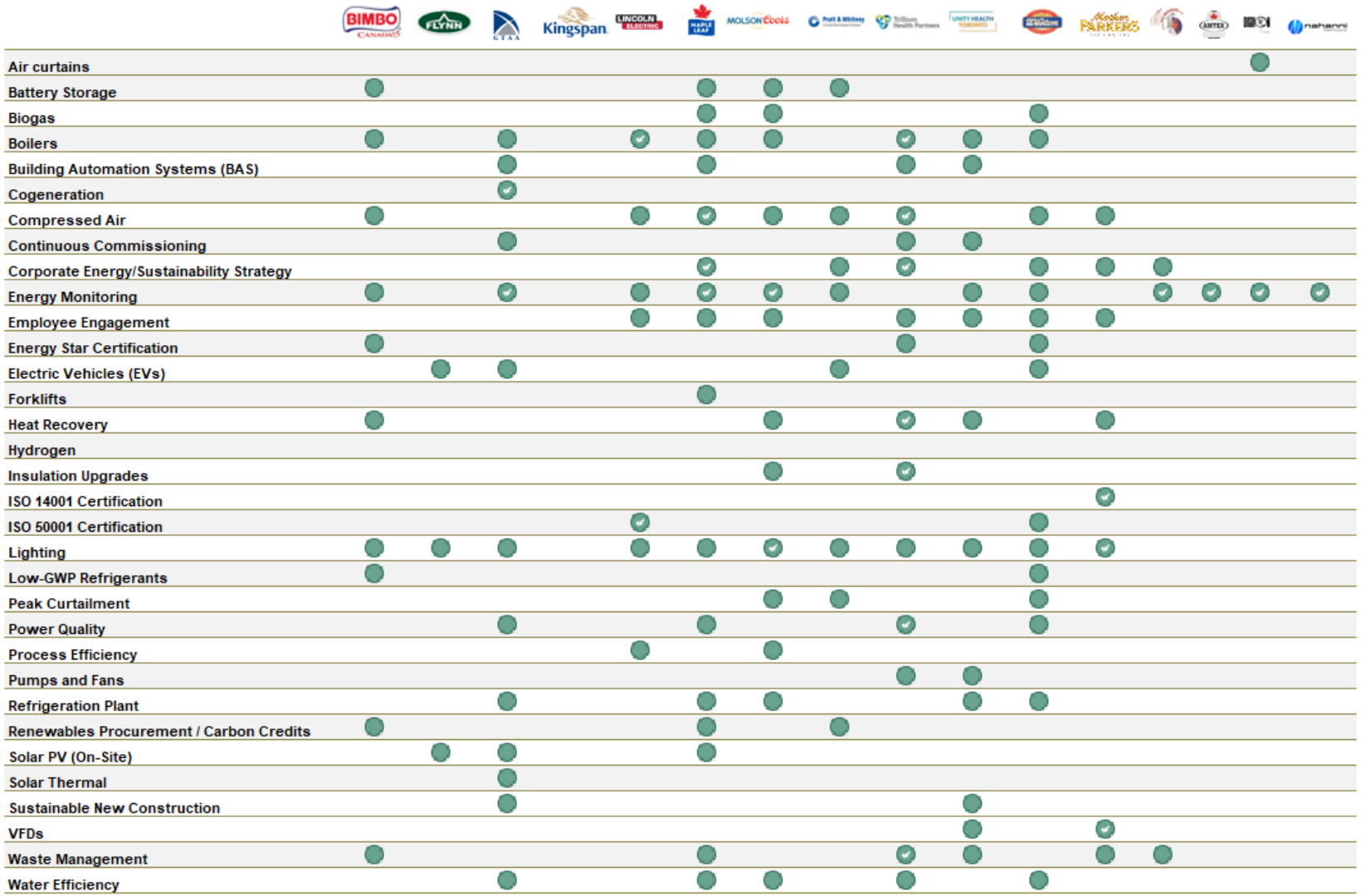
Toronto and Region Conservation Authority

Roundtable

2022 Projects

Toronto and Region Conservation Authority

Member Projects



Roundtable

- Update the group on recent **achievements**
- Relay **ongoing projects**
- Bring forward current **opportunities and challenges**

Thank You!

Toronto and Region Conservation Authority