Noventa®

INNOVATING TO DECARBONIZE OUR FUTURE™

Driving hospital efficiency, resiliency and decarbonization through low-temperature thermal networks.

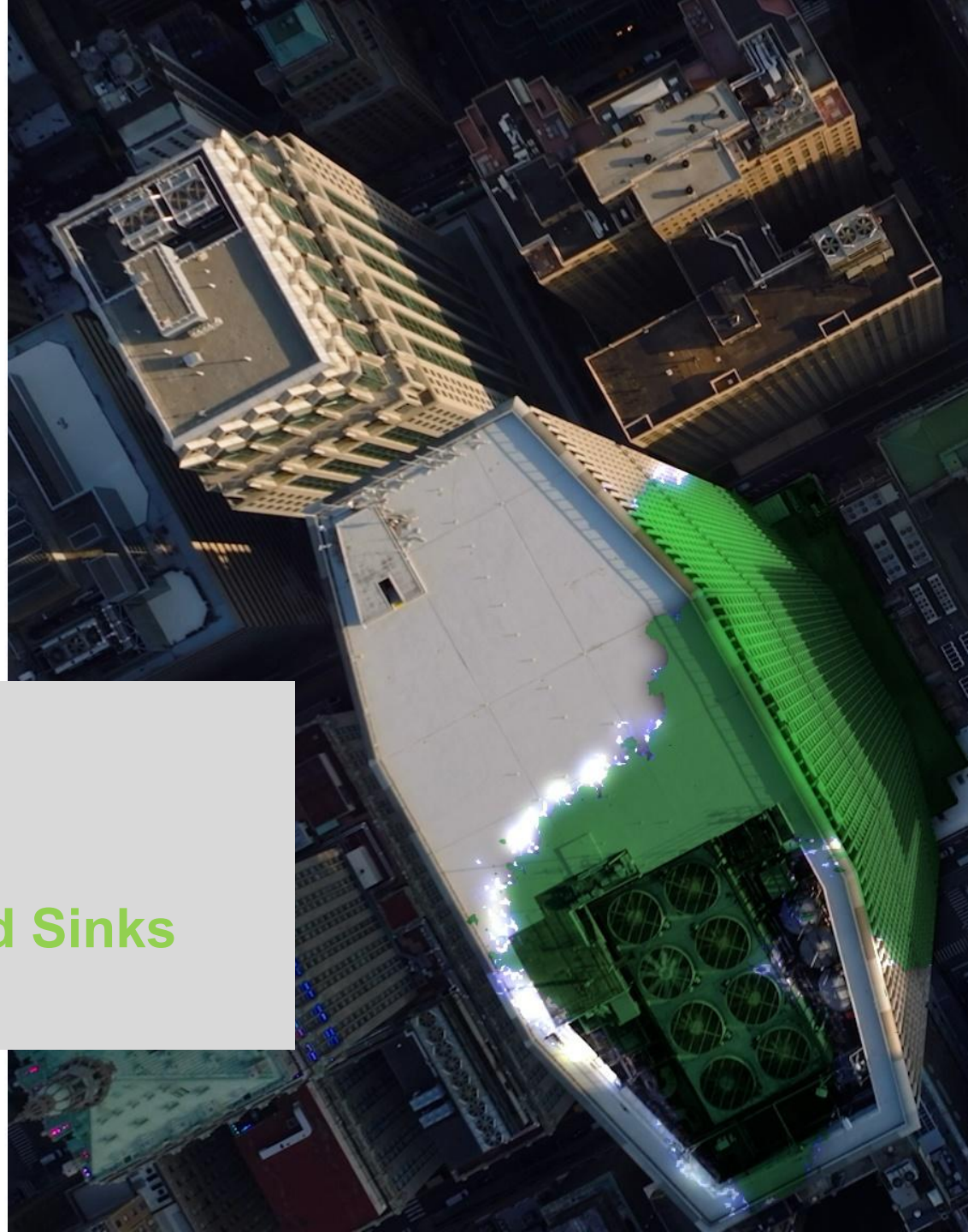
CHES Maritime Chapter Conference
May 5, 2025

Presentation Overview

- **Thermal Energy Networks (TENs)**
- **Wastewater Energy Recovery**
  - The opportunity
  - System overview
- **Toronto Western Hospital WET™ System**
  - The challenge
  - The solution
  - The payoff
  - Lessons learned

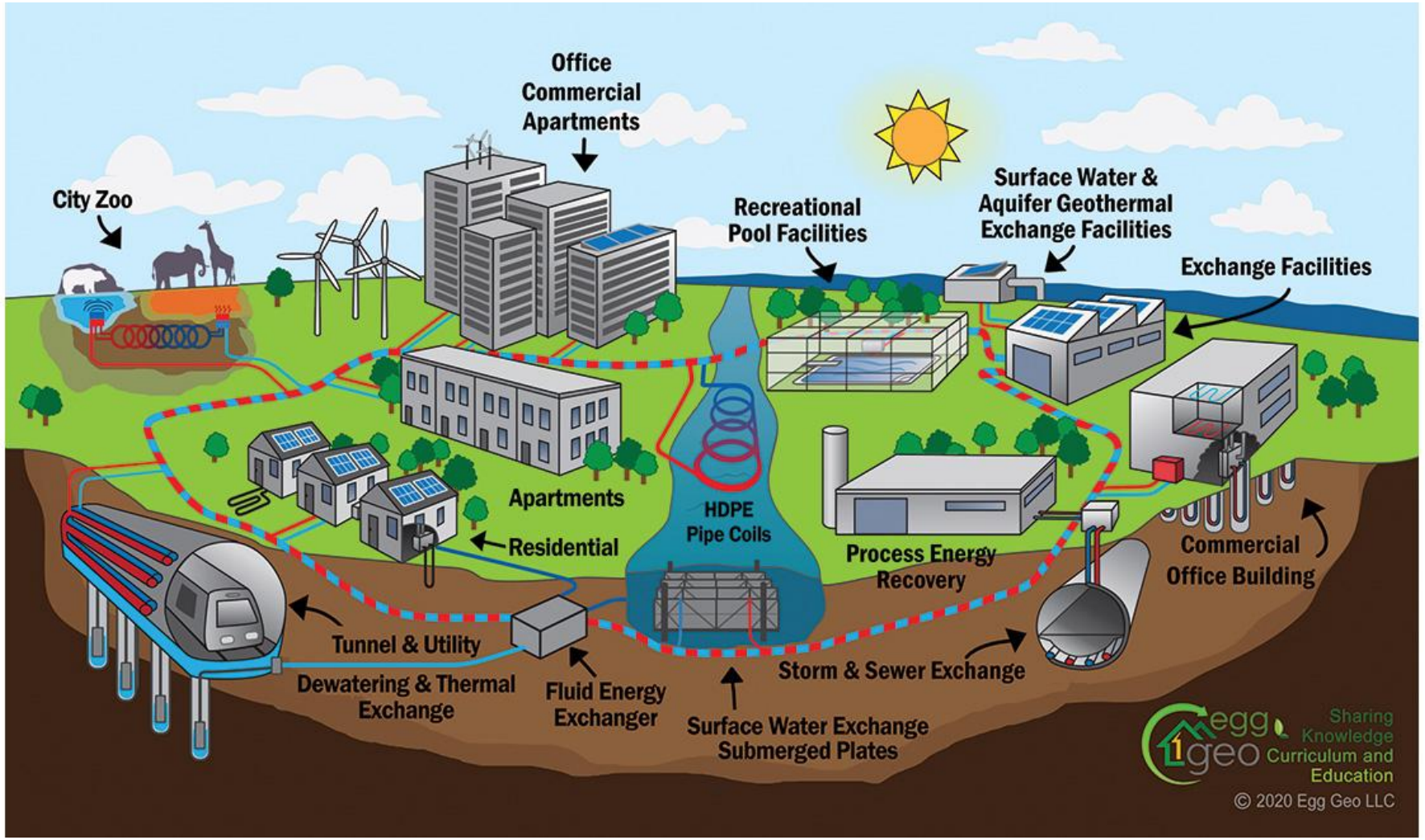
Thermal Energy Networks

An Integrated Network of Heat Sources and Sinks



Thermal Energy Networks (TENs)

An integrated network of heat sources and sinks



source: [Thermal Energy Networks for HVAC&W | Plumbing & Mechanical]

Thermal Energy Networks (TENs)

An integrated network of heat sources and sinks

Thermal Energy Network	Heating/Energy Characteristics
1st Generation	• steam (up to 200°C)
2nd Generation	• pressurized, superheated hot water (>100°C)
3rd Generation	• pressurized hot water (<100°C)
4th Generation	• even lower temperature hot water (70 - 90°C) • sometimes includes heating and cooling capability
5th Generation	• low temperature (10 – 30°C) ambient loop for simultaneous heating and cooling • each building has its own heat-pumps to extract/reject energy from/to the loop • able to use wider variety of decentralized heat sources

Wastewater Energy Recovery

The Opportunity

Wastewater Energy Recovery Potential

Wastewater – An Undertapped, Low-cost, Renewable Energy Source

145 billion litres/day

North American wastewater flow

Sanitary Sewers

- Predictable flow profiles
- Consistent temperatures year-round: 10°C to 25°C

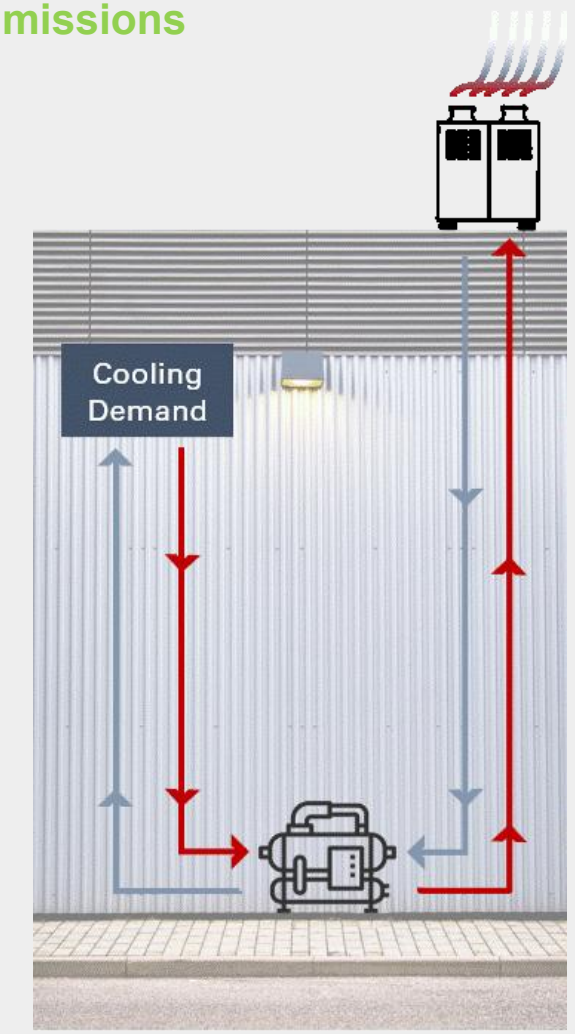
60 billion kWh available annually for every ± 1°C returned to sewer

Wastewater Energy for Cooling

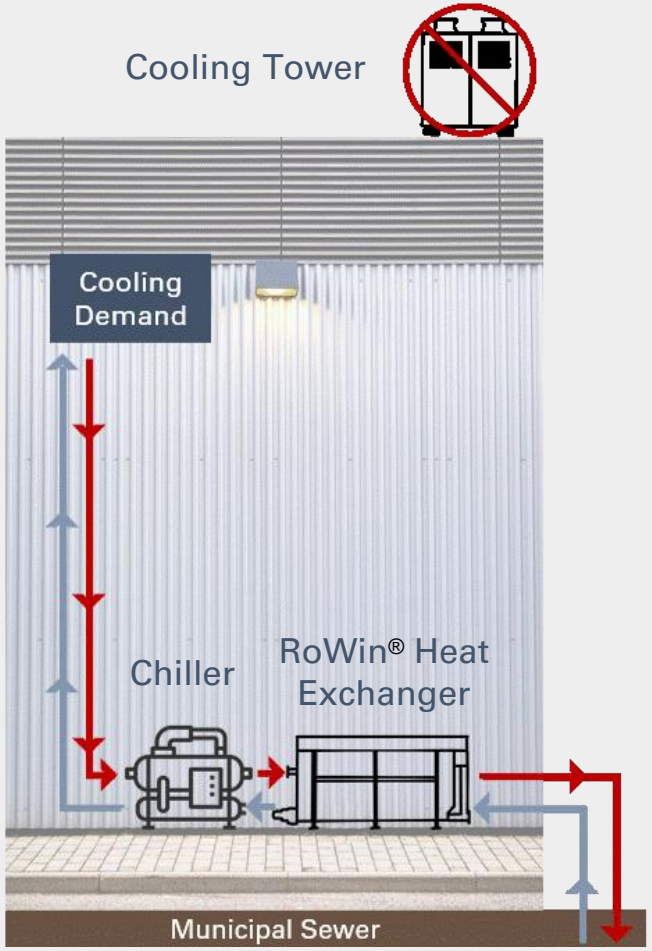
Efficient Cooling with Reduced Scope 2 GHG Emissions

Improved coefficient of performance (COP) as a result of heat rejection to wastewater.

Significant **water savings** realized from decreased or eliminated use of cooling towers.



Conventional cooling plant



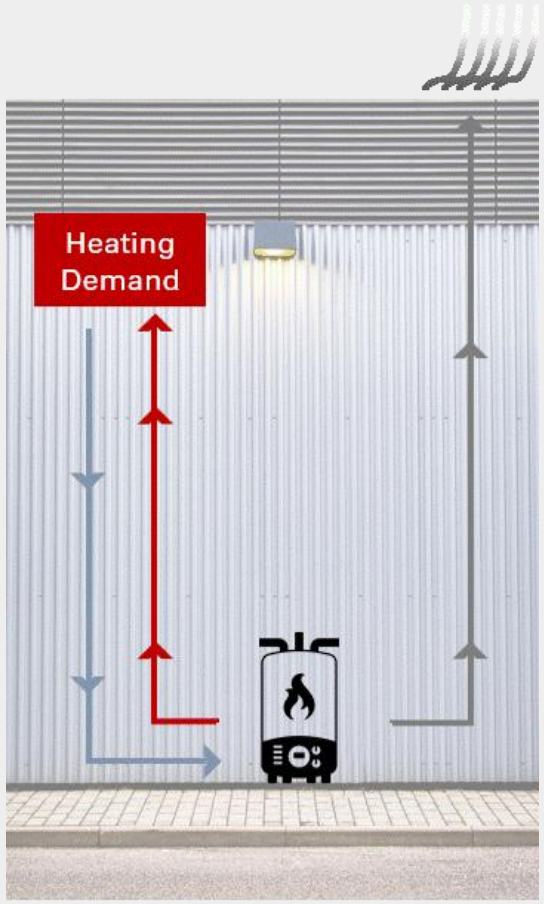
Cooling with wastewater

Wastewater Energy for Heating

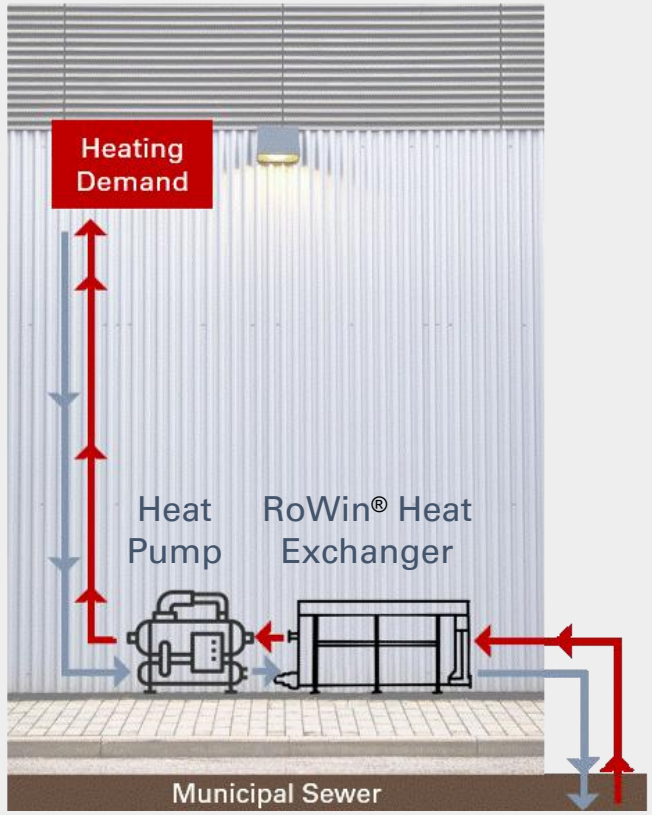
Low Carbon, Efficient Heating

Elimination or significant reduction in natural gas consumption from eliminated or decreased boiler plant use.

Improved COP/efficiency as a result of using wastewater as a heat source.



Conventional heating plant



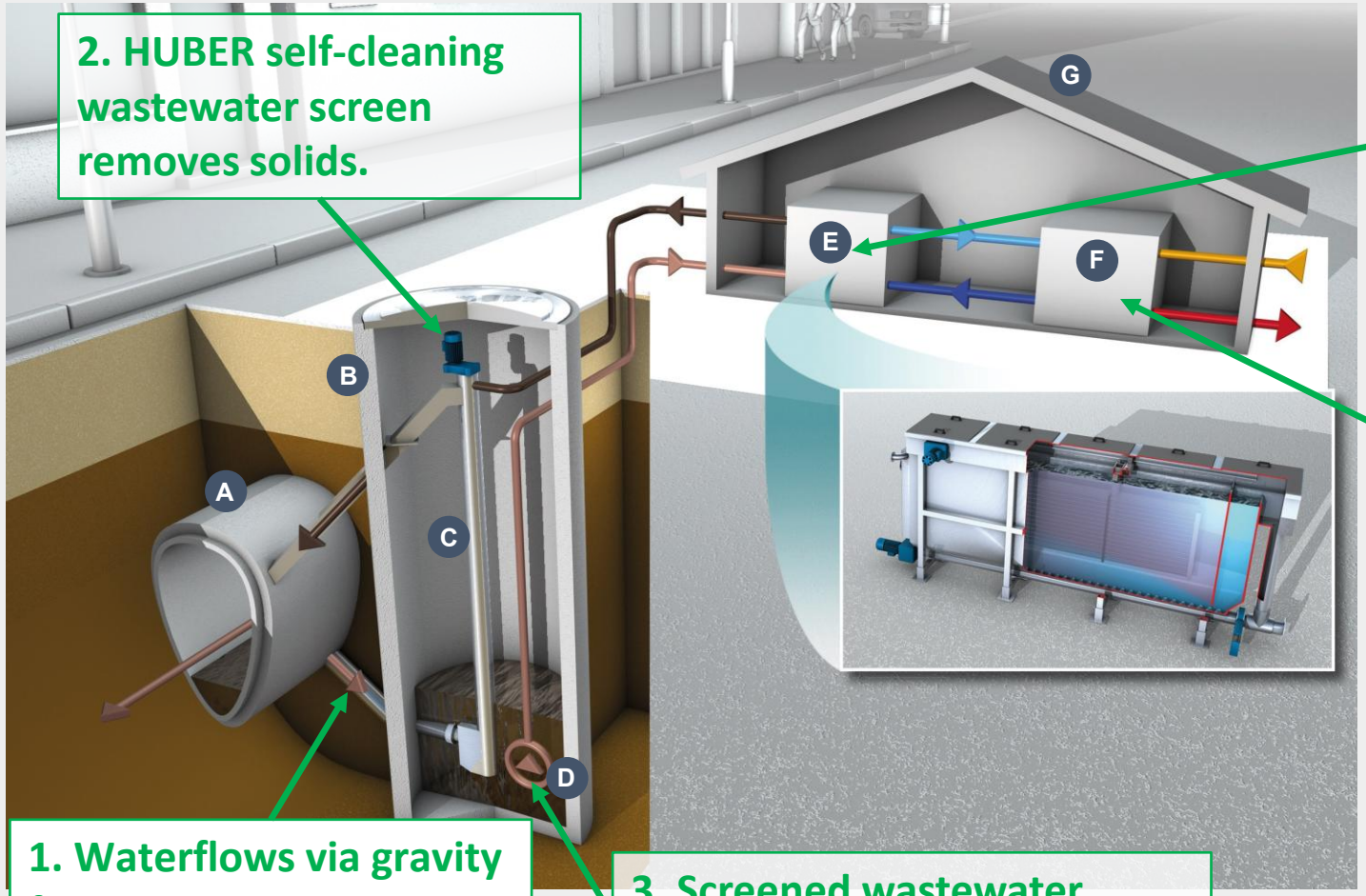
Heating with wastewater

Wastewater Energy Transfer™

System Overview

Noventa WET™ System Design

Typical Design Using HUBER ThermWin® Technology - Flexible, Scalable, Efficient



2. HUBER self-cleaning wastewater screen removes solids.

4. HUBER self-cleaning heat-exchangers extracts heat from wastewater and/or rejects heat into wastewater.

5. Heat-pumps generate hot-water, DHW, chilled water, etc. as required.

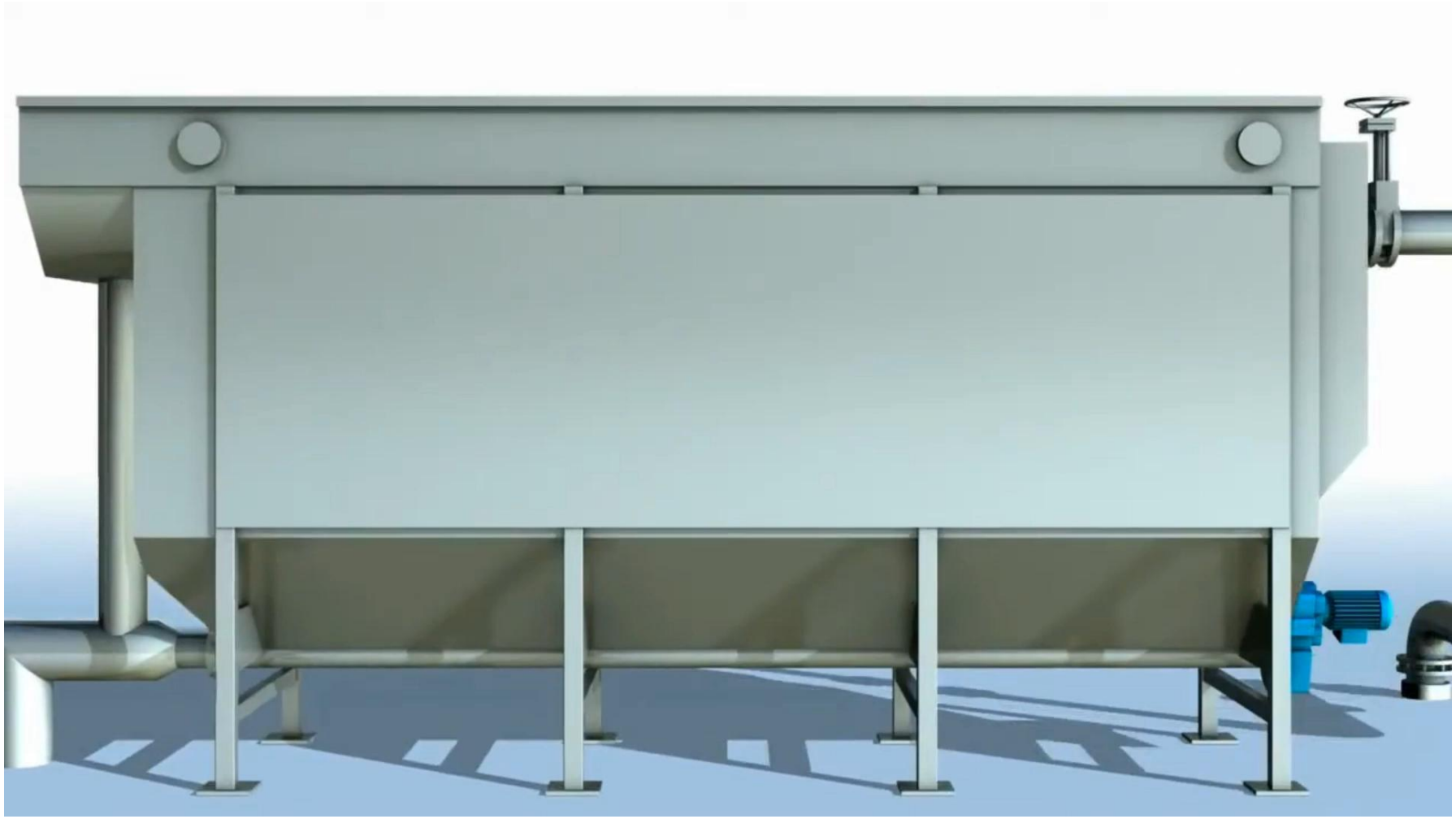
1. Waterflows via gravity from sewer into wastewater screen.

3. Screened wastewater pumped to heat-exchangers.

A) Sewer
B) Wetwell
C) HUBER self-cleaning RoK4 Wastewater Screen
D) Wastewater Pump
E) HUBER self-cleaning RoWin Heat Exchanger
F) Heat Pumps
G) Energy Transfer Station

Tapping The Potential of Raw Wastewater

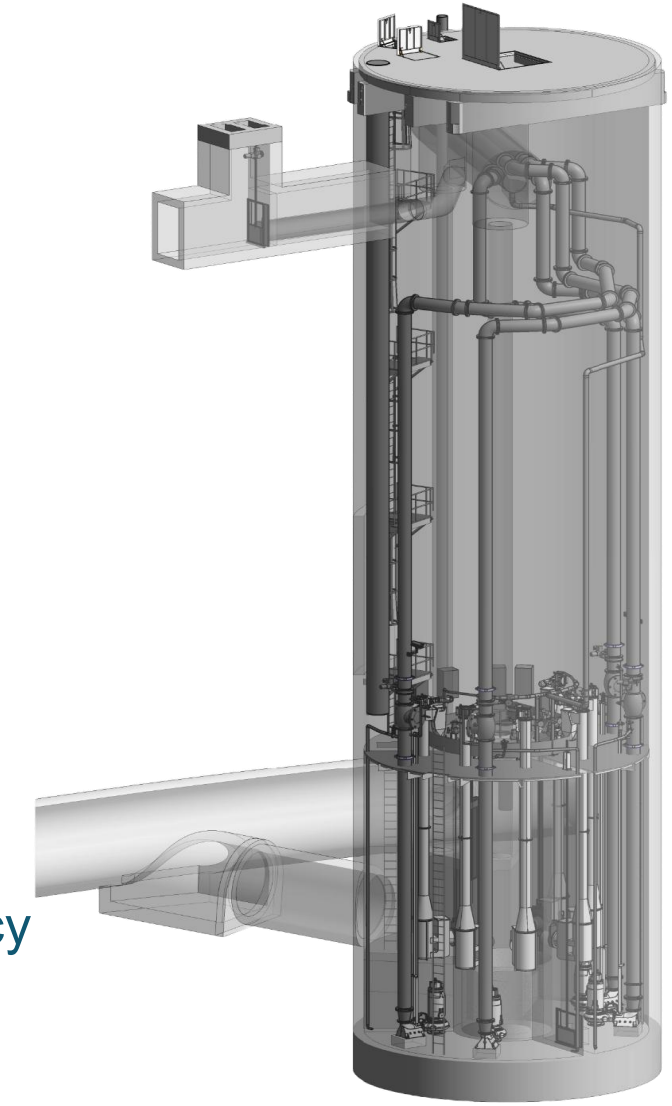
Video Demonstration



System Design

Flexible, Scalable, Efficient

- **Equipment available in a range of sizes and capacities**
  - Allows heat recovery from a broad range of wastewater flows, including “behind-the-meter”
- **Equipment can be installed modularly and in parallel**
  - Facilitates N+1 redundancy and future expansion
- **Equipment designed to handle raw sewage**
  - Provides flexibility in where wastewater energy is accessed
- **Easily integrated with other thermal energy sources**
  - Allows incorporation of a wide range of reliability and redundancy features to create a decentralized thermal network
  - E.g., thermal storage, geothermal, air-source heat-pumps, existing heating & cooling plants



Toronto Western Hospital WET™ System

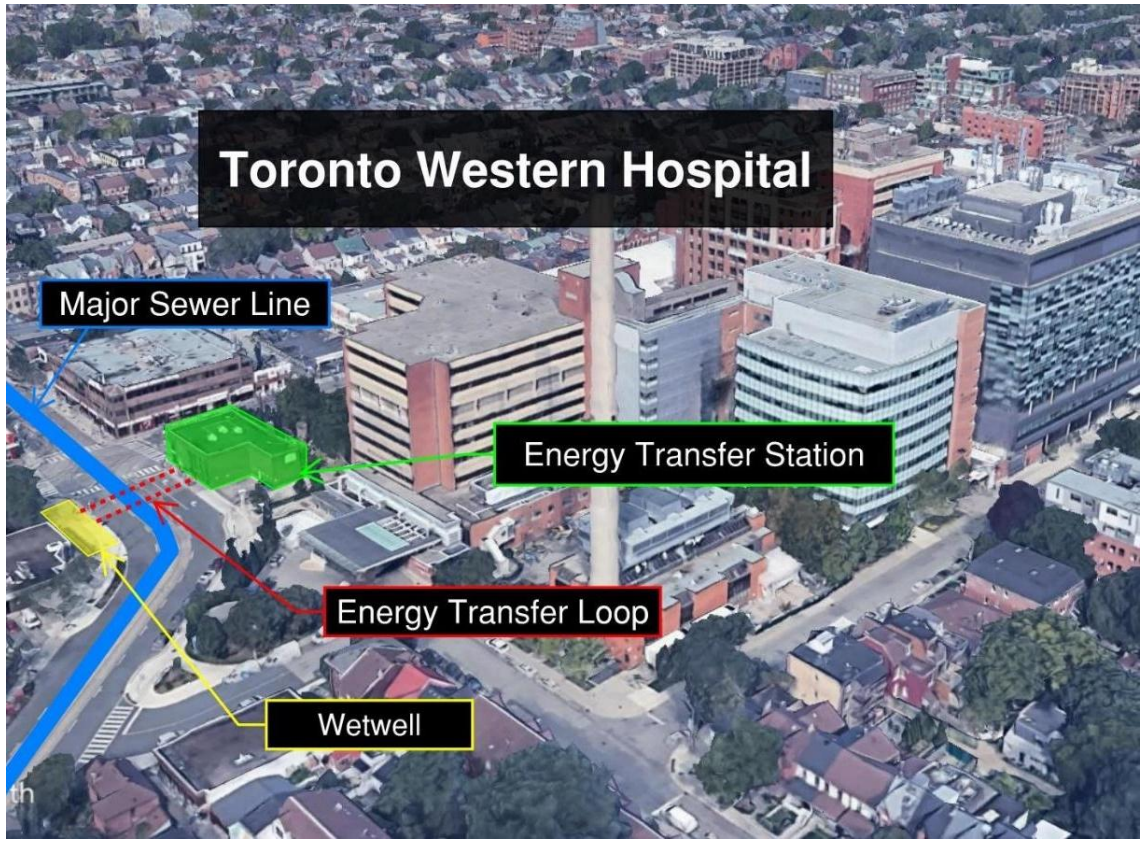
The Challenge

- ABCD

Toronto Western Hospital (TWH) Campus

Patient Care, Teaching & Research, In The Heart of a Busy City

- 5 wing hospital with varying building ages and *multiple* modifications over the year
- steam boilers and distribution system
- significant deferred maintenance backlog
- heating & cooling plant reliability and resiliency concerns
- limited decarbonization options



Toronto Western Hospital (TWH) Campus

Patient Care, Teaching & Research, and an Energy Efficiency Leader In The Heart of a Busy City

Rank	Hospital	Energy (ekWh/ft²)	Emissions (kg/ft²)
1	Humber River Hospital	34.0	2.9
2	Kingston Health Sciences: Kingston General Hospital	48.7	5.5
3	University Health Network: Toronto Western Hospital	53.9	6.8
4	London Health Sciences Centre: University Hospital	55.6	5.7
5	Unity Health: St. Michael's Hospital	55.7	5.9
6	Toronto Eastern Health network: Michael Garron Hospital	55.9	6.9
7	Children's Hospital of Eastern Ontario	56.6	6.3
8	Scarborough Health Network: Centenary Hospital	56.7	7.2
9	Hospital for Sick Children: Atrium	57.1	6.4
10	Windsor Regional Hospital: Metropolitan Campus	57.9	6.3

Source: Climate Challenge Network, 2023

https://greeninghc.com/event/energy-efficiency-rankings-of-ontarios-hospitals/

Toronto Western Hospital WET™ System

The Solution

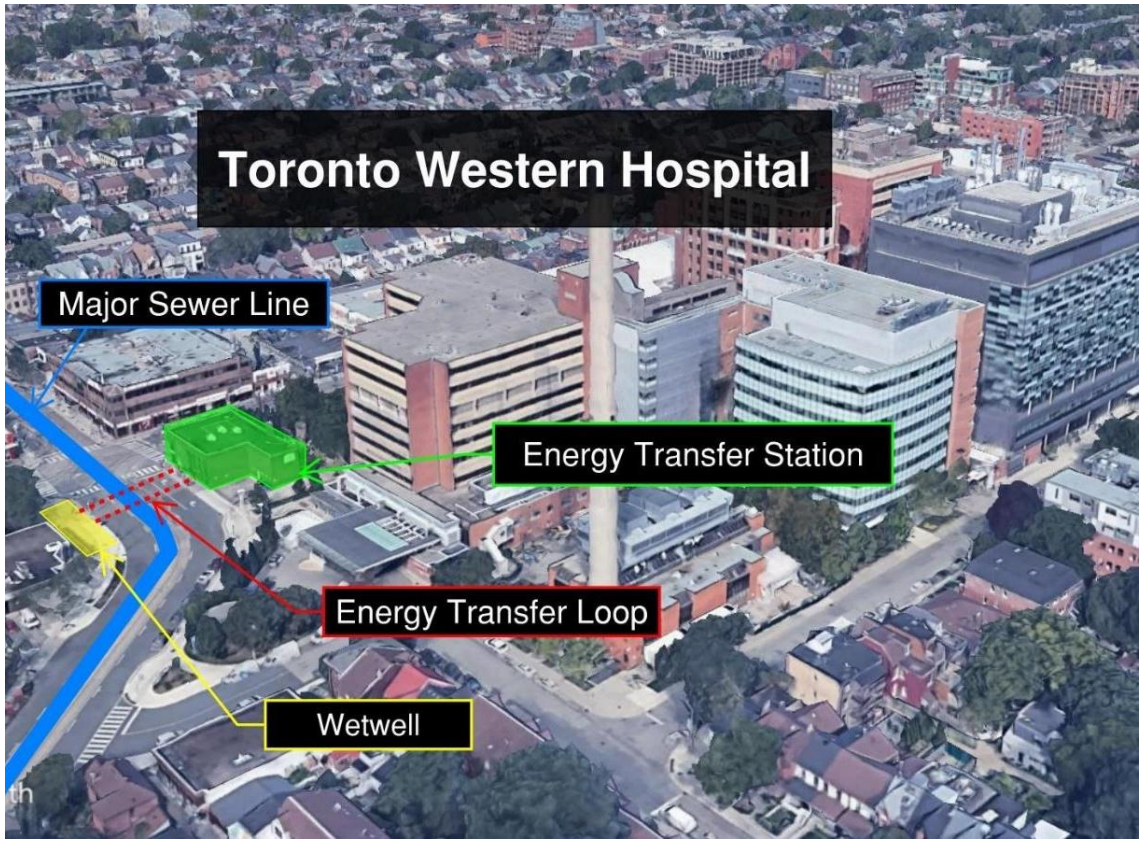
- ABCD

Toronto Western Hospital (TWH) Campus

Patient Care, Teaching & Research In The Heart of a Busy City

- **Toronto Western Hospital**
  - part of University Health Network
  - 1,200,000 ft^2 acute care hospital
  - 4,800 tons chiller, 2,000 bhp steam boiler capacity
  - 51 AHUs, most with steam or high temperature glycol

- **Krembil Discovery Tower**
  - 325,000 ft^2 wet-lab research tower
  - Heating and cooling plant separate from hospital
  - 2,160 tons chiller capacity
  - 900 bhp steam and 1,060 bhp glycol boiler capacity
  - 14 AHUs with glycol heating



TWH WET™ System Project Overview

Design Capacity

- Hybrid system: TWH and KDT plants maintained
  - Provide 10MW+ of heating and 9MW+ of cooling energy from wastewater
  - Meet ~60% of peak loads
  - Provide 90%+ of annual space heating & cooling loads

- “Future ready” design of key infrastructure for system expansion

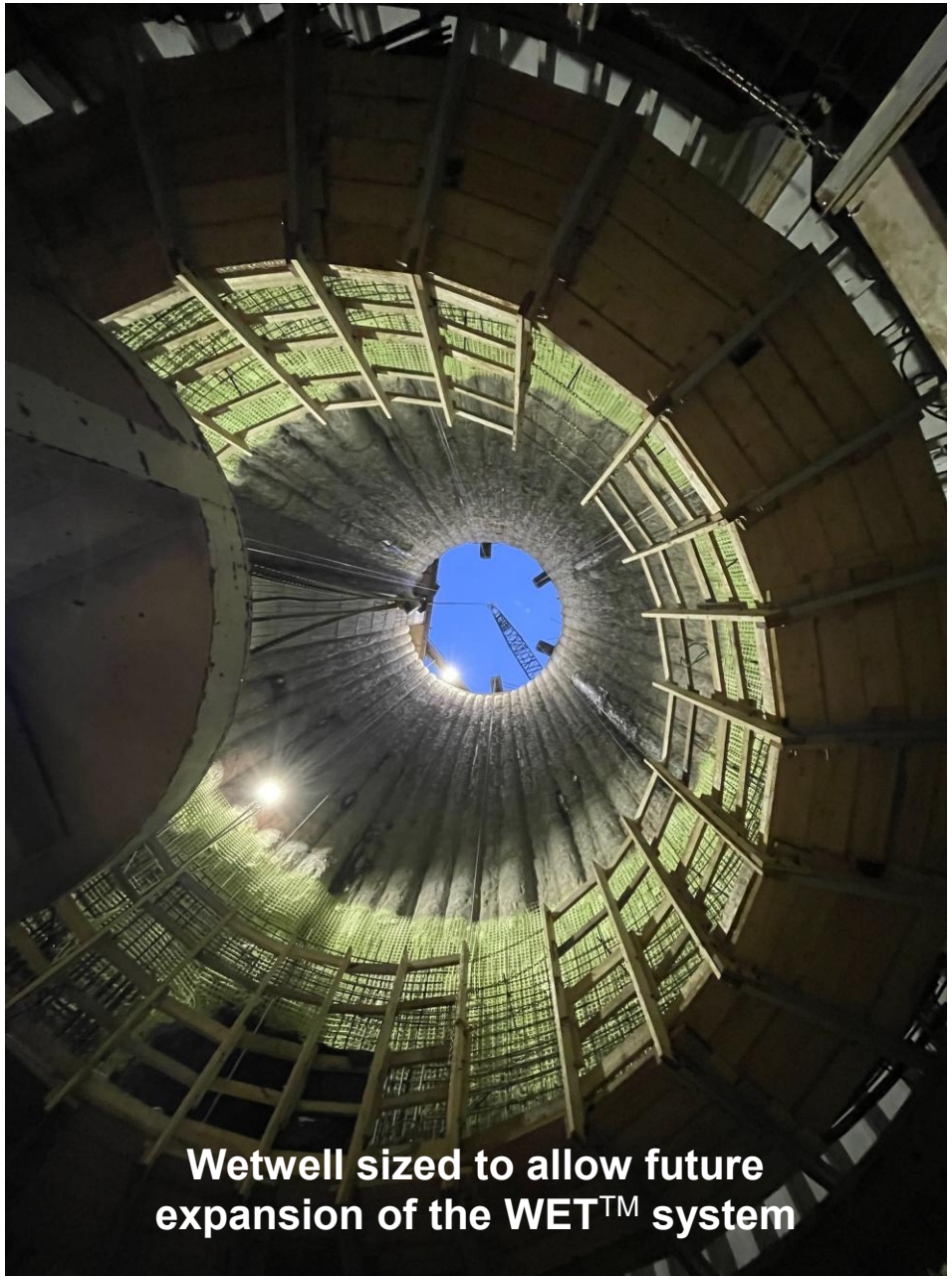
TWH WET™ System Project Overview

- Construct WET™ system
  - Wetwell across the street from hospital
  - Convert former bank owned by hospital into Energy Transfer Station (ETS)
  - Install plate-and-frame heat exchangers within hospital to transfer thermal energy to building heating and cooling loops
- Convert existing hospital steam distribution system to new low-temperature hot-water loop
  - New hot water piping and coils
  - Maintain existing steam infrastructure
- Delivered using an Energy-as-a-Service (EaaS) model

TWH Wetwell

- “A very large hole”
  - 32’ (10 m) diameter, 130’ (40 m) deep
  - Secant piles construction

- Phase 1 equipment installation to process 600 L/s wastewater flows
  - Wetwell sized to fit enough equipment to process 1,200 L/s of wastewater
  - Peak municipal sewer flows ~7,000 L/s
  - 3 x wastewater screens
  - 3 x wastewater pumps



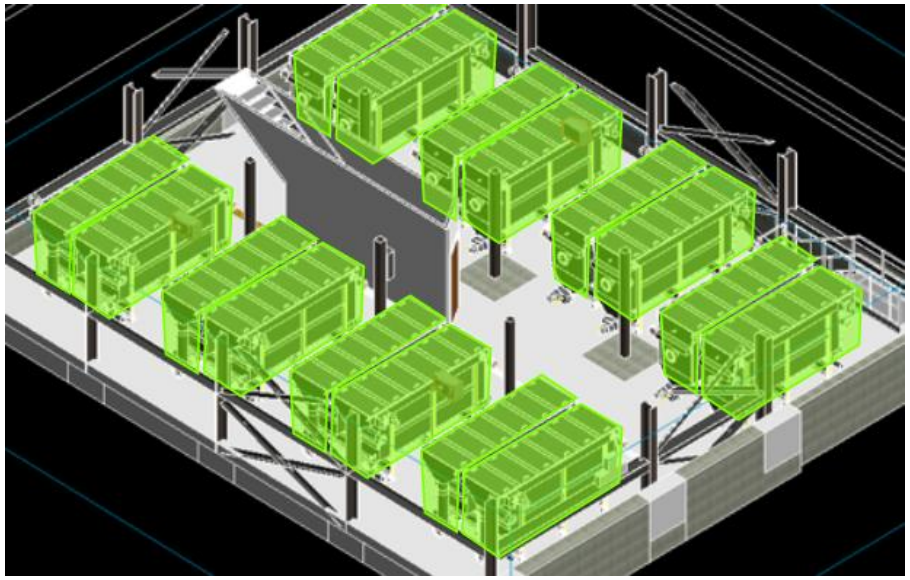
Wetwell sized to allow future expansion of the WET™ system

TWH Energy Transfer Station (ETS)

- Former bank owned by UHN
  - ETS designed to facilitate future expansion
  - Basement deepened to fit equipment
  - 16 x Heat Exchangers
  - 5 x Trane heat pumps
  - Unexpected asbestos (of course)

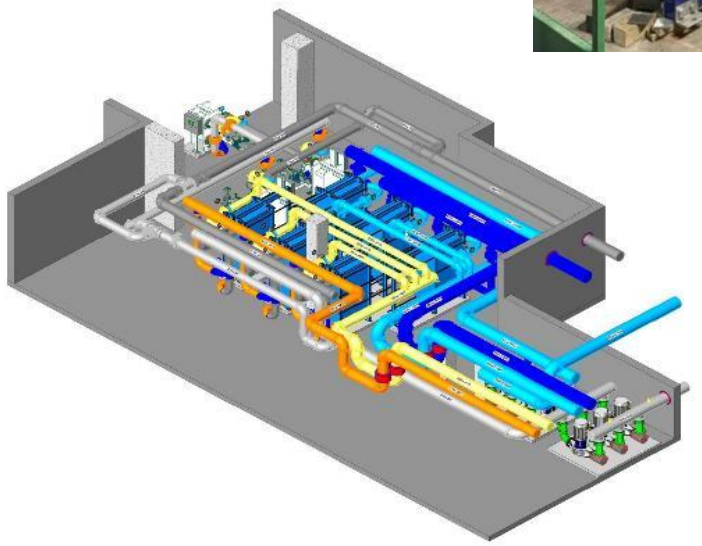
- COP of 4.5 for heating, 5-6 for cooling

- More than just an energy transfer station
  - Wastewater research
  - Energy education center



Energy Transfer to Hospital Loops

- Plate-and-frame heat exchangers installed in existing hospital mechanical room
- Ability to provide energy from WET System and hospital heating & cooling plants simultaneously
- Communication between WET System and hospital controls and Building Automation System (BAS)



Toronto Western Hospital WET™ System

The Payoff

- ABCD

TWH Financial and Environmental Benefits

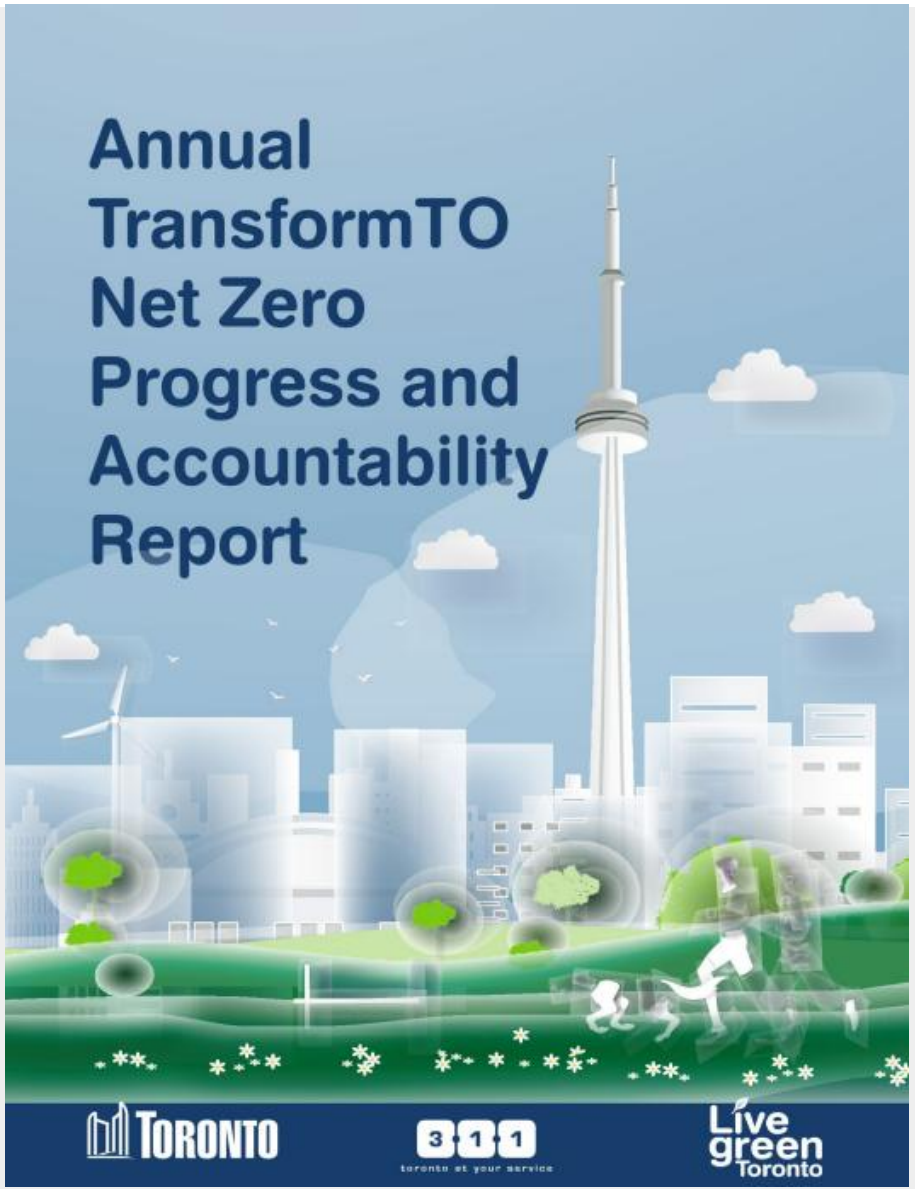
- Greenhouse gas emission reduction of ~8,400+ tonnes CO_{2e}/year: ~60% of UHN's *overall* Scope 1 emissions
- Average annual utility cost savings ~$685,000/year
- Water use reduction of ~45 million liters/year
- Low-carbon district energy system in place for planned hospital expansion

TWH Resiliency and Redundancy Benefits

- N+1 redundancy and back-up generators for wastewater energy recovery equipment
- Decentralized, redundant heating & cooling
  - Integration of wastewater energy transfer station, hospital heating/cooling plant & research tower heating/cooling
- Renewed hospital infrastructure
  - Increased fresh-air capacity, with new hot-water coils, for “pandemic readiness”
- 1-million-gallon thermal storage in planning

City of Toronto Benefits

- New revenue stream
- Renewed infrastructure
- Low-carbon district energy system in place for planned housing development
- Alignment with City of Toronto TransformTO net zero strategy



Toronto Western Hospital WET™ System

Lessons Learned

- ABCD

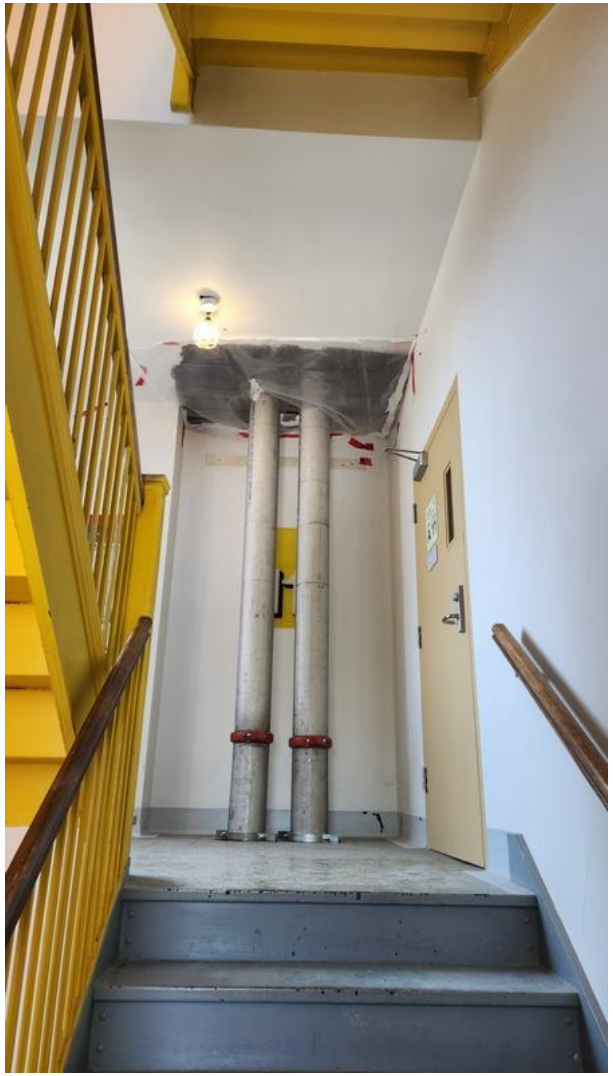
Deep Retrofits Require Deep Planning

Especially in old, active hospitals

- Multiple coil replacements…in an active acute care hospital
  - Hospital air handling units needed to be mapped
  - Detailed shutdown planning with clinical staff
- “As-builts”, even if available, need to be confirmed
- “As operated” conditions need to be understood.

New Pipes In Old Buildings Require Creativity

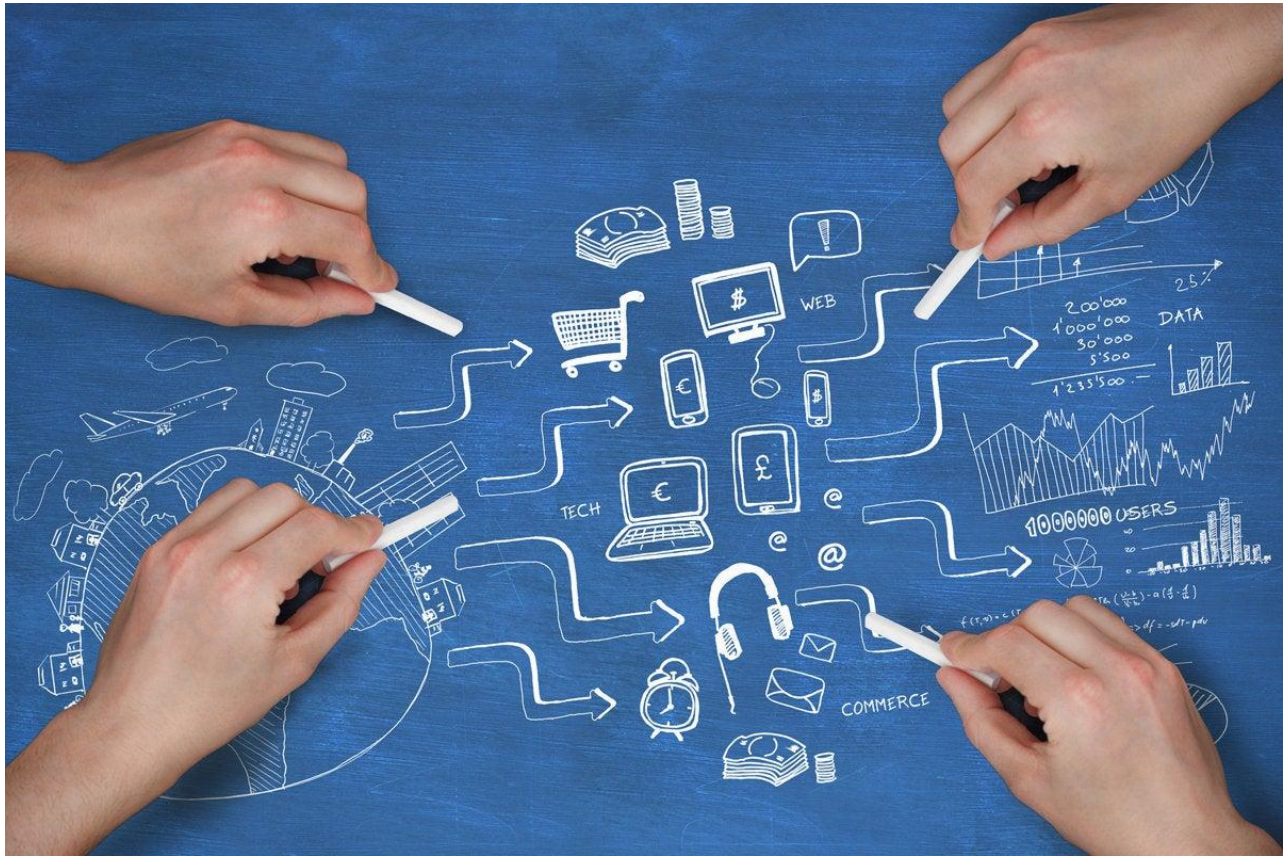
And you will find asbestos



Even Win-Win-Win Projects Need Collaboration!

Flexibility is key

- The municipality (and its many departments)
- The community
- The hospital (and its many departments)
- The financers and funders
- The designers and builders
- The utilities



Thank you!

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