Heat Pump Technology Applied to Energy Recovery for GHG Emissions Reduction at Rossdale WTP

EPCOR

CIMA+

November 2022

Sectors of activity

Energy & Resources

Transportation

Building

Infrastructure

Communication systems

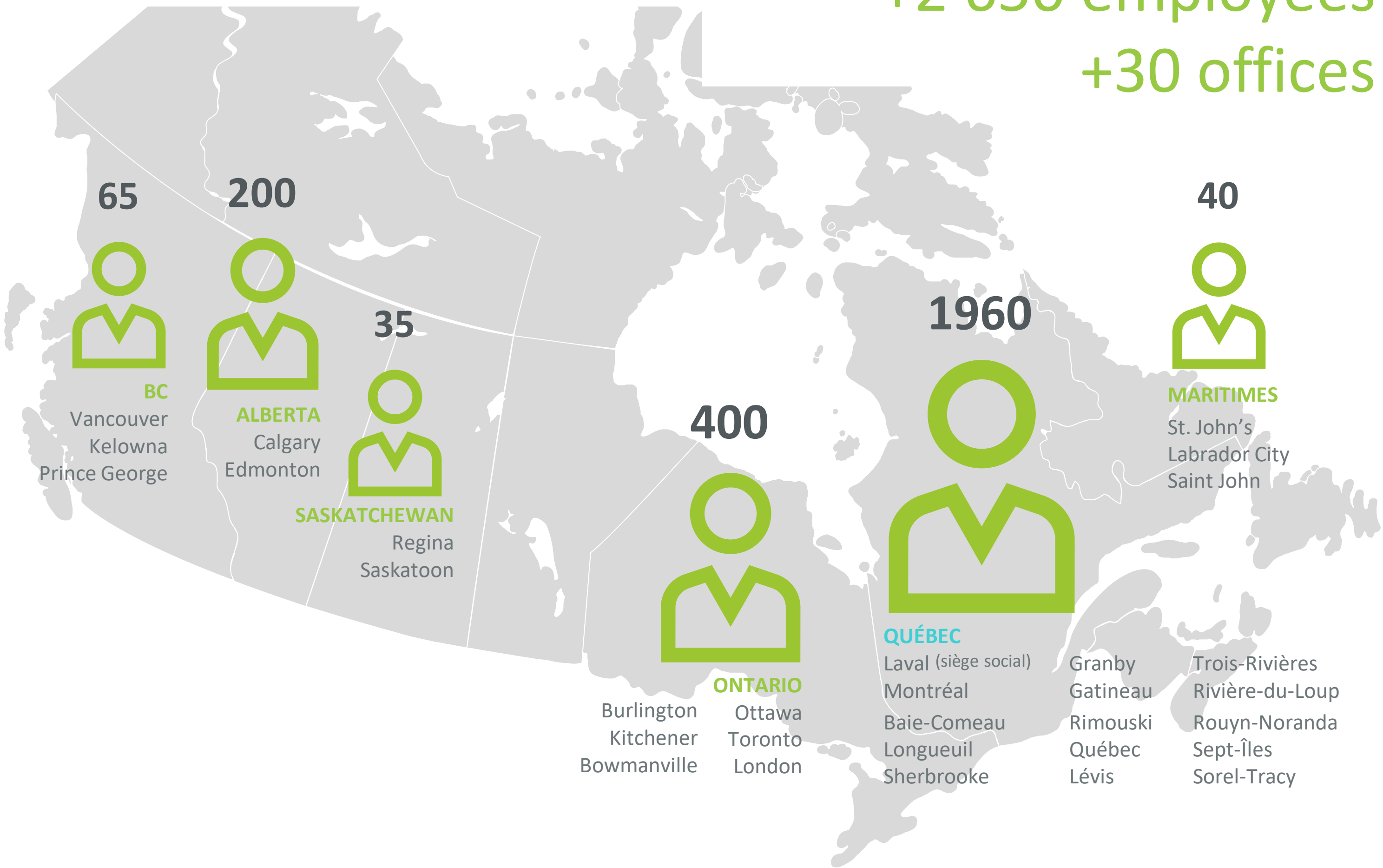
Project Management

Environment

Coast to coast

+2 650 employees

+30 offices



KINCENTRIC Best Employer CANADA 2019

Canadian Council for ABORIGINAL BUSINESS

ISO 9001

CANADA GREEN BUILDING COUNCIL · CONSEIL DU BÂTIMENT DURABLE DU CANADA · MEMBER

Key facts

Founded in 1990, among the largest private consulting engineering firms in the country

Sales of $360M in 2020, 11% annual growth since 2016 (average)

Robust HSE system

Sustainable development & responsible engineering

14 Grands Prix du génie-conseil Québécois

8 out of 10 employees with us for more than 5 years

Long-standing private and public clients across Canada

Climate Change and Sustainability Services

Climate change mitigation and adaptation

- Greenhouse Gas (GHG) emission inventories and management through action planning
- Carbon neutrality strategizing
- Life cycle analyses (LCA)
- Climate Risk and Vulnerability Assessments (CRiVA)
- Climate Lens Assessment
- Climate change resiliency and adaptation plans
- Grant application support

Sustainable Design and Environmental Certifications

- Integrated design process (IDP)
- Green building rating systems (LEED, Zero Carbon Building, WELL, and Passive House)
- Whole building Life cycle analysis
- Energy simulation
- Grant application support

Champions stream: 2022 intake of the Low Carbon Economy Challenge

- Launched in 2017 by Government of Canada’s Low Carbon Economy Fund (LCEF)
- Leverages Canadian ingenuity to reduce greenhouse gas (GHG) emissions and generate clean
- Projects selected for funding will result in measurable GHG emissions reductions toward Canada’s 2030 emissions reductions target
- **GHG emissions reductions** and **co-benefits** will be scored and worth 75% and 25% of the total project score, respectively

Champions stream: 2022 intake of the Low Carbon Economy Challenge

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CIMA+ provided services to conduct the **GHG inventory** and provide recommendations for mitigation measures and documentation for the funding application package:

- GHG emissions reductions estimates
- GHG Workbook: the required template to provide GHG emissions reduction estimates

Champions stream: 2022 intake of the Low Carbon Economy Challenge

Champions stream: 2022 intake of the Low Carbon Economy Challenge

The other co-benefits of the project were:

- Diversity & Inclusion: Indigenous

  EWSI is committed to developing business relationships and commercial partnerships with Indigenous-owned businesses as part of our Indigenous relations journey.

- Diversity & Inclusion: Other

  Diversity, Equity and Inclusion Council's objective is to use decarbonization projects such as this one as a platform to increase awareness and engagement among students/youth on climate change and the technology options available to water utilities and industrial operations at large to tackle it.

Champions stream: 2022 intake of the Low Carbon Economy Challenge

Champions stream: 2022 intake of the Low Carbon Economy Challenge

The other co-benefits of the project were:

- Clean Growth: Ambitious Targets

  EPCOR has committed to reaching net zero GHG emissions by 2050 and has an ambitious target to cut emissions in half by 2025, and 85% by 2035 compared to 2020 emissions. Additionally, EPCOR plans to use 100% green electricity for our Edmonton based operations by 2025 with two key initiatives underway in support of this goal: the E.L. Smith Water Treatment Plant solar farm to be commissioned in Oct 2022, and the purchase of Renewable Electricity Certificates from a new wind farm in Southern Alberta starting Mar 2023.

- Clean Growth: Industry-Leading Practices/Technologies with Potential for Replicability

  Our project has the potential to develop practices that will influence similar water and waste water treatment projects that may be undertaken in Canada in the future.

The Opportunity

Recover and transfer waste heat from plant process sources for use in process and building HVAC systems

Potential Waste Heat Sources Include:

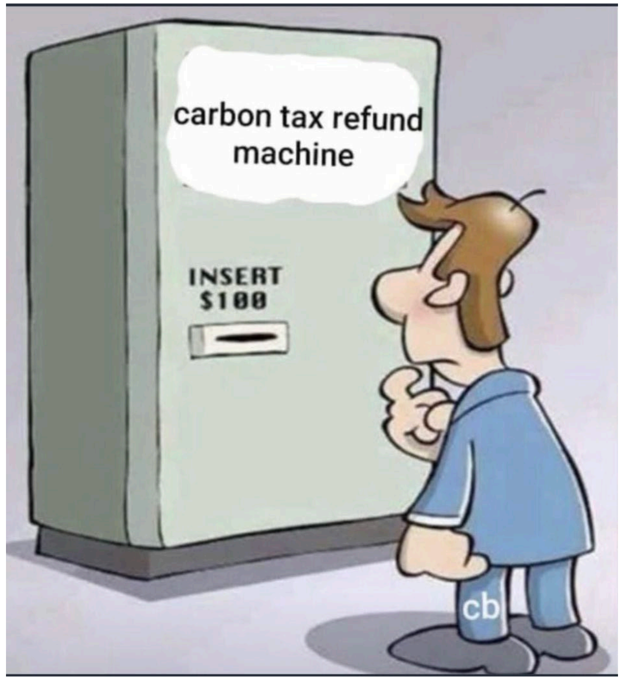
- Hypochlorite generators
- I.T. Data Center
- Electrical rooms
- UPS systems
- VFD cooling

Potential Options for Heat Re-use:

- Building HVAC
- Hypochlorite domestic water input pre-heat
- Domestic water heating

Carbon Tax Timeline

Year	Projected Federal Carbon Tax	Natural Gas Carbon Tax	Gas Rate (approx.)	
2021	$40/ton	-	-	Gas Rates Potentially Double by 2030
2022	$50/ton	$2.50/GJ	$6.40/GJ	
--	+$15/yr	+$0.80 per year		
2030	$170/ton	$8.90/GJ	12.80/GJ	



Project Objectives

Short-term

- Implement process heat recovery with heat pump equipment → Carbon Tax Savings
- Reduce electricity and natural gas consumption → Cost Savings
- Reduce plant GHG emissions → Meet Climate Goals
- Use waste heat productively → Meet Climate Goals

Project Objectives

Short-term

- Improve building comfort, air quality and occupant well-being → Improve Productivity
- Begin to address deferred maintenance items → Future-proof HVAC Systems
- Implement more effective cooling for process loads that can’t rely completely on outdoor ambient cooling → Designs for Climate Resiliency

Project Objectives

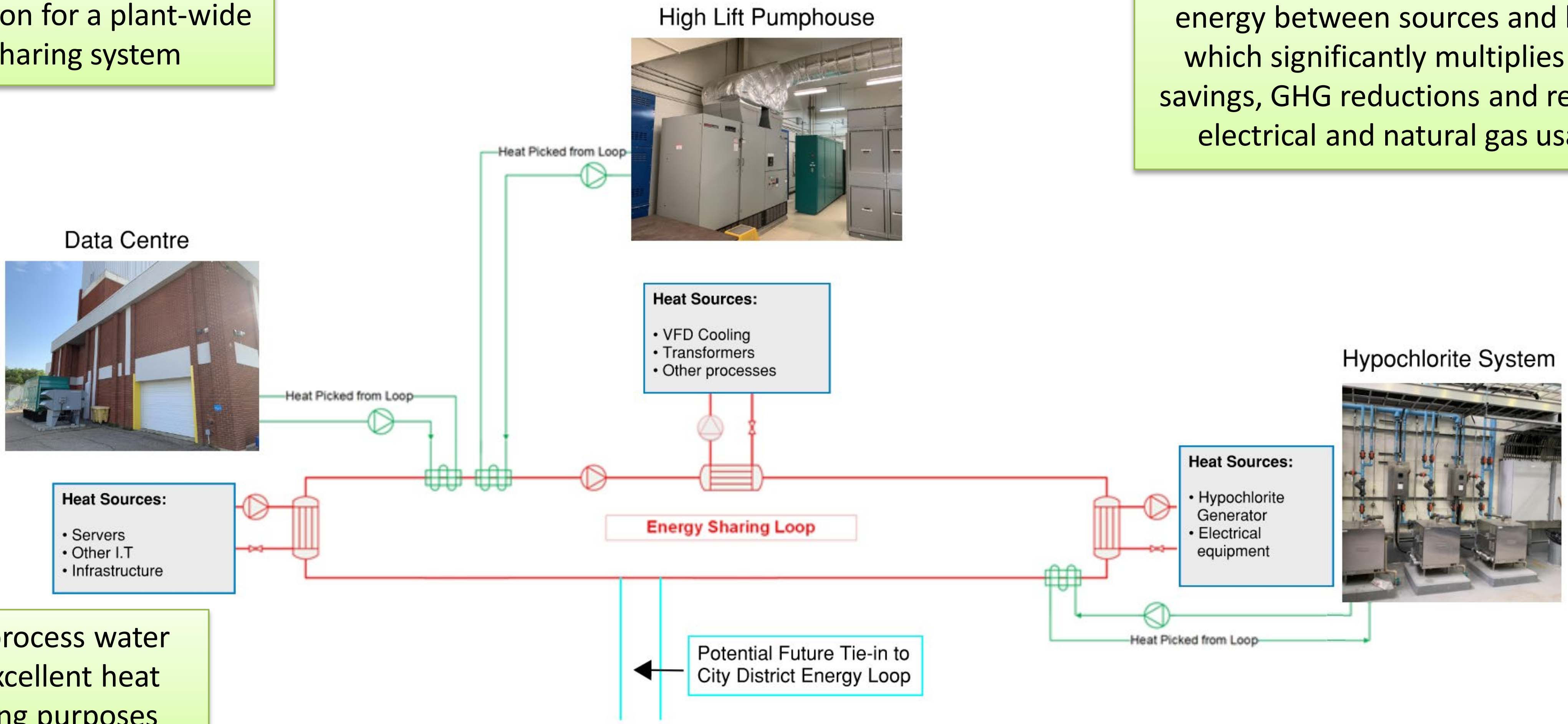
Long-term ➡ Plan a Pathway to Net-Zero

- Prepare Building(s) for Future Upgrades
- Renewable Systems with Scalable Design (Plant & District System Integration)
- Energy Sharing within Buildings
- Flexible, Expandable Heat Recovery and Transfer System, Align with Net Zero Program
- Create Repeatable Template Designs for Use at Multiple Facilities

Path to Net-Zero: District Energy System

This illustration demonstrates the long-term vision for a plant-wide energy sharing system

Concept Schematic
Energy Sharing on Plant Site



The energy sharing loop in red provides an opportunity to share energy between sources and loads which significantly multiplies cost savings, GHG reductions and reduces electrical and natural gas usage

The Rossdale process water provides an excellent heat sinks for cooling purposes

The Technology: Heat Pumps

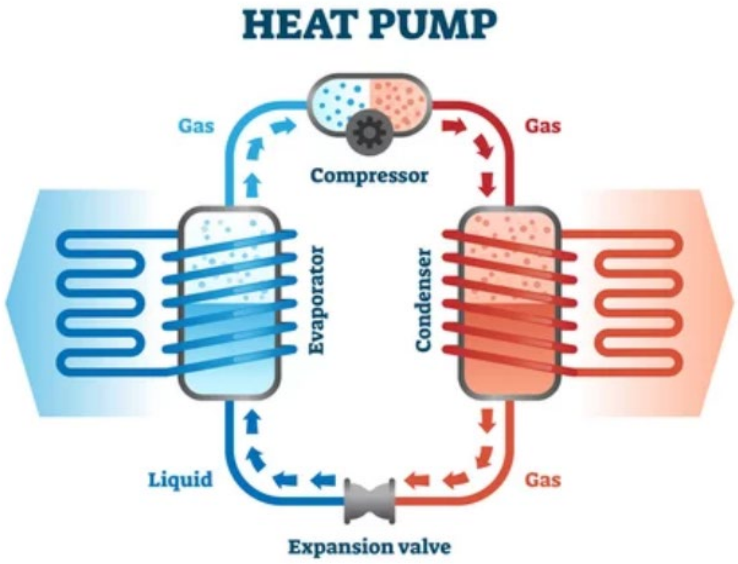
Heat pumps are a type of refrigeration equipment that use compression of refrigerant media to move heat from a cool source to a warmer load.

Heat Pump For Process Applications

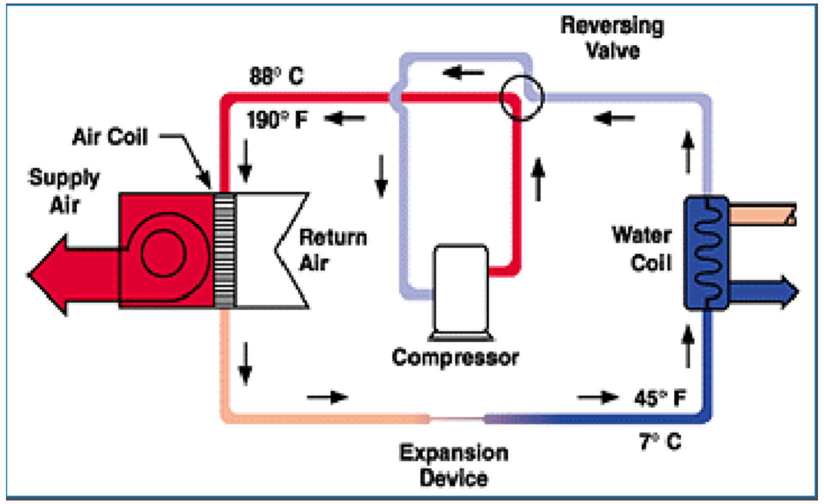
- Water-to-water (process applications)
- Water-to-air systems (HVAC applications)

Energy Efficient

- COP of 3 to 5
- Moves 3-5 kW of heat energy for every kW of electric energy input
- Multiplies 3 to 5 times compared to simple electric heat
- Greatly reduces GHG emissions over simple electric heat



Water to Water System



Water to Air System

Specific Applications – An Overview at Rossdale WTP

Rossdale Water Treatment Plant

- Existing clean water process water loop throughout plant can provide excellent heat sink for heat pump operation
- Existing pipe tunnel infrastructure provides opportunity for lower cost routes for future water source loop: heat sink and source to transfer energy from sources to loads
- On-site buildings with future HVAC renewal needs provide opportunity for heat pump retrofits and use for waste process heat

Specific Applications – An Overview at Rossdale WTP

Rossdale Plant Site Example Waste Heat Sources

- **On-site Data Center**: provides viable source of rejected heat year-round that could be reclaimed and used for building HVAC cooling or efficiently rejected back to process water loop
- **High Lift Pump House**: Very large electrical pump loads provide VFD cooling requirements and an excellent year-round waste heat source
- **Low Lift Pump House**: Existing DX cooling system can be retrofitted for heat pumps. Year-round heat source
- **Hypochlorite Generator System**: Heat pump system can provide high efficiency recovery of waste process heat to pre-heat incoming potable water hypochlorite production (100% electric system)

Data Center Application

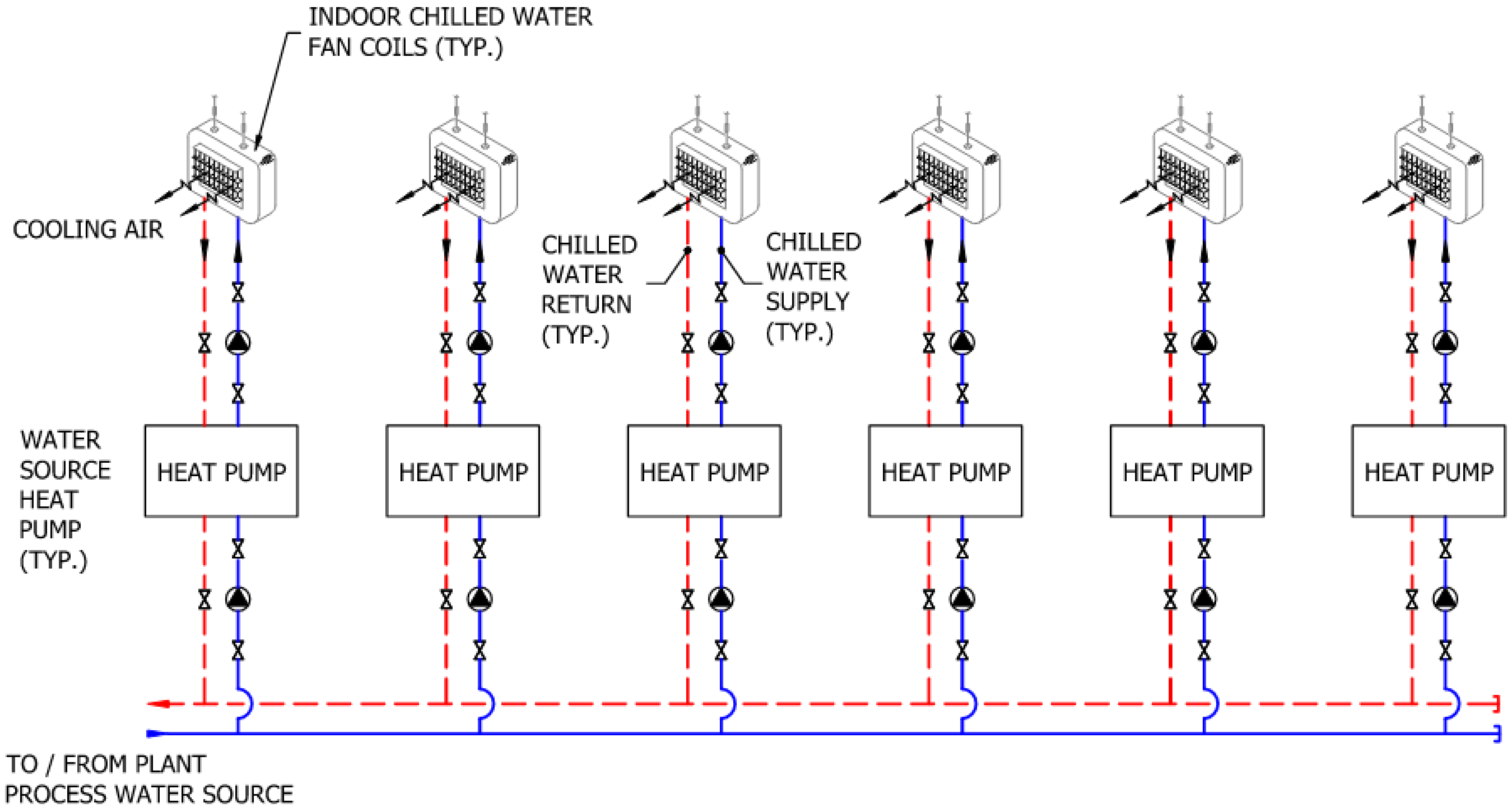
System Description

- Data Centre with 180 tons of cooling capacity
- Existing cooling is traditional electric air-conditioning type
- Evaporators in the building with condensers on the roof
- Fuel source: grid electricity
- Life expectancy: 25 years

Proposed Upgrade

- Replace conventional split-system air-conditioners with water-source heat pumps using plant process water as heat sink
- Incorporate ability to connect heat pump loop into future district loop to enable use of waste heat for building heating

Data Center Application



Data Center Concept Schematic

Data Center Application

Assumptions

- Cooling is required year-round
- Cooling capacity requirement is constant
- Maximum process water temperature of 50 degrees F

Projected GHG Reduction

System Type	Energy Use (kWh/year)	GHG (t CO^2e)
Existing Cooling System	917,679	5,585
Heat Pump System	670,376	4,221
Reduction	247,303	1,364

Data Center Application

Benefits

- Building for the future: capture and transfer of waste heat to other plant areas with heating requirements
- Reduce future electricity usage for Data Centre cooling
- Reduce GHG output
- Prepare for future plant-wide heat recovery and transfer system, align with Net Zero Program

High Lift Pumphouse Application

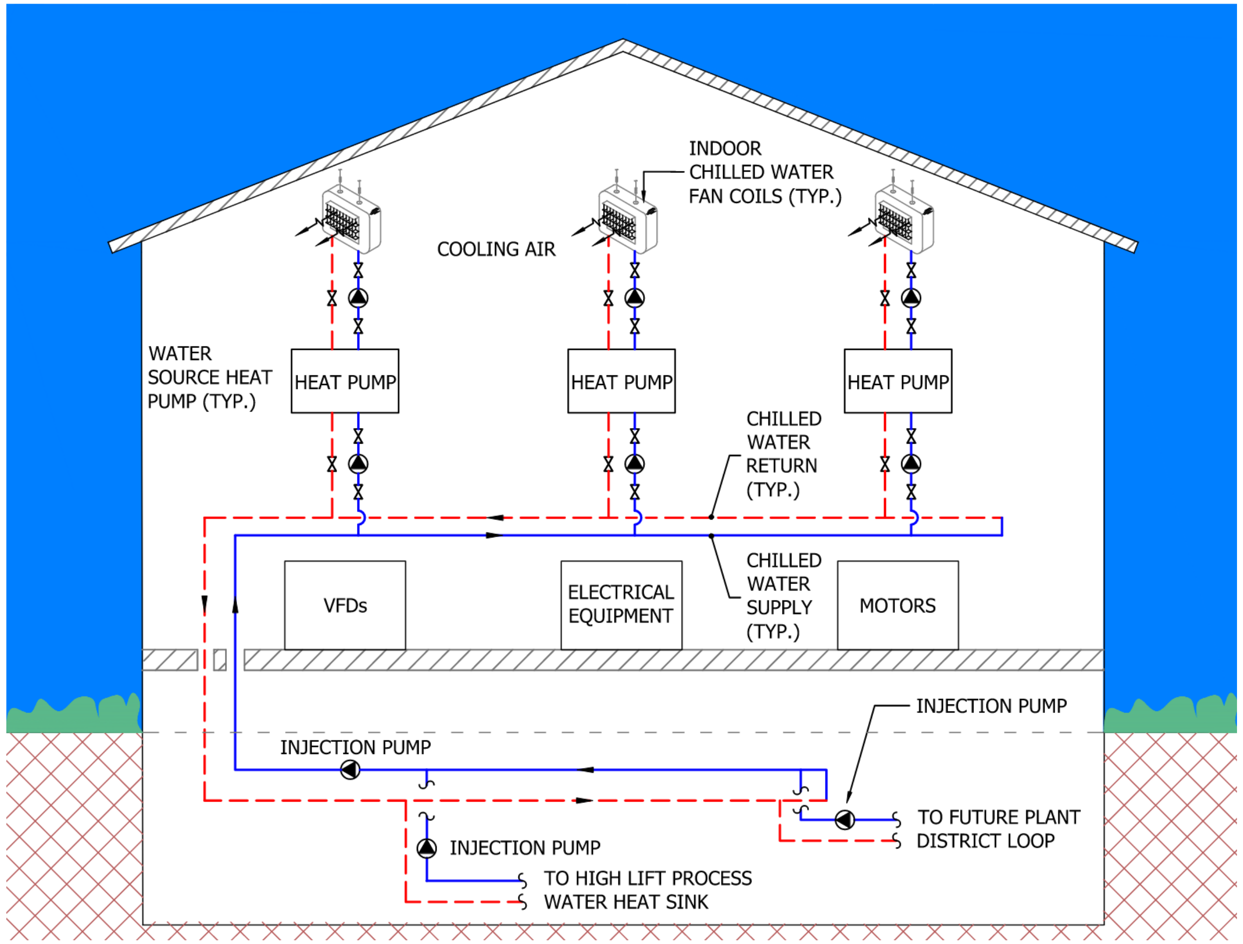
System Description

- Existing cooling system uses 100% outdoor air
- During “heat dome” events, outdoor temperature too high to sustain cooling requirement
- Baseline (future): traditional DX cooling
- Fuel source: grid electricity
- Life expectancy: 25 years

Proposed Upgrade

- Lower electrical energy use using water source heat pumps to cool VFDs as alternative to traditional DX cooling
- System supplements 100% outdoor cooling – climate resiliency
- Incorporate ability to connect heat pump loop into future district loop to enable use of waste heat for building heating

High Lift Pumphouse Application



High Lift Pumphouse Concept Schematic

High Lift Pumphouse Application

Assumptions

- Electric cooling is required at outdoor temperatures above 30 deg. C
- Cooling capacity requirement is constant
- Process water temperature of 5-20 deg. C
- Proposed system capacity of 64 tons cooling

Projected GHG Reduction

System Type	Energy Use (kWh/year)	GHG (t CO^2e)
100% O/A Cooling (w/ future supp. Electric A/C)	25,709	229
Heat Pump System	15,561	173
Reduction	10,149	56

High Lift Pumphouse Application

Benefits

- Provide climate resiliency for cooling requirements that cannot be met using older 100% outdoor air system
- Building for the future: capture and transfer of waste heat to other plant areas with heating requirements
- Reduce GHG output
- Prepare for future plant-wide heat recovery and transfer System, Align with Net Zero Program

High Lift GHG numbers are small now when comparing gains simply from heat pump vs. air-conditioner use. However, once energy sharing loop is in place, gains become significantly more substantial

Hypochlorite Generator System

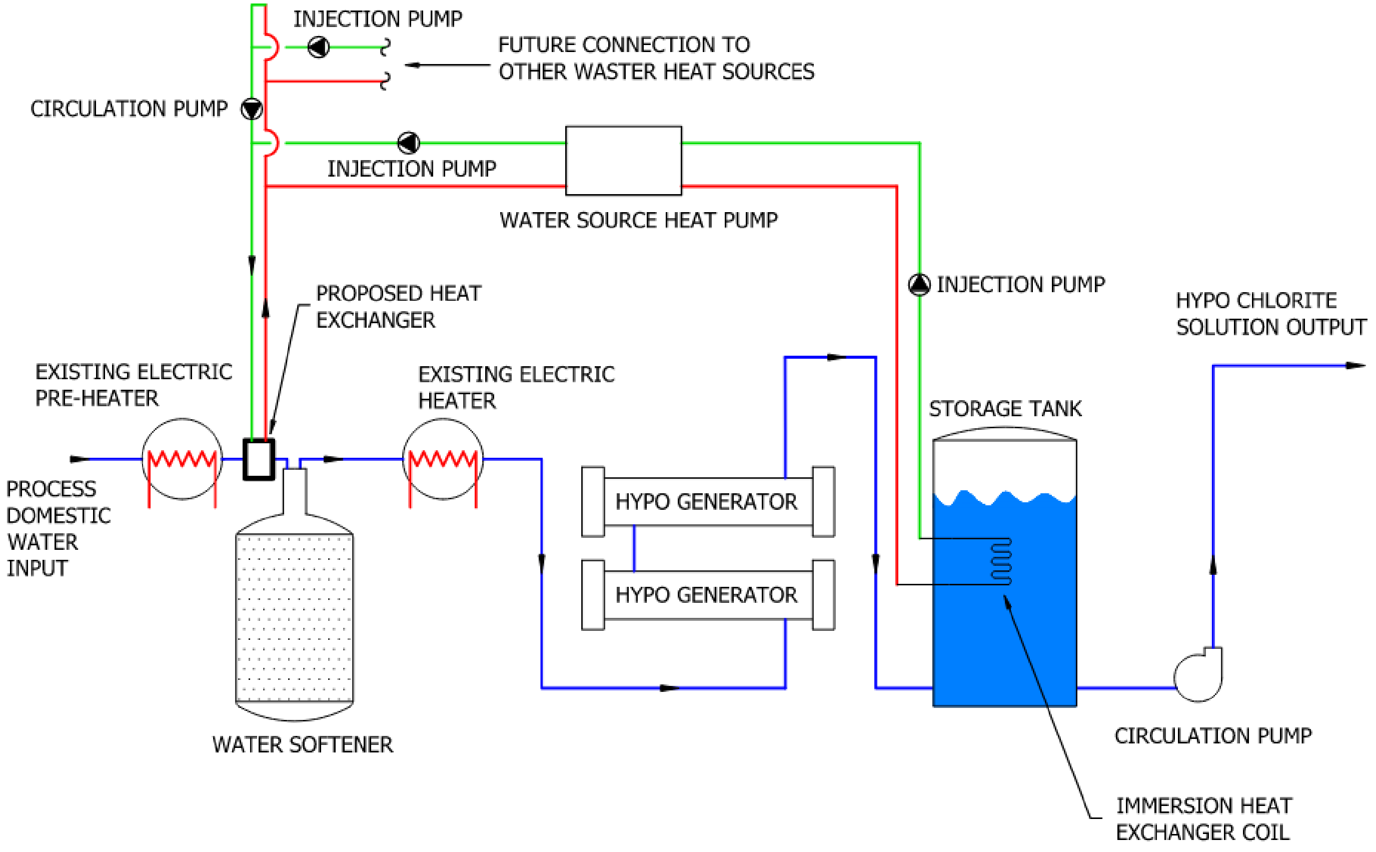
System Description

- Existing system uses electric domestic water heaters for process pre-heat (90 kW total capacity)
- Fuel source: grid electricity
- Life expectancy: 25 years

Proposed Upgrade

- Add water source heat pumps to transfer waste heat generated by hypochlorite process to re-use for preheat
- Incorporate ability to connect heat pumps to enable future use of waste heat from other building sources for process pre-heat

Hypochlorite Generator System



SOURCE: ADVISIAN 202 ENERGY AUDIT REPORT (APR.18, 2022)

Hypochlorite System Concept Schematic

Hypochlorite Generator Application

Projected GHG Reduction

System Type	Energy Use (kWh/year)	GHG (t CO^2e)
	218,182	1,343
Heat Pump System	50,182	416
Reduction	168,000	927

Hypochlorite Generator Application

Benefits

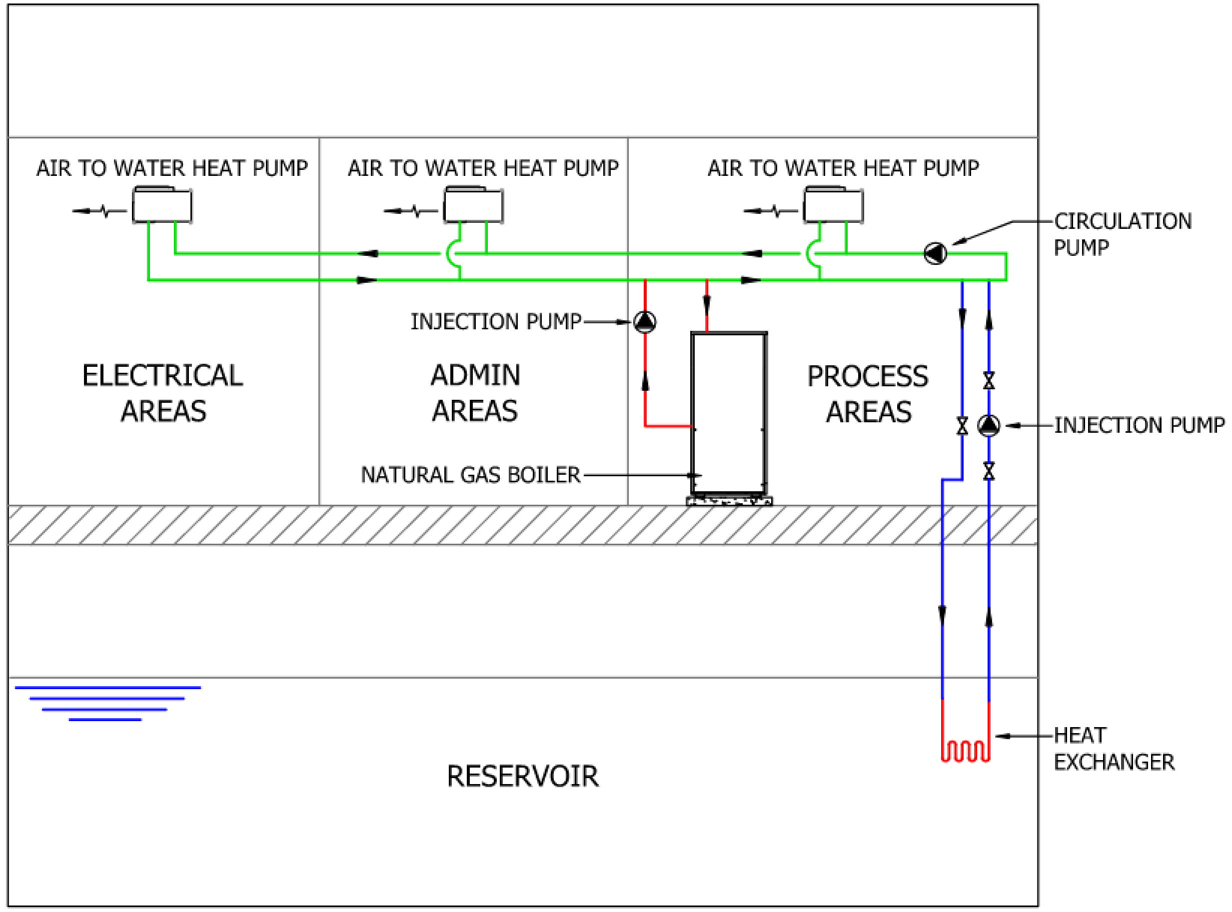
- $23,000 in yearly energy cost savings (Source: Advisian 2020 Energy Audit)
- Lower ambient operating environment in hypochlorite process area could extend PVC piping life and improve environment for electronic systems
- Potential to use waste heat from other parts of building (e.g. electrical room cooling) to supplement hypochlorite process pre-heat.

Off-site Opportunities - Reservoirs

Reservoirs

- Summer cooling opportunities using reservoirs as heat sinks
- Air-to-water source heat pumps can transfer energy from high heat areas to office spaces and process areas using water loop during heating season
- Provide supplemental heat with high efficiency boiler
- Heat pump cooling provides climate resiliency during cooling season with high outdoor ambient conditions
- Goal is to create a repeatable, scalable design that can be applied to future reservoir designs as a standard

Off-site Opportunities - Reservoirs



Reservoir Facility Concept Schematic

Conclusion

Using water-source heat pump technology to recover and transfer waste heat from plant process sources shows excellent potential for:

- Preparing buildings for future upgrades
- Provides renewable systems with scalable design for integration with future plant and district energy systems
- Energy sharing within individual buildings
- Flexible, expandable heat recovery and transfer system: aligns with Pathway to Net Zero Program

Benefits

- Reduce electricity and natural gas consumption
- Reduce plant GHG emissions
- Use waste heat productively
- Improve building comfort, air quality and occupant well-being
- Creating a repeatable, scalable design that can be applied to future designs
- Provides climate resiliency during cooling season with high outdoor ambient conditions

For Further Information

Contact the CIMA+ Team!

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Questions?