Women's College Hospital

2024-2028 Energy Conservation & Demand Management Plan

Prepared for:

WOMEN'S COLLEGE PARTNERSHIP

WCH
WOMEN'S COLLEGE HOSPITAL
Healthcare | REVOLUTIONIZED

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WCH WOMEN'S COLLEGE HOSPITAL Healthcare | REVOLUTIONIZED

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Executive Summary

The Ontario Provincial Government has committed to help public agencies better understand and manage their energy consumption. As part of this commitment, Ontario Regulation 25/23 filed & published on February 23, 2023 under the Electricity Act, 1998 requires public agencies, including municipalities, municipal service boards, school boards, universities, colleges, and hospitals to report on their energy consumption and greenhouse gas emissions (GHG) annually, to develop an Energy Conservation and Demand Management (ECDM) Plan, and to update their ECDM plans every 5 years.

Women's College Hospital is committed to developing and executing on strategies to reduce environmental impacts and ensure regulatory compliance, in accordance with Ontario Regulation 25/23.

Black & McDonald Limited has assisted in developing the five-year ECDM plan. This ECDM plan was created in accordance with the requirements set forth under the Electricity Act. It is broken up into sections according to the hospital's categories which make up the largest percentage of WCH's energy consumption. The report comprises three main sections – past, present, and future:

- The past examines historical energy consumption and GHG emissions, as well as energy conservation measures (ECMs) that have been implemented since the 2019 ECDM plan.
- The present examines whether the goals of the 2019 ECDM plan have been met and set goals for the 2024 ECDM plan to meet by 2028.
- The future examines which proposed ECMs should be included to meet the goals established within this plan.

Project Description

Women's College Hospital (WCH) is an outpatient hospital established to offer various clinical offerings. Throughout the history, it has maintained its focus on advocating for women's health and recognizing women's special health care needs. Additionally, it has committed itself to improving women's healthcare worldwide, which includes providing a hospital/clinic in the downtown core that facilitates easy access, care, and information for patients.

The facility was constructed between 2010 and 2015 under the Renew Ontario 2005-2010 strategic infrastructure renewal initiative that replaced the existing Women's College Hospital facility and several other supporting buildings. The project was delivered utilizing an Alternative Financing and Procurement (AFP) model as a Design, Build, Finance, Maintain (DBFM) Public Private Partnership (P3) project. The facility was designed and built with several environmental and sustainable initiatives achieving LEED Gold certification for construction.

The facility is a ten-story facility with an additional 3-levels of underground and a combined conditioned space of 40,214 m^2. Desired space comfort and indoor air quality are achieved by 17 Air Handling Units, perimeter heating coils and supplemental fan coil units.

The annual energy usage is a combination of energy required for heating, cooling, and overall electricity consumption at Women's College Hospital. Heating energy consumed in the form of pounds (lbs.) of steam supplied at 125 psi while cooling is in refrigeration ton hours (Rth) of chiller water, both supplied by local district energy provider Enwave. The electricity supplied is metered in kWh, and the adjusted valued is used throughout the energy calculations as it factors in estimated losses by the utility.

B&M Scope of Work

Black & McDonald Limited provides comprehensive facilities management and operations for the entire facility. B&M was heavily involved during the design & construction of the project as the prime mechanical and electrical contractor and installer. B&M continues to play an integral role in the long-term sustainability and lifecycle considerations of Women's College Hospital infrastructure and fit outs.

Energy monitoring is performed and includes primary metering of incoming utilities as well as sub-metering. Energy consumption is adjusted to weather and climate data and variations due to end user consumption. Value management reviews are conducted to ascertain whether any minor design alterations, technology changes or other technological enhancements would improve energy performance and are submitted to the Utility Subcommittee for review, evaluation, and approval for implementation.

Capital upgrades or changes are evaluated and proposed and then dealt with through the existing project Variation Procedure for implementation and may be subject to additional financing by the Hospital. Cost – benefit analysis evaluations are a significant part of determining if any capital or change improvement is implemented. Broader environmental considerations would also be part of the calculus and may lead to the implementation of initiatives. These however may be regardless of budgetary return on investment expectations based on the availability of funding, grants, or other government initiatives if the environmental benefit is thought to warrant the expenditure.

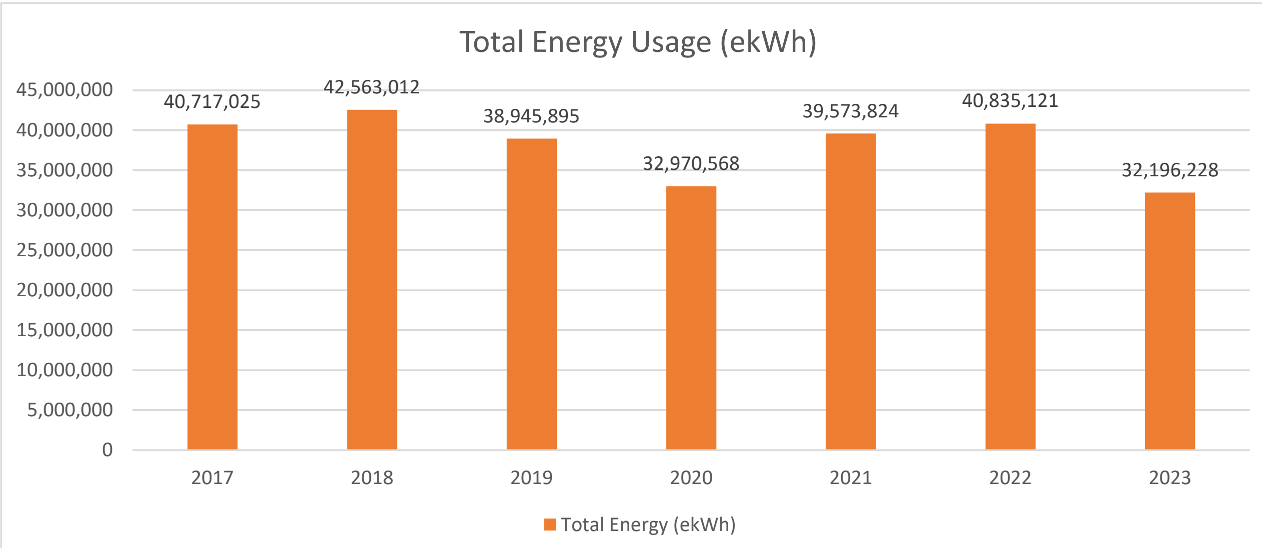
Women's College Hospital's Commitment

In addition to WCH's existing Utility subcommittee that meets quarterly to analyze energy performance in previous months, an energy team was set up to meet monthly to analyze energy performance at a much granular level to actively derive insight for performance optimization, detect anomalies and determine drivers of unusual increase. The team is responsible for planning the implementation of energy conservation measures and work in hand to adjust the facility operation based on changes in clinical schedules and operation. The team members are listed below:

Name	Position	Company
Stacey Callender	Facilities & Project Specialist	Women's College Hospital
Lauren Seager	Director, Facilities & Operations	Women's College Hospital
Harris Culic	Project Co Representative	Women's College Partnership
David Damboise	Project Co Representative	Women's College Partnership
Roshan Shreedhar	Operations Manager, FMO - ICI	Black & McDonald Ltd.
Ashwani Sharma	Operation Manager, FMO – Healthcare & Research	Black & McDonald Ltd.
Yogeshwar (Chuck) Singh	Facility Manager	Black & McDonald Ltd.
Jaspreet Kaur	Facility Supervisor	Black & McDonald Ltd.
Percy Gallegos	Project Manager	Black & McDonald Ltd.
Salvador Vinluan	Lead Hand HVAC Mechanic, FMO	Black & McDonald Ltd.
Erica Brabon	Director, Energy & Sustainability Services Team	Black & McDonald Ltd.
Vrund Pandya	Energy & Sustainability Technical Specialist	Black & McDonald Ltd.
Anighoro Friday	Asset Manager, P3 Asset Management	Infrastructure Ontario
Mohammed Nadim	P3 Energy Manager, Procurement and Program Management	Infrastructure Ontario

Energy Target Potential (2019-2023)

Based on the benchmarking analysis and from an existing audit finding, over the period of 2019-2023 the target was to reduce the total energy usage to 25% of Year 2017 total energy consumption. To achieve this, the target was to attain a minimum of 5% annual reduction which was successfully achieved.



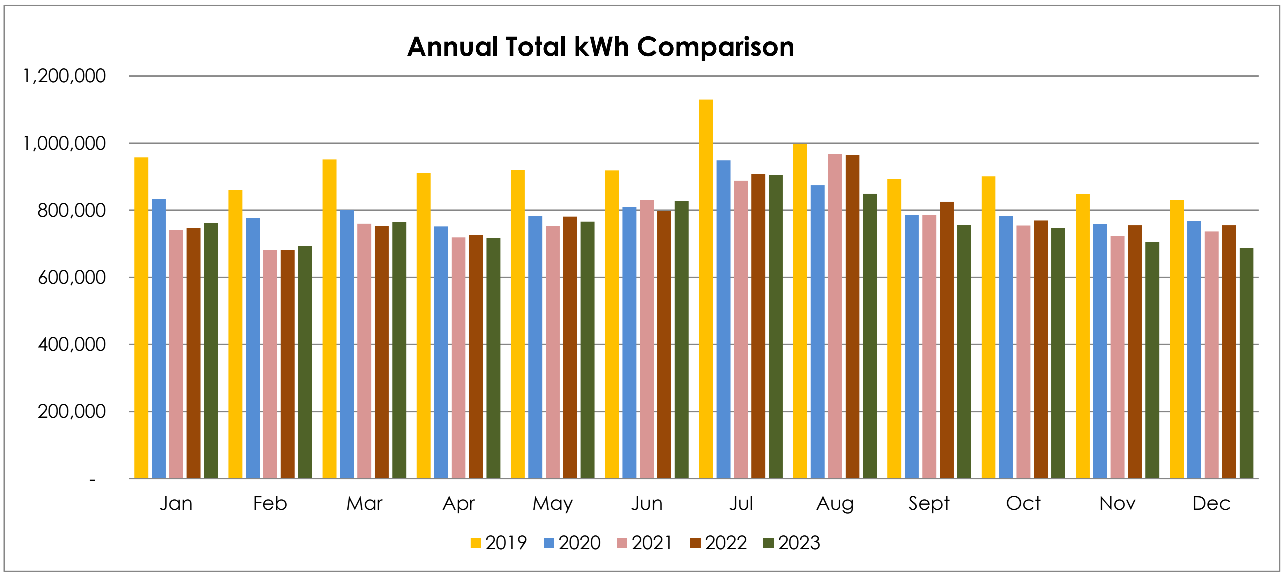
Energy Year	Electrical Energy (ekWh)	Heating Energy (ekWh)	Total Energy (ekWh)
2017	12,572,750	28,144,275	40,717,025
2018	12,911,544	29,651,468	42,563,012
2019	12,256,103	26,689,792	38,945,895
2020	10,581,912	22,388,656	32,970,568
2021	12,779,427	26,794,396	39,573,824
2022	12,619,012	28,216,109	40,835,121
2023	10,075,496	22,120,732	32,196,228
	% Variance Electrical Energy	% Variance Heating Energy	% Variance Toal Energy
2018 vs 2017	3%	5%	5%
2019 vs 2017	-3%	-5%	-4%
2020 vs 2017	-16%	-20%	-19%
2021 vs 2017	2%	-5%	-3%
2022 vs 2017	0.4%	0.3%	0.3%
2023 vs 2017	-22.0%	-25.4%	-24.4%
Total Variance %	-36%	-50%	-46%

Utilities Energy Performance (2019-2023)

The service contract mandates that an annual energy target be estimated in ekWh at the end of the "Baseload and Slope Review Period". The Baseload and Slope Review Period means the 60 calendar months ending on a baseload & slope review date. Energy data from Utilities within this period is converted to ekWh using conversion factors. The new energy targets were implemented from January 2023 onwards.

Total Yearly Electricity Consumption – (2019-2023)

Electricity usage covers lighting, plug loads, fans, pumps, chillers, retail tenant usage etc.



The graph above demonstrates electricity usage over the past four years. Overall, a mixed trend in electricity usage can be noted with the impact of chilled water curtailment factored in.

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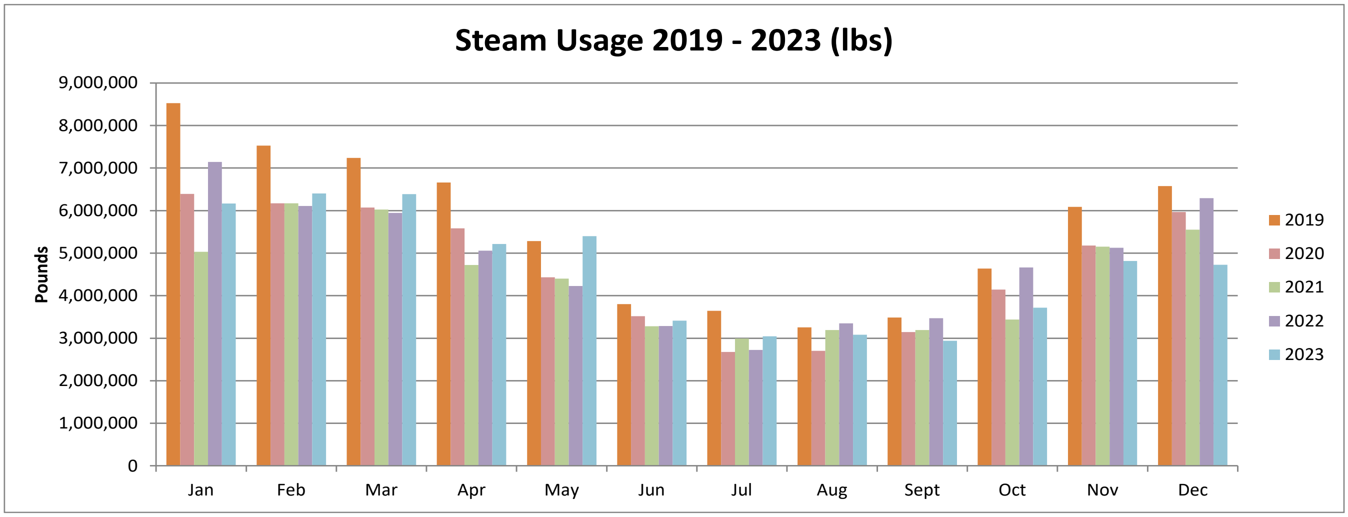
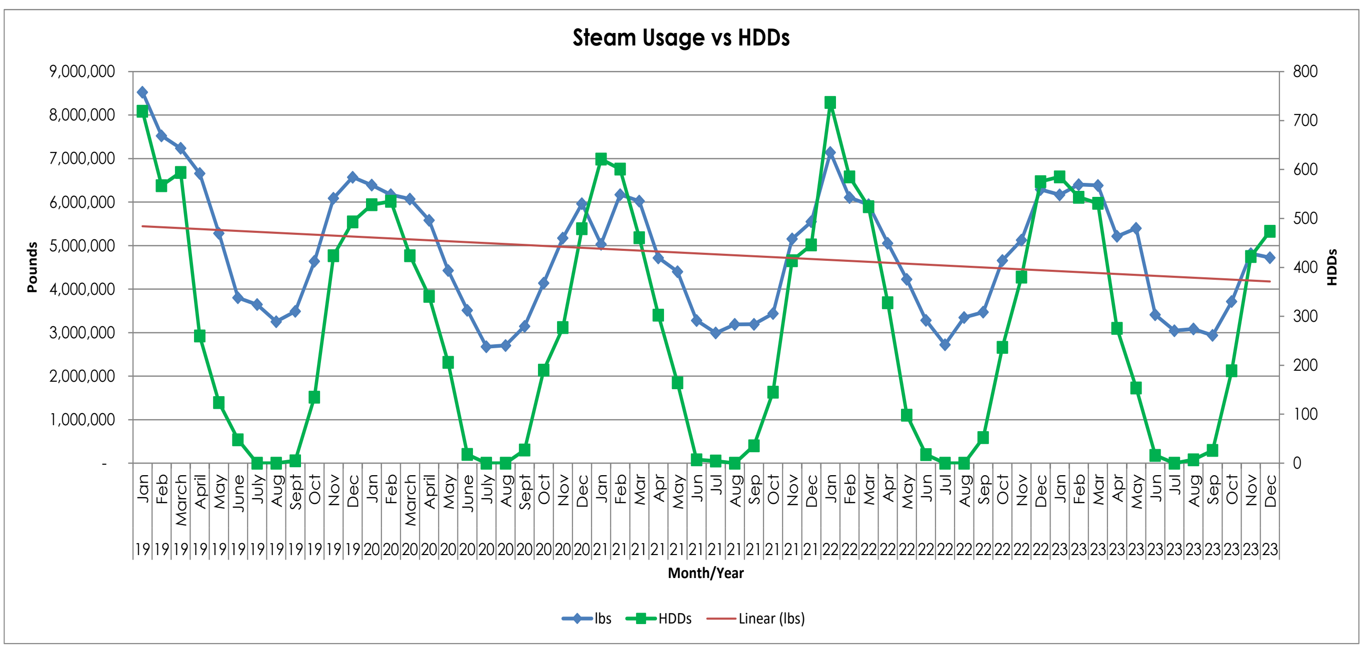
Total Yearly Steam Consumption – (2019-2023)

Enwave provides steam, which is used for space heating, domestic hot water, humidification, cart wash and sterilization. The graph below shows the steam consumption in pounds (lbs.).

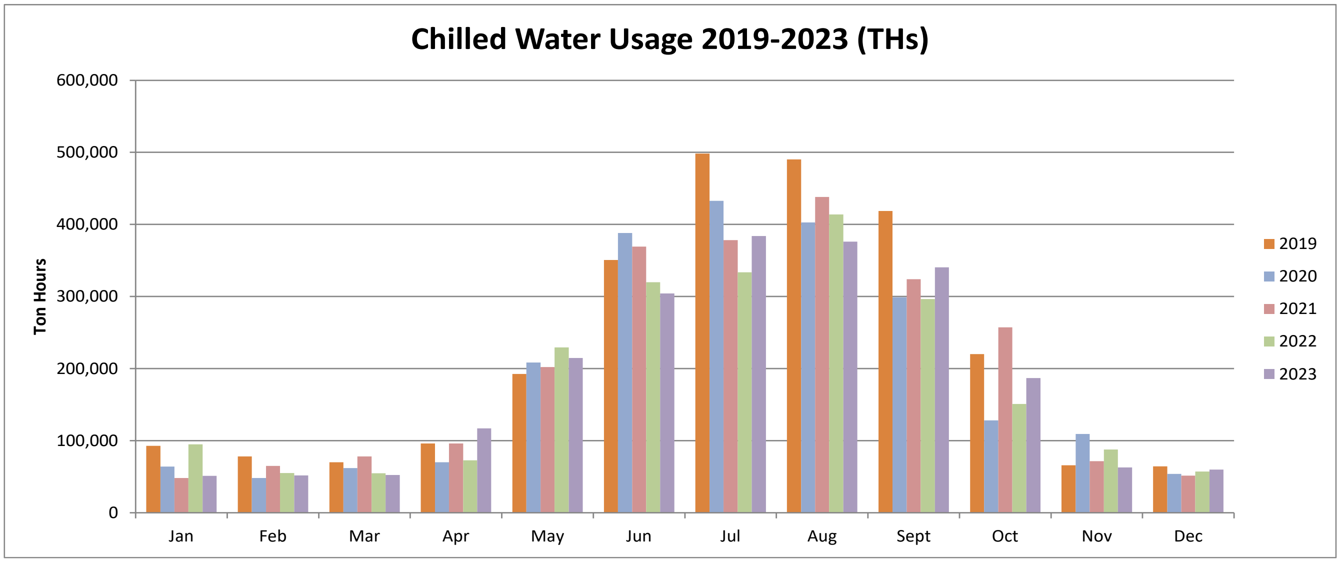


The figure below demonstrates steam usage over the past 5 years compared to HDDs across the same period. Winter weather continues to be fluctuating each year, increasing the facility heating requirements. It can be noted that steam usage strongly correlates with HDD, and usage per HDD has been on a steady decline.

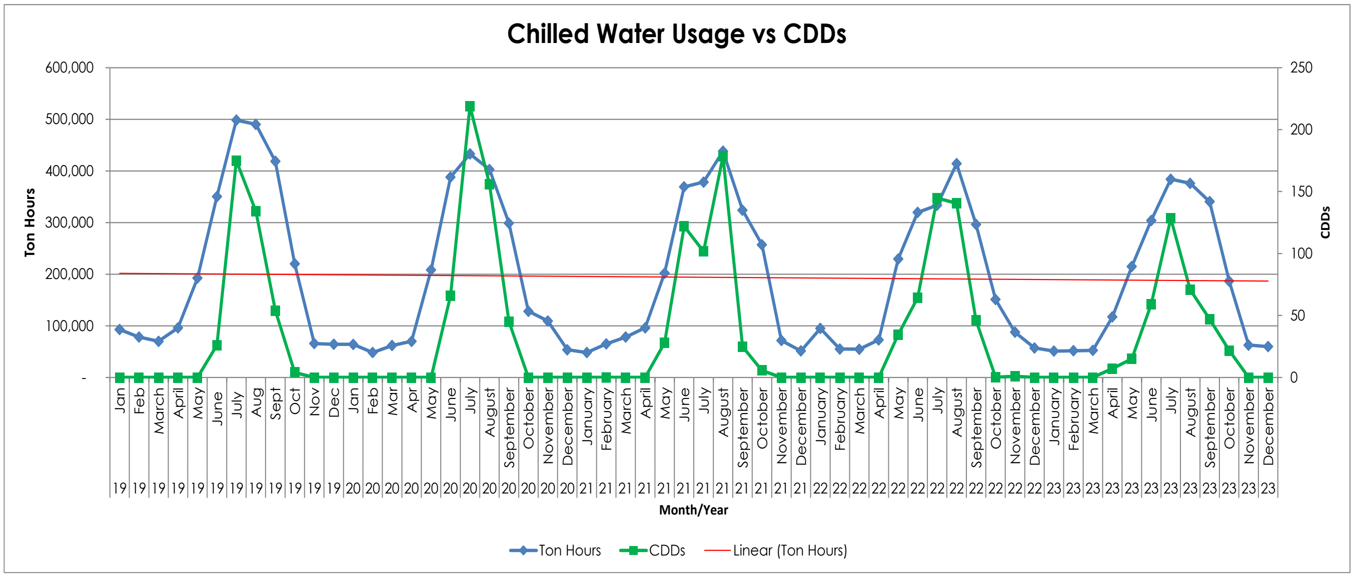


Total Yearly Chilled Water Consumption – (2019-2023)

Enwave provides chilled water all months of the year for space cooling, MRI cooling, computer room air conditioning and dehumidification in summer. The graph below shows the chilled water consumption in ton-hours (THs).

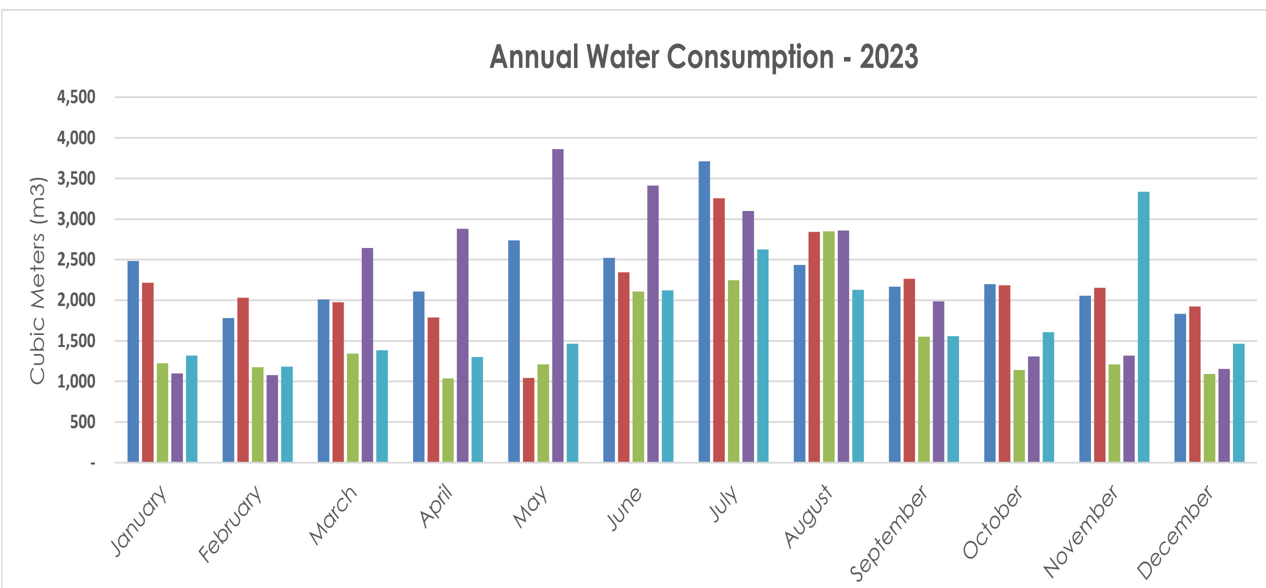


The graph below demonstrates chilled water usage over the past 5 years compared to CDDs during that period. Summer weather continues to be fluctuating each year, increasing the facility cooling requirements. A direct correlation between chilled water usage and CDD can be noted across all the months presented in the graph. Overall, a consistent decrease in chilled water usage can be noted over the past 4 years.



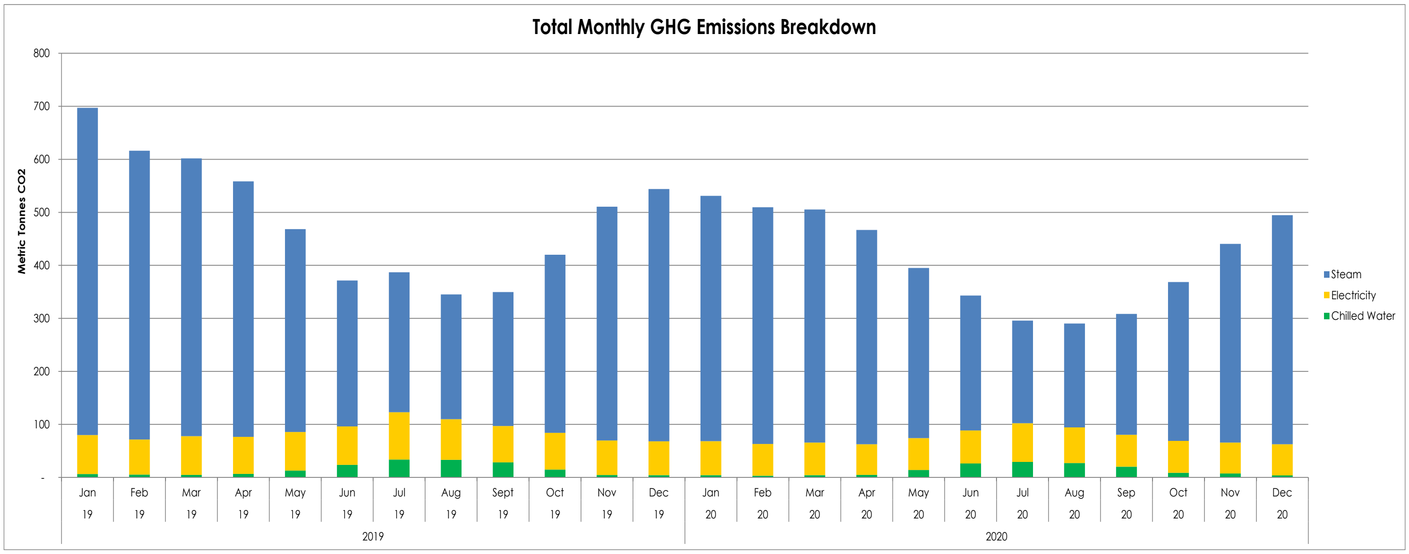
Total Yearly Water Consumption – (2019-2023)

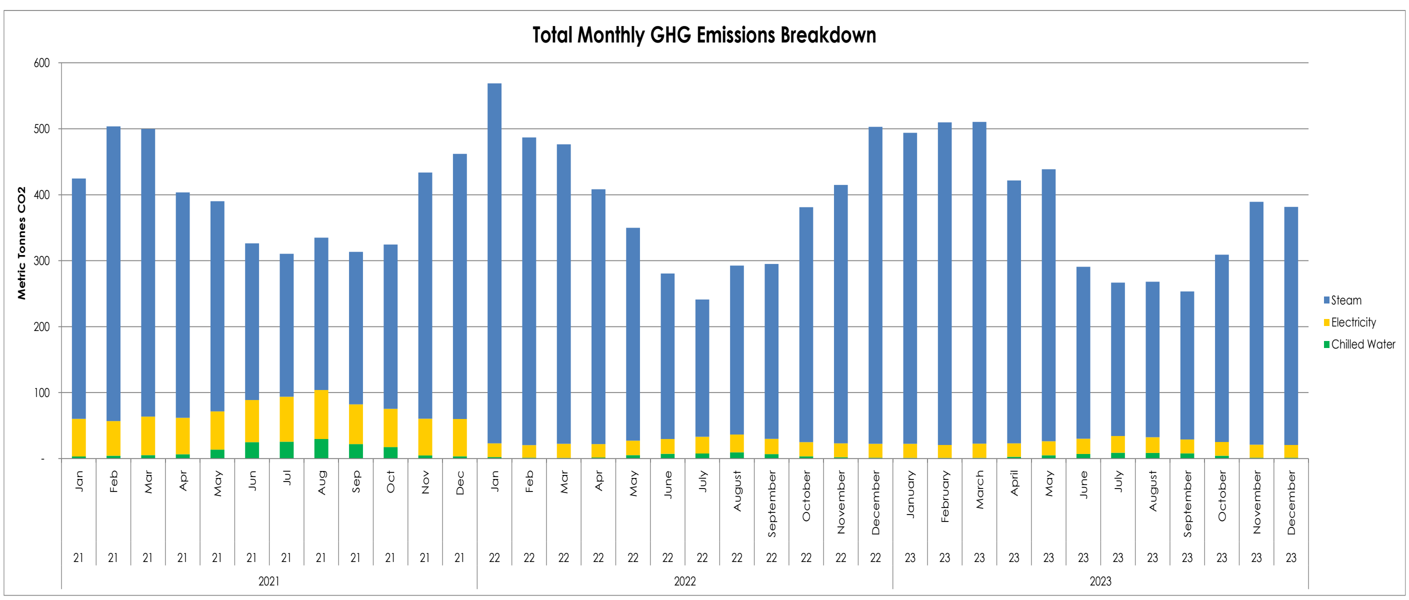
Water consumption data for the reporting period was compiled using logged meter readings from the City of Toronto Water portal and is demonstrated in the graph below. It can be noted from this graph that monthly water usage varies significantly, with higher consumption in summer months, mainly because of cooling tower makeup water.



GHG Emission Breakdown – (2019-2023)

The GHG inventory includes GHG emissions from electricity, chilled water, and steam. Black & McDonald have used Canada's National Inventory Report and Enwave conversion values to calculate emissions factors. Due to the nature of electricity and chilled water being produced from relatively clean sources, their resulting emissions are low in comparison to steam which is produced using natural gas.

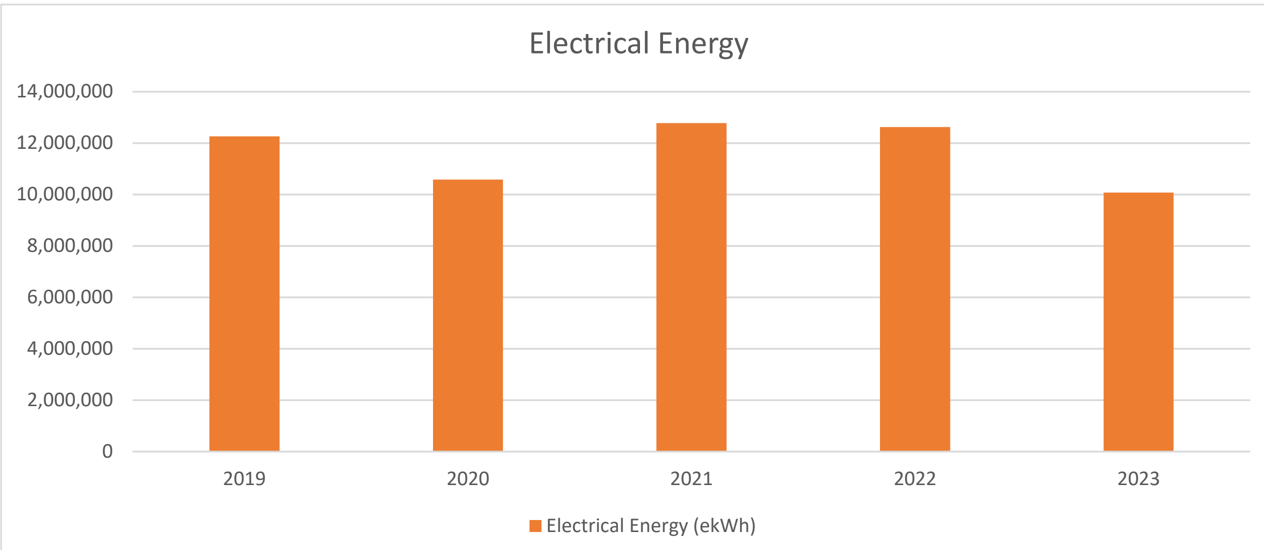


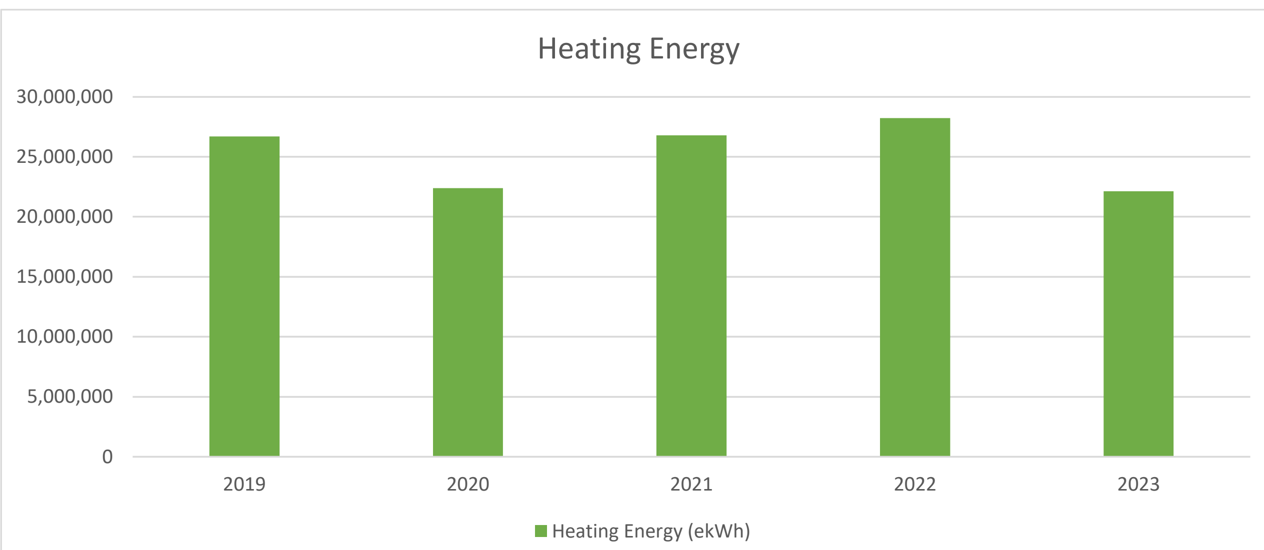


Heating & Electrical Energy (ekWh) – 2023

The annual energy usage is a combination of energy required for heating, cooling, and overall electricity consumption at Women's College Hospital. The service contract mandates that an annual energy target be estimated in ekWh at the end of each period.

Energy data from Utilities within this period is converted to ekWh using conversion factors.





Performance Benchmarking – Canadian Energy Use Intensity by Property Type (Energy Star)

The national median source EUI is a recommended benchmark metric for all buildings. The median value is the middle of the national population – half of buildings use more energy, half use less. The median works better than the mean (arithmetic average) for comparing relative energy performance because it more accurately reflects the mid-point of energy use for most property types and removes the effect of high-value outliers that may skew the data.

The reference table below was designed to help compare property's energy use intensity (EUI) to the national median energy use of similar properties. EUI expresses a building's energy use as a function of its size or other characteristics. It represents all energy consumed, converted to a common unit, compared to size, and is expressed in GJ per square meter per year.

WCH's EUI accounted to 3.17 GJ/m^2 in 2023 which increased from 3.13 GJ/ m^2 in 2022.

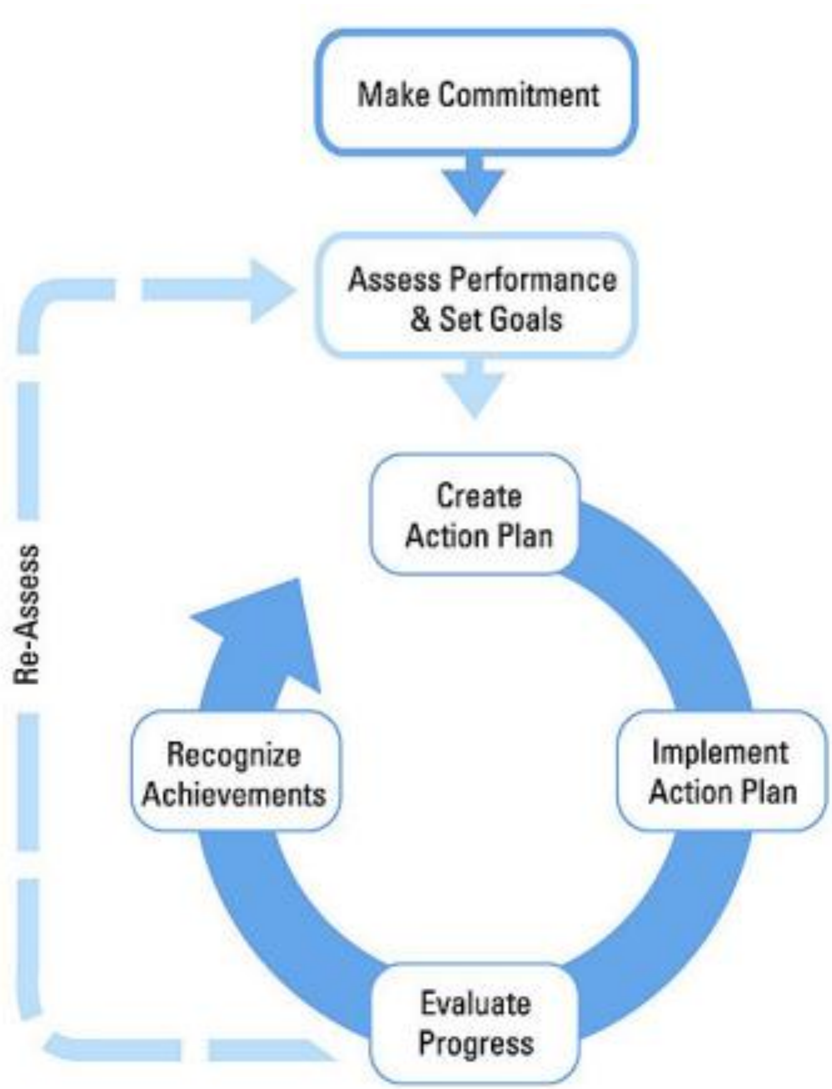
Broad Category	Primary Function	Further Breakdown (where needed)	Source EUI (GJ/m^2)	Site EUI (GJ/m^2)	Reference Data Source - Peer Group Comparison
Health Care	Ambulatory Surgical Centre		2.96	2.20	SCIEU 2019 - E - Hospital
	Hospital	**Hospital (General Medical & Surgical)***	2.96	2.20	SCIEU 2019 - E - Hospital
		Other/Specialty Hospital	2.96	2.20	
	Medical Office*		1.03	0.74	SCIEU 2019 - B - Office space - medical
	Outpatient Rehabilitation/Physical Therapy		1.03	0.74	
	Residential Care Facility*		1.72	1.21	SCIEU 2019 - B - Assisted Living Facility
	Senior Living Community*		1.72	1.21	
	Urgent Care/Clinic/Other Outpatient		1.03	0.74	SCIEU 2019 - B - Office space - medical

The table above presents the median in both site & source EUI. Site EUI contains a mixture of what is called primary energy (i.e. a raw fuel like natural gas) and secondary energy (i.e. a converted product like electricity or district steam). Source energy converts secondary energy types into a unit that is comparable to primary energy which considers all transmission, delivery, and production losses, limiting credits or penalties based on energy source or utility.

While EUI is a very important metric to assess energy performance against comparable facilities, it doesn't tell the whole story. Some other important metrics such as full-time equivalent workers per 1,000 ft^2, patient Beds per 1,000 ft^2, MRIs per 1,000 ft^2, etc., according to Energy Star are all very important parameters that could account for significant variations. Also, it is important to note the uniqueness in the mechanical system setup at each hospital.

Energy Management Road Map

Energy Management is the continuous process of managing behavioral, organizational, and technical change to improve organization's energy performance. Using best practices to improve organization's energy performance produces a more sustainable building that has an extended life cycle. The US EPA's Energy Star Guidelines for Energy Management provides a proven strategy for creating an energy management program focused on continuous improvement of energy performance. WCH's energy management plan for the next five years is adopted from EPA-ENERGY STAR's energy management guideline (Energy Star, 2021) summarized in the flow chart below.



Step 1: Making Commitment

Step 2: Assess Performance

Step 3: Set Goals

Step 4: Create Action

Step 5: Implement Action

Step 6: Evaluate Progress

Step 7: Recognize Achievement

Energy Conservation Measures

The following section contains ECMs and other strategies that were implemented & presented during the Utilities Management Committee meetings between the period from 2019-2023:

2019

- Air Recirculation Mode was set in unoccupied mode for non-clinical areas.
- Some of the exhaust fans were placed on schedule.
- Implementation of an energy management dashboard.
- Low pressure steam humidifier was reconfigured for optimal operation in summer and shoulder seasons.
- Parking garage lighting was put on setback to save on electricity overnight.
- Good catch program was initiated to incentivize building operators to identify and document inefficiencies in operation.
- Economizer was configured to enthalpy control to capture maximum free cooling in shoulder seasons.
- Select VAV reconfiguration.

2020

- The LED retrofit for the parking garage was completed by end of March.
- Low pressure steam humidifier control was optimized for summer operation.
- AHU unoccupied hour setback was extended by 2 hours.
- OR ACH setback was tested and implemented.
- Chiller reprogramming for curtailment was completed and monitored.
- IT equipment energy assessment/survey was completed.
- New BAS integration with Building OS platform.
- Unoccupied hour setback for next set of AHUs.
- Heat wheel optimization was reviewed for winter operation.

2021

- Installed additional temperature sensors and utilized the return air damper to optimally operate the heating and cooling for AHU 14.
- Replaced 14 reheat globe valves on several VAV reheat coils for AHUs.
- 11 VFDs scheduled to be replaced on five critical (AHU 05 SF, AHU 05 RF, AHU 13A SF, AHU 07 RF, AHU 15 SF) and four non-critical units (EF 24, EF 48, CND P2, DHW P23).
- B&M recalibrated and repaired actuators for dampers on AHU 6,8,14 & 15 under active maintenance.
- Reprogramming of Operating Rooms VAV to get more accurate discharge temperature.

2022

- B&M worked with Siemens to reprogram parking fans to get more accurate Static.
- For Air Handling Unit #14, B&M installed some extra sensors to help better program the operation of the heat wheel under active maintenance.
- B&M calibrated exhaust fans to yield electrical savings.
- Close the door program was implemented and currently being monitored – EVS and Security teams were informed regarding the relation between door closing and energy savings.

2023

- B&M replaced existing 40W/T8 fluorescent lighting fixtures to 13W LED lights to yield energy savings for P1 level.
- B&M implemented setbacks on VAVs for P1 level.
- B&M implemented lighting setback over weekends on all floors except for floors 1 & 2.
- B&M completed the configuration of the two eGauge devices and integrated 3 chiller & 5 AHU real-time energy points to the energy management platform - Atrius.
- B&M retrofitted fluorescent lighting fixtures to LED for floor 1.
- B&M implemented further setbacks on AHUs #10 & #12 & 14 during unoccupied hours on weekdays & throughout weekend working alongside with Siemens.

WCH Energy Goal & Action Plan Timeline

Upon analyzing the energy performance review period (2019-2023), Black & McDonald Ltd. understands that there is further room for improvement in energy efficiency and greenhouse gas emissions reductions.

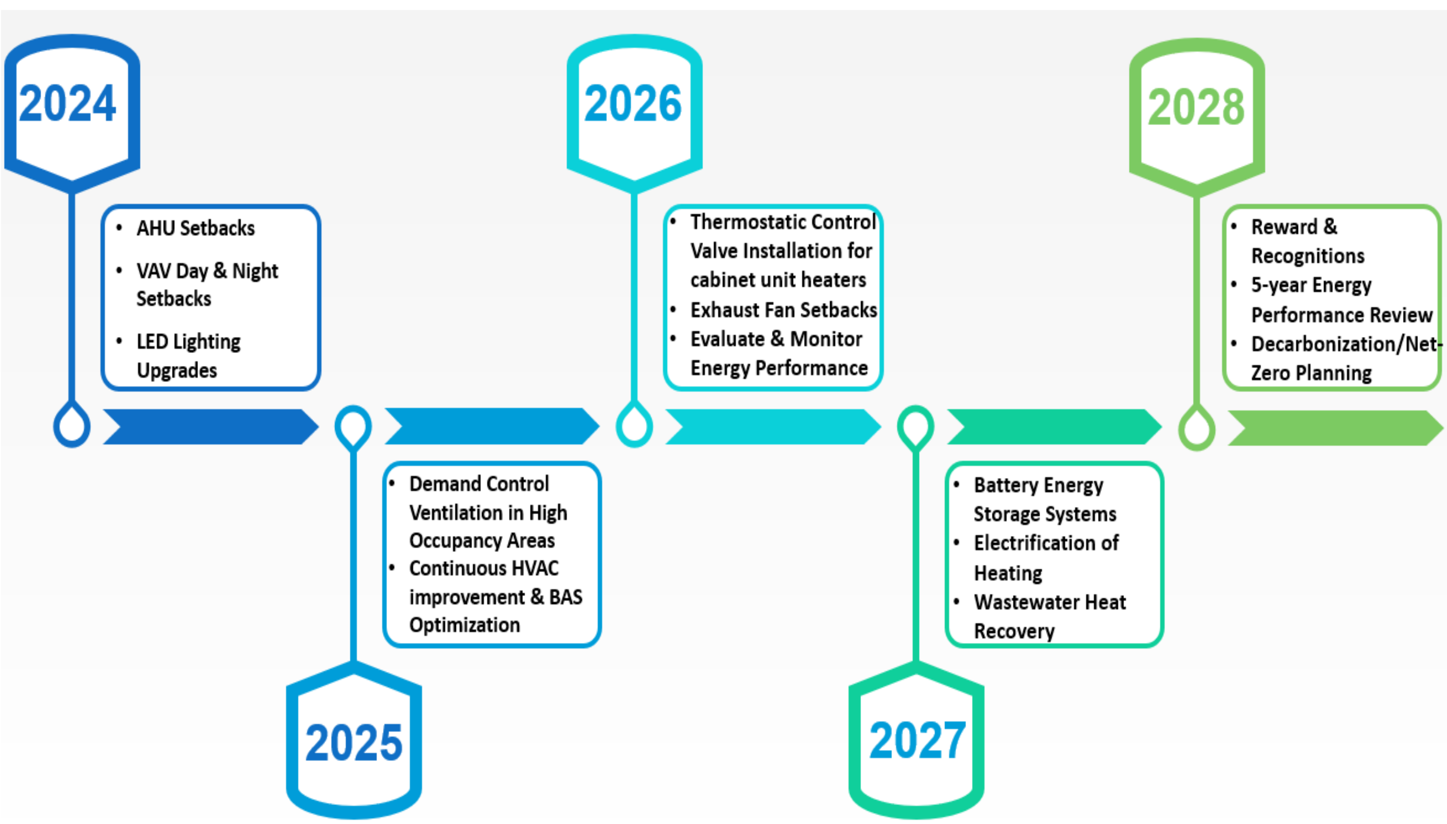
Over the next five years, the target is to reduce the total energy usage to 15%. To achieve this, the target is to attain a minimum of 3% annual reduction.

Short-term goal →

- To be achieved by implementing all low/no-cost ECMs.
- To constitute 5 to 7% energy reduction.

Long-term goal →

- To be achieved by implementing capital intensive ECMs by prioritizing based on business case.
- To constitute 10 to 12% energy reduction.



Projected Impact of Key Measures

Measure	Estimated Energy Savings	Estimated Energy Cost Savings ($)	Payback (Years)	Measure preferred state
Continuous HVAC improvement & optimization	O&M Measure	O&M Measure	O&M Measure	Ongoing identification and implementation of O&M improvements, optimizing the building subsystems performance as well as how they function together.
Right-sizing Ventilation Air-flow volumes	O&M Measure	O&M Measure	O&M Measure	Energy savings due to reduced air flow. Air flow sized based on current code requirements and space usage.
Air-Handling Unit Setbacks	20-25%	TBD	<2	Energy savings due to occupancy scheduled control. Improved thermal comfort by scheduling AHUs.
LED Upgrade – Floor 9	112,347 kWh	$16,036.06	1.2	Energy savings. Improved lighting quality and lamp life.
Lighting Occupancy Sensors	5-10%	$2,875	<1	Optimization of Space control
Variable Air Volume Setbacks – Floor 2 Phase 1 & Phase 2.5	5-10%	TBA	<1	A dynamic control of the HVAC system and the integration of lighting control and occupancy override will save energy, improve comfort/
Demand Control Ventilation	TBA	TBA	2.5 - 6	Install DCV system. Reducing the speed of the supply fans during slows periods not only saves electrical energy but also the thermal energy used to heat the air that is exhausted unnecessarily.
Thermostatic Control Valve Installation for cabinet unit heaters	10-20%	TBA	<3	Through installation thermostatic control of heater can achieve optimum control for the entrance areas
Exhaust Fan Setbacks	O&M Measure	O&M Measure	O&M Measure	Scheduled and managed HVAC system to operate according to building occupancy and space usage.
Re-commissioning (EBCx) – Audit Phase	IESO Incentive Available	TBA	Capital Project Measure	Tuning up hospital's energy efficiency while reducing cost and increasing market value
Battery Energy Storage System (BESS)	TBD	TBD	<10, Capital Project Measure	Reducing demand charges, strategy to demand response.
AHU Heat Recovery Optimization	TBD	Varies on efficiency	Capital Project Measure	Heat wheel optimization strategy to reduce energy consumption.
BAS Optimization	10-20%	TBD	O&M Measure	Ensure facility is running at peak performance. Optimize the systems and to figure out where the energy is going.
Electrification of heating	TBD	Further Investigation Required	Capital Project Measure	In conjunction with cleaner electricity grids, the electrification of space, domestic hot water and process heating systems are an important strategy to help organizations achieve deep GHG emissions reductions (e.g., air-source heat pumps, ground-source heat pumps, etc.).

Wastewater Heat Recovery: Noventa Energy	TBD	TBD	Capital Project Measure	Reduced energy, GHG emissions through waste heat recovery strategy.

Table 1: Proposed ECM's

Table 2: Ongoing Organizational & Behavioral ECMs

Measure	Type of Measure	Costs ($)	Responsible Parties	Key Performance Indicators (KPI)
Close-the-door program	Behavior	minimal, internal resources	Energy & Sustainability, Facilities Management, EVS & Security, Hospital staff	Percentage of doors closed off when room unoccupied, Energy saved
Engage and recognize staff commitment to energy conservation	Behavior	minimal, internal resources	Energy & Sustainability, B&M Facilities Management	Earth day events to promote and raise awareness on energy & sustainability along with waste management component
Environment, Social & Governance (ESG) Committee	Organizational	Varies, internal & external resources	Facilities & Operations, Women's College Partnership (WCP), environmental services, B&M FM & Energy Team, Operating Room, Family Health Team, Mohawk Medbuy, Finance & Procurement, Research, Ad Hoc	Provides advice and recommendations on ESG issues. The committee will investigate, implement measures, and champion initiatives to reduce WCH's environmental footprint while maintaining compliance with municipal, provincial, and federal legislation. The Committee will integrate the principles of sustainability and sound environmental practice into all functions and operations within the hospital to continue to improve our social accountability and presence while advancing WCH's strategic plan.
Energy Working Group	Organizational	minimal, internal resources	Energy & Sustainability, B&M Facilities Management, WCH Facilities Management, WCH Partnership, Infrastructure Ontario	Energy working group team led initiatives and events. Monitoring & Evaluating energy performance. Regular performance of utilities data and identification of energy savings opportunities.
Quarterly Utilities Meeting Group	Organizational	minimal, internal resources	Energy & Sustainability, B&M Facilities Management, WCH Facilities Management, WCH Partnership, Infrastructure Ontario	Monitoring & Evaluating energy performance each & every quarter of the energy performance period. Regular performance of utilities data and identification of energy savings opportunities.

Air-Handling Unit Setbacks

B&M has implemented after-hours setback on Air Handling Units:

- AHU #10 (Level 4) - Phase 1 (Serve Type 2 and Type 3 Area as per CSA standard)
- AHU #12 (Level 5) - Phase 1 (Serve Type 2 and Type 3 Area as per CSA standard)
- AHU #14 (Level 3) - Phase 1 (Serve Type 2 and Type 3 Area as per CSA standard)

The purpose of the occupancy scheduled control is to efficiently control the building systems during unoccupied mode which in turn can significantly reduce cost and energy consumptions at the hospital. These units will be programmed to automatically work at reduced levels or shut down during unoccupied hours (11 PM to 5 AM) on Weekdays and throughout the weekend.

The goal is to have significant energy savings for nights and weekends. Setbacks will comply with the minimum standards for hospital outlined in CSA Z317.2:19. These units serve TYPE 1, TYPE 2, and TYPE 3 areas in the hospital as per CSA Standard.

AHU 10, 12 and 14 will stay shut down between 11PM and 5 AM during weekdays and throughout the weekend. While maintaining the temperature and humidity levels as per CSA standard.

To ensure temperature and humidity stay within limits, Black and McDonald Ltd. will collaborate with Siemens to establish programming on the BAS to automatically start these AHUs if the temperature or humidity levels on the floor exceed their designated limits.

There is an alarm system for humidity and temperature in place for all floors, and it will notify the 24/7 B&M call center, Shift Operator, and Site-Supervisor if the levels go beyond the established range.

Potential Energy Savings:

The energy performance of a ventilation system is influenced by several factors: the air flow rate, the amount of fresh air introduced in the system, the presence of the reheat coil and a heat recovery device, the type of fan and ventilation control.

Implementation of the proposed saving measure would reflect an average of 20-25% energy savings per annum for the existing Air-Handling Units working conditions.

LED Retrofit Project

WCH is illuminated with a variety of fluorescent and LED lighting fixtures. Black & McDonald Limited recommends retrofitting the fluorescent lighting fixtures in the common corridors, stairwells, office spaces, training rooms and meeting rooms with LED lamps and low power or dimmer ballasts as areas with long operating hours will maximize savings. It is evident that the facility is transitioning to LED technology as there were several LED lights installed throughout the facility.

The benefits of using LEDs over linear fluorescent technology include:

- Mercury Free – LEDs contain no mercury which are more environmentally-friendly than fluorescents.
- Directional Lighting – LEDs offer directional light (illumination exactly where you need it). On the other hand, fluorescents have multi-directional light, which means some light is lost in the fixture and other unnecessary places.
- Controls – Fluorescent lights tend to burn out faster when integrated with occupancy sensors and other controls. In contrast, LEDs work perfectly with control systems since their life is not affected by turning them on/off.
- Better Efficiency – LEDs are approximately 30% more efficient.
- Quality Light - LEDs produce light in a variety of color temperatures like fluorescent, but do not have any flickering issues that can happen with fluorescent.
- Lifespan – The average life of a T8 LED is 50,000 hours, versus only 30,000 hours for an average T8 LFL. One thing to keep in mind though is that there are now linear fluorescent T8 lamps that last up to 90,000 hours but operate on programmed start ballasts.

With spot re-lamping (replacing lamps as they burn out), most labor costs are typically associated with getting equipment and personnel to the space and setting up the work area. With group re-lamping, these costs still exist but are spread over multiple fixtures thereby reducing the per-fixture labor cost. With group revamping, all the lamps in each area are replaced at a scheduled time. This method is the most effective and least cost-intensive approach than spot re-lamping. This procedure often includes the repairing or replacement of defective parts in the fixtures such as sockets and ballasts. It also includes washing and cleaning the reflective surfaces and lenses. It is recommended implementation of this strategy be considered.

Converting to LED can help bring lighting levels more in line with Illuminating Engineering Society of North America (IESNA) guidelines and enhance the visual environment. To confirm this estimation prior to implementation, a photometric analysis is recommended to ensure illumination requirements set by the IESNA are met.

The LED replacement was recently completed on floor P1 that yielded approximately over $28k in energy savings.

Savings Potential

The ongoing plan is to convert approximately 452 existing 40W fluorescent light fixtures to 13W LED fixtures on floor 9.

Philips Energy Consumption Results (13W Option)			**Calculations**		**Notes**
Existing Conditions (40W)			Number of lights	452	light count
Existing Demand:	25.4	kW Demand	Cost of kWh	$0.15	January 2024 electricity utility rate
Existing Consumption:	158,381	kWh	*40W CFL uses 25W of power*	Existing conditions	
Existing Utility Charges:	$23,757	Annually	158,381	kWh	*8760 hours in a year*
Proposed Retrofit (13W LED)			$23,757.12	$ annually	
Proposed Demand:	8.3	kW Demand	*13W CFL uses 8.3W of power*	Post-retrofit state	
Proposed Consumption:	51,474	kWh	8.255	kW	*8760 hours in a year*
Proposed Utility Charges:	$7,721	Annually	51,473.76	kWh	
Estimated Savings			$7,721.06	$ annually	
Demand Reduction:	17	kW Demand	Payback Period (Years)	1.2	
Consumption Reduction:	106,907	kWh			
Reductions in Utility Charges:	$16,036.06	Annually			

Fixture Type: CFL	
Total Light Counts (# no. of lights)	452
Total cost for lamp ($/lamp)	$12
Installation Cost ($)	$30
Total Energy Lamp Costs ($)	$18,984

Lighting Occupancy Sensors/Hallway Motion Sensors

While occupancy sensors can be used in tandem with HVAC to provide demand control ventilation (DCV), they are also great for conserving electrical power by turning off lighting in unoccupied spaces. The current practice is for building management and occupants to turn off lights around the building at the end of the day or during low occupancy. However, this process could be automated through occupancy sensors and may eliminate the possibility of missed illuminations.

PIR sensors detect occupancy by sensing thermal differences between a human body in motion and background space and require a direct line of sight between themselves and the occupant.

Figure 1: Passive Infrared (PIR) Coverage Pattern

Ultrasonic sensors send out ultrasonic sound waves and sense motion by detecting changes in the echo of the sound waves that return to the sensor. They do not require direct line of sight, making them beneficial in areas where obstacles such as partitions exist.

Figure 2: Ultrasonic Coverage Pattern

Dual technology sensors use both PIR and ultrasonic technologies, and therefore have the higher accuracy for occupancy sensing. Energy Ottawa recommends using dual technology sensors for this application. A total of three wall switch-mounted dual sensors and three ceiling-mounted PIR sensors have been identified as part of this recommendation.

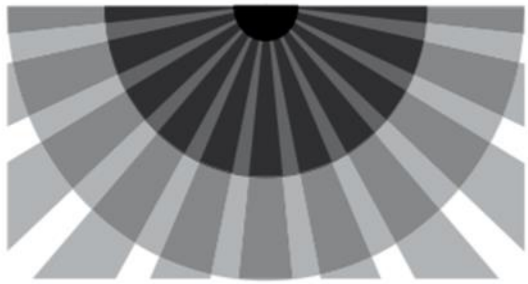


Figure 3: Dual-technology Coverage Pattern

Installing occupancy sensors with ON/OFF/AUTO selector in the common washrooms, emergency stairwells, mechanical spaces and storage areas can control the lighting based on actual occupancy. Energy savings will be realized through reduced electrical consumption from lighting during facility operation hours and at night for any areas where lighting is left on after hours.

Space Control - An occupancy sensor that automatically turns lighting off within 30 minutes, must be installed in hallways, common washrooms, emergency stairwells and mechanical spaces. Occupancy sensors are recommended for all mechanical rooms, emergency stairwells, several storage areas, and common washrooms which account for approximately 5% of all light fixtures in the facility.

Savings Potential

Using a lighting density of 0.7 W/ft^2 (as per ASHRAE 90.1), we can effectively have controls on roughly 10% of the GFA (gross-floor area) which equates to 43,286 ft^2. Sensors can reduce the time the lights stay on each day by approximately 2 hours, resulting approximately in annual savings of $2,875 and having a payback period of less than 1 year.

Increasing Efficiency with VAV System Day & Night Setbacks

Supply air fans on variable air volume (VAV) systems are typically controlled to maintain static pressure in the duct system at a given setpoint. Outdoor airflow into a building is necessary for occupant health & comfort, but conditioning it requires large amounts of energy and makes overventilation an expensive problem. However, in variable air volume (VAV) systems a way exists to reduce this cost by increasing the efficiency of how the ventilation air is distributed.

The secret is to oversupply discharge air to certain zones, despite the reheat penalty incurred by doing so. The counterintuitive notion reveals a trade-off in how much energy can be consumed in different parts of the system. Advanced control systems can take advantage of this dynamic to optimize system setpoints in real time, yielding significant energy cost savings.

A significant number of the Variable Air Volumes (VAVs) in the hospital can be reconfigured to provide improved damper modulation that would translate to more precise modulation of supply air fan speed.

This measure is currently being implemented on P1 level, hallways, and examination room to 21°C. Due to which we have already seen reduction in energy consumption on AHU-7 by roughly 5-10%.

Savings Potential

Black & McDonald Limited proposed implementing VAV (Day/Night) Setback on floor 2 Phase 1 & Phase 2.5. This setback will only be implemented in the offices and conference rooms, including the Pink Cube of the 2nd floor. The setback will be active between 11 PM to 5 AM and throughout the weekend. The areas where we plan to implement setbacks are classified as TYPE 3 areas, according to CSA standards. Siemens will program the BAS system to ensure compliance with CSA requirements.

During unoccupied periods, Air handing system serving Type 3 areas may have air volumes reduced or shutdown. Such reduction or shutdown shall not affect space pressurization relative to adjacent zone.

Note – Air handling Systems Serving only Type 3 areas may be shut down without need for monitoring and maintenance and humidity.

Demand Control Ventilation in High Occupancy Areas

With this measure, the recommendation is to install CO_2 sensors in high occupancy spaces such as waiting areas. The sensors would monitor CO_2 in the space and ventilation would be modulated to improve indoor air quality and satisfy code requirements. This is expected to vary the % fresh air intake and in turn reduce the heating and cooling load, and as well reduce electricity consumption by supply fans. As per ASHRAE standard 62.1, the ventilation rate will be slightly higher than 10% as the actual fresh air will increase slightly during a CO/CO_2 call for fresh air per the sensors.

Potential Energy Savings:

- Estimated Average Incremental Initial Costs (Ventilation Control) for the CO/CO2 sensor: $6,500 (based on RETScreen Cost Database of $5,500 for control unit, $1,000 for contaminant sensor and proposing for “Tight & Insulated” intake air damper leakage of $(0.2/(L/s)).
- Considering the upfront cost and maintenance savings, the estimated payback period for a conventional DCV system range between 2.5 years to 5 years.

Control Valve Installation via Thermostat

Cabinet unit heaters effectively make each area serve an independent heating zone. Through installation thermostatic control of heater can achieve optimum control for the entrance areas. On steam systems a low limit may be used to prevent fan from blowing cold air unless the heater has steam passing through the coil.

Small hot water systems could have the circulating pump controlled directly by the room thermostat. On large systems, zone valves could be used to control the individual unit heater where constant water circulation is used on the main system.

Potential Energy Savings:

The estimated energy savings ranges from 10-20% of the existing cabinet unit heaters in place at the facility and payback time are less than 3 years (heating seasons) in most cases.

Exhaust Fan Setbacks

Building exhaust systems removes the air and expel the contaminants to the atmosphere. If the intake or exhaust system is not well-designed, contaminants from nearby outdoor sources or from the building itself can enter the building before dilution. Poorly diluted contaminants can cause bad odors, health impacts and poor indoor air quality.

Fan power savings are even greater because of the affinity (cube) law, and reheat savings are proportionally greater because of the reduced heat loads in the occupied rooms.

To address these setbacks, healthcare facilities should prioritize routine inspections, preventive maintenance, and invest in modern and efficient ventilation systems. Regular training of staff on the importance of proper ventilation and prompt resolution of any identified issues are also crucial to maintaining a safe and healthy environment in healthcare settings.

IESO – Existing Building Re-commissioning Program

IESO's Existing Building Commissioning (EBCx) program delivered by Siemens is designed to execute industry standard phases: provide an energy-focused review of mechanical systems, implement labor-based/" keystroke" repairs/improvements in ana expeditious manner and establish a protocol to ensure persistence of all building performance improvements provided by this initiative. SBCx from Siemens delivers operational improvements and potential energy efficiency improvements aimed to achieve faster and persistent results. These objectives are met by employing a mix of people, process, and technology through the development of an integrated commissioning team comprised of Siemens' commissioning team and key stakeholders from Women's College Hospital. This will require the involvement of Women's College Hospital, operations, management staff and any requisite third-party participants.

A complete SBCx project will comprise of 3 phases:

1. Assessment/Investigation
2. Implementation
3. Hand-off/Persistence

This current proposal is inclusive of the Assessment/Investigation phase. The Implementation and Persistence phase proposals will be provided to Women's College Hospital in a sequential manner based on the findings/activities of the previous phase. This process aligns with industry practices as well as the IESO SaveOnEnergy EBCx- incentive program.

Siemens will execute an SBCx project at WCH 76 Grenville St, Toronto, ON. This project will include the equipment listed below:

Air Handling Unit	Area Served
AHU1	Auditorium & MP Library Phase 2
AHU 2	Retail Phase 2, Public Areas & Atrium
AHU 3	Interprofessional Office & Education
AHU 4	Interprofessional Office & WCRI Phase 2
AHU 5	UCC / CDU
AHU 6	Imaging
AHU 7	Records, Archives, Material Management
AHU 8	WCRI Phase 1 & Admin Office
AHU 9	Mental Health
AHU 10	SMS-MSK, Gym, SMS-CP
AHU 11	Pharmacy, Frozen Lab, Compounding
AHU 12	Dermatology, Women & Cancer
AHU 13	Surgery
AHU 13A	Surgery A
AHU 14	Primary Care
AHU 15	Peri-Operative Services
AHU 16	CSR
Chillers & Enwave Hx	Various
Cooling Towers	Various
Steam (Enwave)	Various

The main goal of the Investigation Phase is to identify deficiencies and potential improvements and determining the most cost-effective corrective actions/repairs required to satisfy the Current Facility Requirements and conserve energy. Siemens will look at aspects of the current O&M program/practices and other variables that influence the operability of the equipment. The main activities in the Investigation Phase are as follows:

• Setup/analysis of trending & operational data

• Review of PPCL/programming logic to identify improvement opportunities

• Functional testing of equipment

• Developing the Commissioning Corrective Action Matrix (CCAM)

• Selecting initial opportunities for implementation

Utility Rebates

Through its SaveOnEnergy program, the IESO has recently launched an Existing Building Commissioning rebate program. For eligible facilities, this program provides:

• $0.06/ft2 (up to the lesser of $50,000 or 75% of project cost) for the Investigation Phase

• $0.03/kWh of projected first-year electricity savings (up to $50,000 or 30% of baseline electricity use) for identified measures which are approved for implementation (calculation based)

• $0.03/kWh of actual first-year electricity savings (up to $50,000 or 30% of baseline electricity use) for implemented measures after a 12-month monitoring period (performance-based)

Key criteria for eligibility include buildings which:

• Have not undergone an EBCx project within the last two years

• Can provide 12 months of consecutive energy data

• Consume a minimum of 750,000 kWh/year

Battery Energy Storage System (BESS)

A power outage can be caused by electricity spikes where there is a temporary increase in the electricity supply voltage and can result in equipment damage or loss of power. A brown out is the reduction of electricity supply in each area where the voltage drops due to a supply shortage and power can become unstable or lost altogether. Reduced power quality to a site can lead to electrical equipment damage and increased costs. A battery energy storage system (BESS) or capacitor bank are measures that can be implemented to reduce the impacts of power spikes and drops.

The average load factor for the months of December 2023 to February 2024 was 0.75. If your load factor ratio is above 0.75 your electrical usage is reasonably efficient. If the load factor is below 0.5, you have periods of high usage (demand) and a low utilization rate.

The use of a battery energy storage system (BESS) allows energy to be stored and used at any time and can serve to substitute or compliment many elements of power generation. BESS systems can also be viewed as a tool for demand response, as they can be brought online at time where energy demand outstrips energy supply. BESS can reduce demand charges by discharging when a building is approaching its peak load and are particularly well suited in energy markets with high demand charges. Energy storage also helps provide resilience since BESS can serve as a backup energy supply when power plant generation is interrupted. Stored energy in a BESS can be accessed to combat power outages so that building operations can avoid disruption.

There is also the potential to use battery storage for future renewable energy projects that could reduce energy costs and carbon emissions. The cost of a BESS can vary greatly depending on size, use, location, and payment structure. Battery providers can offer different payment plans and contracts that impact upfront costs and long-term savings. Further investigation would be required to determine which type of battery and which provider would be the best fit for the Women's College Hospital.

AHU Heat Recovery Optimization

A heat pipe system is a thermal transfer device, basically a sealed tube filled with refrigerant. It consists of three elements: a sealed pipe, a capillary wick structure, and a refrigerant fluid. Because the pipe is sealed under a vacuum, the working fluid is in equilibrium with its own vapor. The capillary wick distributes the working fluid over the inside of the heat pipe. Hot air flowing over end of the pipe evaporated the working fluid. The vapor is then condensed on cooler end, giving up its head to second air stream. The vapor flows back to the evaporator, completing the cycle.

These heat pipe recovery units were not investigated while on site as they are hidden inside the air handling units. The units do not require any special maintenance; however, it is suggested that they be investigated for proper operation and refrigerant levels. Currently, there are more efficient refrigerants available on the market that improve overall efficiency of the heat transfer.
It is recommended that the units be investigated by an HVAC specialist to measure the refrigerant pressures and check for proper operation of the system. Heat pipe recovery systems are sensible devices with efficiencies ranging from 45% to 65%. Efficiency can be lowered by the pressure drop of moving air through each side of the system. A well operating heat pipe can provide significant savings to the overall heating and cooling loads.

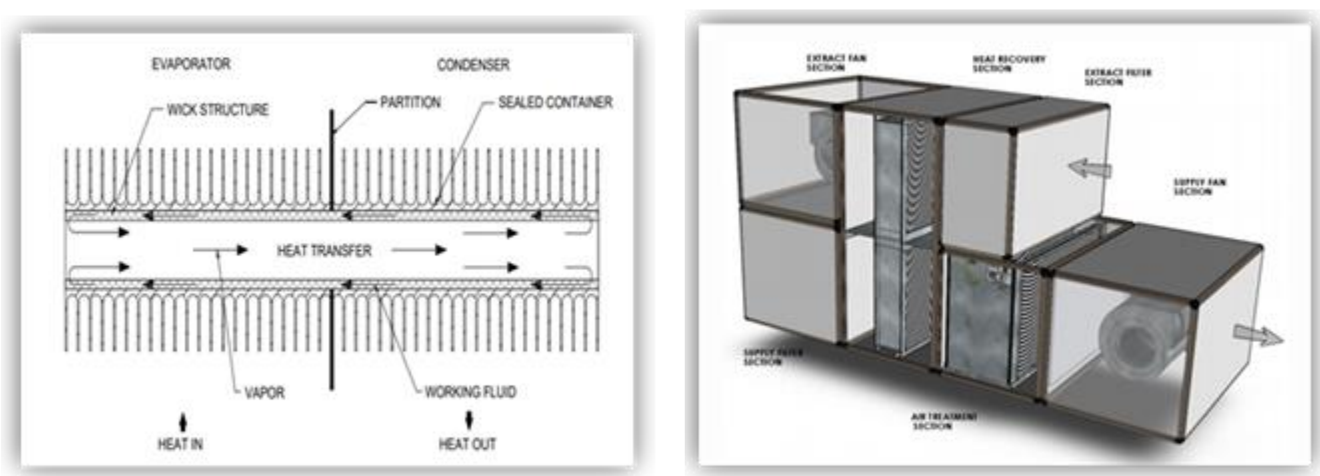


Figure 4: Heat Pipe System with Section View on Right

BAS Optimization

B&M team recommends involving Schneider Electrical integration engineers and support team more often to ensure the building is running at peak performance. If the building's energy usage showing incremental trends and there haven't been any major changes in the building, then the rising energy usage should be an alarm bell to get in, optimize the systems and to figure out where the energy is going. Well-designed building automation can save a property owner 5% to 20% annually in energy costs.
The following are best practice control strategies commonly implemented by building automation systems and proven financially justifiable:

- Zone Scheduling – Permits defined sections of a building to have HVAC and lighting reduced or shut down on a schedule. Zone scheduling means that a whole building does not need to run at a 100% comfort setting if on only a few occupants are in the facility.
- Night/Unoccupied Setback – Changes the comfort settings (set points) of HVAC so that space temperature decreases in winter and increases in summer, thereby reducing demand for heating and cooling during unoccupied hours. This feature can also be done using a programmable thermostat, but with only a few schedules and no flexibility to change setback temperatures more aggressively.
- After-Hours Override – Allows temporary changes to comfort settings after-hours. This eliminates the need to modify schedules, which can sometimes become permanent by accident. This also avoids having the entire building run in occupied mode to meet the needs of a small group.
- Occupancy Sensors – Detect motion or infrared signatures in the space, and trigger lights or HVAC accordingly. The BAS also enables scheduled overrides or triggers based on card access to an area of the building.
- Holiday Scheduling – A calendar defines HVAC and lighting control for an entire calendar year, saving staff time implementing special schedules and ensuring holiday weekdays do not run in occupied mode.
- Optimum Start – Starts HVAC equipment only as early as required to bring the building set points to comfort levels for occupancy. Control routines consider outside air temperature and inside space temperatures when initiating the morning warm-up or cool-down cycles. Optimum start takes the guesswork out of scheduled start- up.
- Optimum Stop – Determines the earliest possible time to initiate setback temperatures before unoccupied periods while still maintaining occupant comfort, also known as coasting. Space temperature drifts gradually beyond comfort levels in anticipation of the unoccupied period.
- Temperature setbacks are a well-known means for saving heating energy by allowing the temperature in a conditioned space to drop to a specified set point when the space is not occupied. The general rule of thumb is that energy savings are typically 1% of space heating or cooling energy use per degree of temperature setback for each 8-hour period. Of course, a few factors contribute to the heating and cooling energy required for any facility, including insulation, ventilation, infiltration, windows, weather conditions, and indoor conditions.

Electrification of Heating: Ground-source heat for district energy

Ground source heating—which includes stored solar energy that can be utilized for heating and cooling—can replace the fossil fuels currently being used. While some critics believe that Canada isn't ideal for geothermal systems due to its low amounts of geothermal activity, when it comes to direct use of heat, geothermal resources are not required to be quite so hot. Stored solar energy that can be found underground just four meters deep is sufficient for heating buildings.

Ground source heat pumps (GSHPs) use the ground, groundwater, or surface water as a source and sink for heat. GSHP systems can absorb or reject heat from the ground through a heat exchange system called the ground loop. Via the heat pump, the indoor air exchanges heat with the fluid running through the ground loop. Although geothermal energy can't be considered 100% clean energy (the heat pumps may be using electricity produced by fossil fuels), heat pumps reduce carbon emissions as there is no combustion involved and no flue gases emitted. As such, GSHPs for district heating are a key technology to decarbonize the heating sector and reduce the dependency on fossil fuels.

To support this initiative, B&M team can assist in feasibility studies, planning, engineering, and setting up a business case to investigate use of geothermal energy in district energy applications.

Although geothermal heat as a resource is free of cost, there are high upfront costs associated with using it. Typically installing GSHP systems can be very expensive for an individual household or building. However, economies of scale when implementing these systems in district heating applications by serving multiple existing homes or a community enable more affordable and widespread use. Another benefit is that portions of the pipes for these systems can be buried horizontally as opposed to vertically underground, which can further reduce costs as vertical drilling is expensive. Ultimately, savings in energy and maintenance costs in the long run offset the upfront expenses.

Utilizing ground source heat to provide heating and cooling to customers in district heating applications is possible for new developments if sufficient planning is done ahead of time to integrate these systems into the design, supportive policies by the government are implemented, and if grants are made available to help advance geothermal community energy systems.

Wastewater Heat Recovery: Noventa Energy

Wastewater heat exchangers can recover heat from the hot water used in showers, bathtubs, sinks, dishwashers, and clothes washers. They generally have the ability to store recovered heat for later use. You'll need a unit with storage capacity for use with a dishwasher or clothes washer. Without storage capacity, you'll only have useful energy during the simultaneous flow of cold water and heated drain water, like showering.

Some storage-type systems have tanks containing a reservoir of clean water. Drain water flows through a spiral tube at the bottom of the heat storage tank. This warms the tank water, which rises to the top. Water heater intake water is preheated by circulation through a coil at the top of the tank.

Non-storage systems usually have a copper heat exchanger that replaces a vertical section of a main waste drain. As warm water flows down the waste drain, incoming cold-water flows through a spiral copper tube wrapped tightly around the copper section of the waste drain. This preheats the incoming cold water that goes to the water heater or a fixture, such as a shower.

By preheating cold water, drain-water heat recovery systems help increase water heating capacity. This increased capacity really helps if you have an undersized water heater. You can also lower your water heating temperature without affecting the capacity.

In conventional cooling systems, heat is removed from the building and rejected outside via cooling towers. In ideal conditions, today's chillers can achieve a COP of 5.0 – 6.0 however hot & humid climatic conditions can result in COP reduction to 3.8 – 4.2. In conventional heating systems, natural gas is burned in boiler plants to produce hot water or steam (75 – 80% efficiency). In ideal conditions, a boiler plant can achieve COP of 0.8.

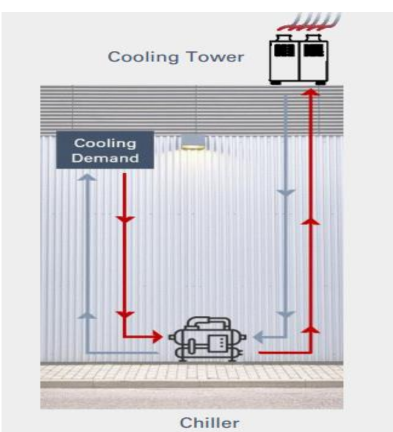


Figure 5: Conventional Cooling System

Figure 7: Conventional Heating System

Noventa Energy, a global renewable energy company providing innovative ways of decarbonizing buildings, is HUBER's exclusive North American distributor and energy partner for the ThermWin® series of equipment. HUBER Technology, a global leader in wastewater management, providing wastewater solutions and equipment for over 180 years, is the manufacturer of ThermWin® equipment for wastewater heat recovery.

Noventa WET System for Cooling: an efficient way of cooling with reduced Scope 2 GHG emissions. Heat is removed from a building and rejected to wastewater via the ThermWin® system. Overall COP of 6.5 (or higher) as result of heat rejection to wastewater rather than cooling towers, with minimal impact from weather conditions. Significant water savings realized from decreased or eliminated use of cooling towers.

Noventa WET System for Heating: Heat is extracted from wastewater via the HEBER ThermWin system. Heat pumps are used to produce hot water or steam at the required temperatures. Elimination or significant reduction of natural gas usage and overall COP of 4.5 (or higher).

Further investigation is required to determine feasibility of wastewater heat recovery system at Women's College Hospital.

The Noventa Wastewater Heat Recovery advantages:

- Reduced energy consumption
- Reduced GHG Emissions
- Reduced water use
- Lower operating costs
- Improved System reliability & resiliency
- Reduced Capital cost

Progress Evaluation

To achieve Women's College Hospital short and long-term goals, our approach is to strategically plan and invest in technical, organizational, and behavioral measures.

Proposed energy conservation measures will be evaluated and approved using the following tools and criteria:

- Staff, patient's safety, and patient care.
- Financial parameters such as simple payback, internal rate of return, capital cost and energy cost/savings over the life of the equipment or design.
- Impact on environmental performance which includes EUI, WUI and GHGs.

Figure 6: RETScreen Workflow

- The RETScreen Clean Energy Management Software platform enables low-carbon planning, implementation, monitoring, and reporting.
- ENERGY STAR Portfolio Manager – an interactive resource management tool that enables you to benchmark the energy use of any type of building, all in a secure online environment.
- Atrius (Building OS Energy Management Platform) – an online data management platform used to analyze and report various facility consumption metrics such as energy, water, waste, and greenhouse gas emissions. Atrius offers many tools and features so that data from different sources can be easily incorporated onto the platform and analyzed using calculators and graphics.

Figure 7: WCH AHU Operational Dashboard - Atrius

Where possible, more costly conservation projects will be bundled with more cost-effective ones to leverage their development.

Implementation of the project depends on the:

- Funding allocated by WCH.
- Incentives from utility providers, government and/or other partnerships.
- Availability of staff.

Availability of Financial Incentives

Whenever the "retrofit projects" opportunities will be identified during the ECDM action plan timeline, we will explore all potential incentives and funding streams available. The following are the few examples of the financial incentives available in the market currently:

- Independent Electricity System Operator (IESO): The Save on Energy Retrofit program offers businesses incentives to upgrade equipment, reduce energy bills, lower carbon footprints, and enhance staff comfort. The program offers financial incentives through various streams.
  - *Custom Stream*: The custom stream offers financial incentives for businesses to undertake larger, more complex retrofit projects, that are more reflective of the participant's actual operating conditions. The custom stream is structured to accommodate a wide range of project types to help participants capture greater energy savings.
  - *Prescriptive Stream:* The prescriptive stream offers financial incentives for targeted retrofits, helping participants upgrade to more energy-efficient equipment. The prescriptive stream, which focuses on commonly used products and technologies, is suitable for more typical upgrades of equipment. Businesses can receive incentives for a variety of energy-efficient measures available in three areas: Lighting controls, HVAC, and Manufacturing and other equipment.
  - *Greenhouse Stream*: Incentives are available as part of the Retrofit program for horticulture lighting, both top lighting and inter-lighting, and advanced lighting controls for greenhouses across the province. For Greenhouses in the Southwest region of the province, incentives are available for Distributed Energy Resources (DERs), including incentives for photovoltaic (PV) systems in combination with battery storage.
- Save on Energy's Strategic Energy Management (SEM) program is a transformational new program, designed to help organizations improve their energy performance by implementing an integrated system of organizational practices, policies, and processes to achieve persistent energy savings.
  - The SEM program will provide your organization with knowledge, expertise and training in energy management that can help increase your profitability through reduced energy costs and productivity, build organizational skills, and help your organization achieve your carbon reduction and environmental goals.
  - Participants will also receive incentives of $0.02/kWh of electricity savings for implementing eligible measures. These incentives are available for savings from projects that do not receive incentives from another Save on Energy or Ontario ratepayer-funded program.
  - Additional incentives for energy management tools such as meters and testing kits up to a value of $5,000, are available to participants who reach key program milestones.

Monitoring & Evaluation

Progress on projects is monitored using the monthly, quarterly, and annual energy reports. B&M references and follows the International Performance Measurement and Verification Protocols (IPMVP) as methods to develop, define and assess energy and power performance metrics.

The IPMVP is a set of framework documents used to develop strategies and plans for quantifying energy and water savings at the project level for retrofits and new construction. IMPVP groups measurement and verification methodologies into four categories: Options A, B, C and D. The four options provide a range of approaches to determine energy efficiency depending on the characteristics of the energy projects being implemented and balancing the accuracy in energy savings estimates with the cost of conducting measurement and verification activities.

Recognize Achievements

At every stage, progress made towards making WCH operation more energy efficient would be celebrated and key individuals whose contribution made it possible will be recognized. Achievement made will be communicated across the departments in the hospital and shared as best practices via articles and presentations at events and conferences.