Kingston Health Sciences Centre

Centre des sciences de la santé de Kingston

May 2024

Kingston Health Sciences Centre 2024-2029 Energy Conservation and Demand Management Plan

Management sign-off

I confirm that Kingston Health Sciences Centre's senior management has reviewed and approved this 2024-2029 Energy Conservation and Demand Management Plan.

Signature: 

Name: Nick Anand

Date: June 27, 2024

Title: Vice President, Facilities, Redevelopment, Planning and Protection Services

Under Ontario Regulation 25/23, Ontario's broader public sector organizations are required to develop and publish an Energy Conservation and Demand Management (ECDM) Plan by July 1, 2024. Technical advice and analysis for this ECDM Plan were provided by Enerlife Consulting Inc.

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Part 1: Introduction

1. About Kingston Health Sciences Centre

This Energy Conservation and Demand Management (ECDM) plan addresses Kinston General Hospital (KGH) and Hôtel Dieu Hospital (HDH), which together form Kingston Health Sciences Centre (KHSC). KHSC is one of southeastern Ontario's largest hospital complexes with acute and specialty care, research and teaching. It is one of the region's largest employers providing care for over 500,000 patients and their families. Affiliated with Queen's University, it is ranked as one of Canada's top research hospitals.

KHSC is committed to a sustainable future and has embraced a commitment to energy efficiency and environmental stewardship, while ensuring occupant comfort and efficiently delivering high quality healthcare. We have undertaken numerous projects aimed at lowering energy and emissions and improving facility operations.

Table 1 KHSC sites

Site	Address	Building Area (ft²)	Description
Kingston General Hospital	76 Stuart Street Kingston, ON K7L 2V7	1,238,560	Acute care facility
Hôtel Dieu Hospital	166 Brock Street Kingston, ON K7L 5G2	622,009	Ambulatory care facility

2. Planning horizon and scope

The horizon for this plan is the 5-year period from 2024 to 2029, prioritizing projects and organizational improvements which are manageable within this period.

3. Leadership in sustainability

KHSC has been participating in Greening Health Care for over 15 years, a program that helps hospitals work together to lower energy costs, raise their environmental performance and contribute to health and well-being of communities. During this time, KGH won two awards in 2010 and 2019 for saving over 5% energy in a year.

KHSC has won numerous additional awards for efforts in sustainability including the Ontario Hospital Association's Green Hospital Scorecard silver award in 2015 and bronze in 2013. The Green Hospital Scorecard is a benchmarking and recognition program that evaluates environmental performance in five areas: energy, waste, water, pollution prevention, and corporate leadership, planning and management.

Other awards include the SWITCH Sustainable Energy Award/Kingston Hydro Electricity Conservation Award in 2011 and 2015; Canadian Healthcare Engineering Society's (CHES) Wayne McLellan Award of Excellence 2014; and OHA Water Conservation and Protection Award in 2014.

Part 2: Results from the past 5 years (2019-2023)

1. Energy and water progress compared to targets

In the 2019 ECDM plan, KHSC set electricity conservation targets for each of our hospital sites, as steam and natural gas use at each site is primarily driven by weather conditions. As illustrated below, Kingston General Hospital exceeded its target while Hotel Dieu did not.

1.1 Kingston General Hospital

In the 2019 ECDM plan, KHSC was targeting a 5% reduction in electricity for Kingston General Hospital. Table 2 presents actual, weather-normalized performance results from the 2023 calendar year compared to the 2018 baseline, which resulted in net utility cost savings of $89,091.

Table 2 KGH: Energy and water savings vs 2018 baseline

	2019 Plan Target savings				**Actual savings (2023 vs 2018 baseline)[1]**			
	Units	**%**	**$**	**GHG (tonnes eCO_2)**	**Units**	**%**	**$**	**GHG (tonnes eCO_2)**
Electricity (kWh)	1,140,000	5.0%	$105,000	-	771,230	3.0%	$57,842	23
Natural Gas (m^3)	-	-	-	-	4,727	2.8%	$1,560	9
Steam (Klbs)	-	-	-	-	9,641	7.0%	-	718
Total Energy (ekWh)	**-**	**-**	**-**	**-**	**-**	**5.4%**	**$59,402**	**750**
Water (m^3)	-	-	-	-	6,905	4.4%	$29,689	1
Total	**-**	**-**	**-**	**-**	-	-	**$89,091**	**751**

Monthly savings graphs help identify the periods of recorded savings or increases. On the graphs in Figure 1 through Figure 6, the blue points are actual monthly energy use, and the red points are the comparative, weather-normalized 2018 baselines. Blue dots below red represent real savings.

The electricity consumption trend over the last 5 years in Figure 1 demonstrates small increases in 2019 and 2020 followed by savings between 2021 and 2023. The 5-year cumulative improvement was 1,498,042 kWh valued at $112,353.

[1] Using 2024 utility rates: Electricity $0.075/kWh, gas $0.33/$m^3$, water $4.30/$m^3$.

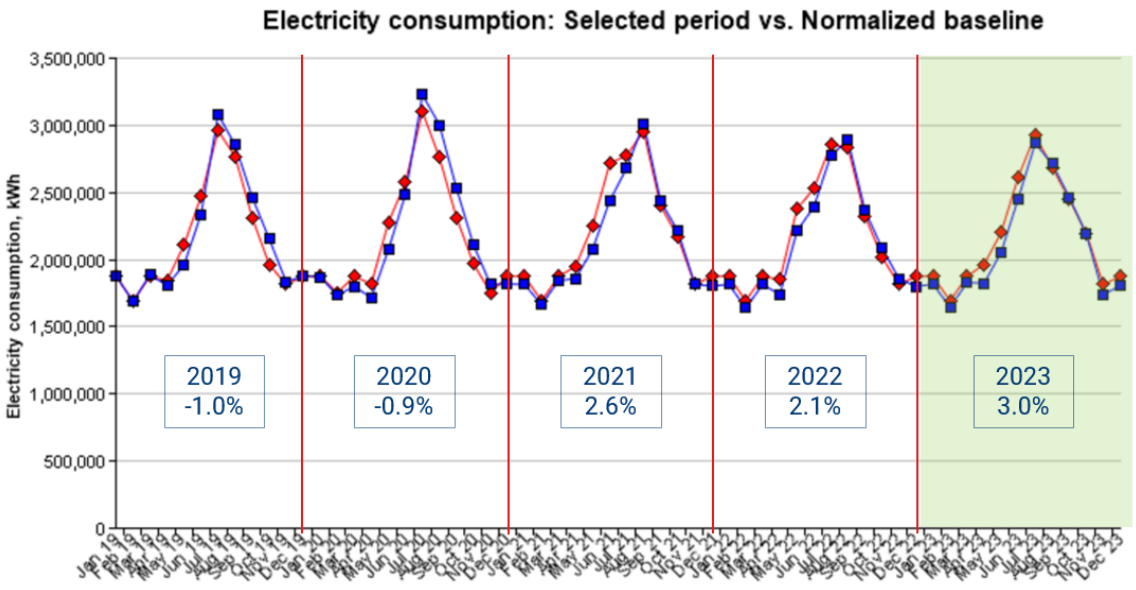

Figure 1 KGH: Electricity consumption (kWh) in 2019-2023 vs 2018 baseline

The natural gas trend in Figure 2 indicates substantial savings through each of the five previous years. The savings are likely a result of the boiler being offline for 2021 and 2022. The 5-year cumulative improvement was 364,251 m³ valued at $120,203.

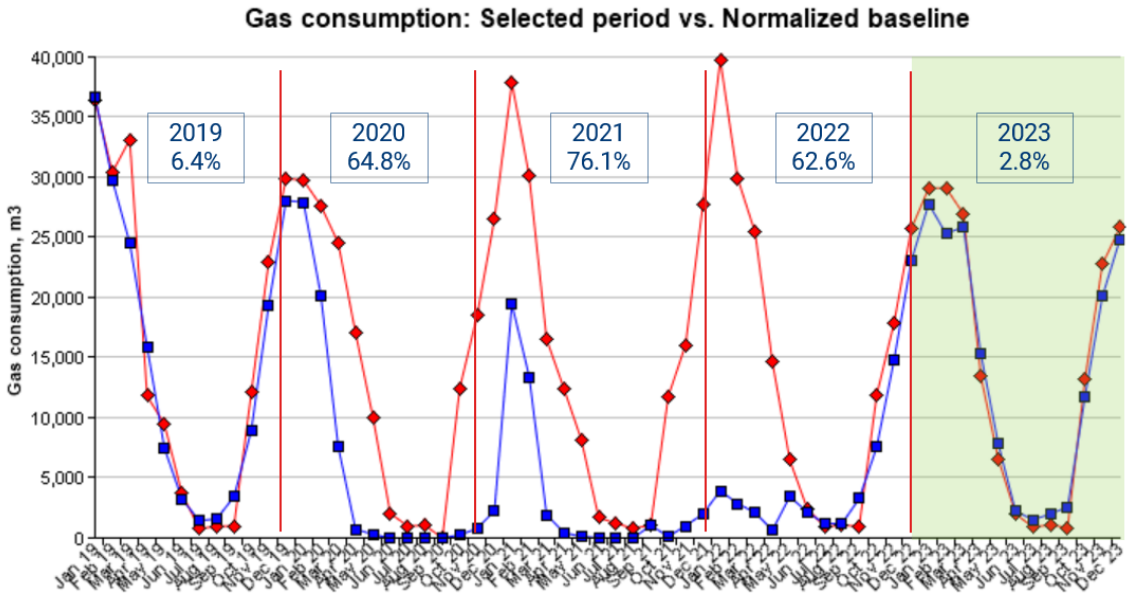

Figure 2 KGH: Natural gas consumption (m^3) in 2019-2023 vs 2018 baseline

The steam consumption trend over the last 5 years in Figure 3 demonstrates savings in each of the first 4 years. There was an increase in consumption in 2023. The 5-year cumulative improvement was 100,101 Klbs valued at $1,561,812.

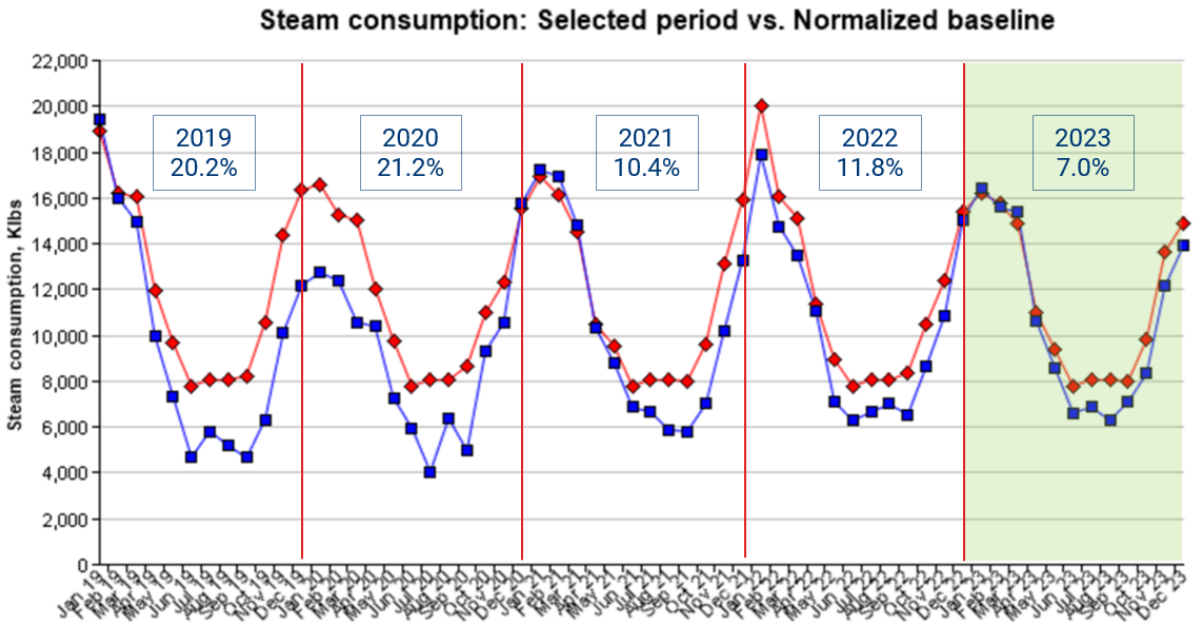

Figure 3 KGH: Steam consumption (Klbs) in 2019-2023 vs 2018 baseline

The water use trend in **Error! Not a valid bookmark self-reference.** shows significant savings across all five years. The 5-year cumulative improvement was 32,886 m³ valued at $141,410.

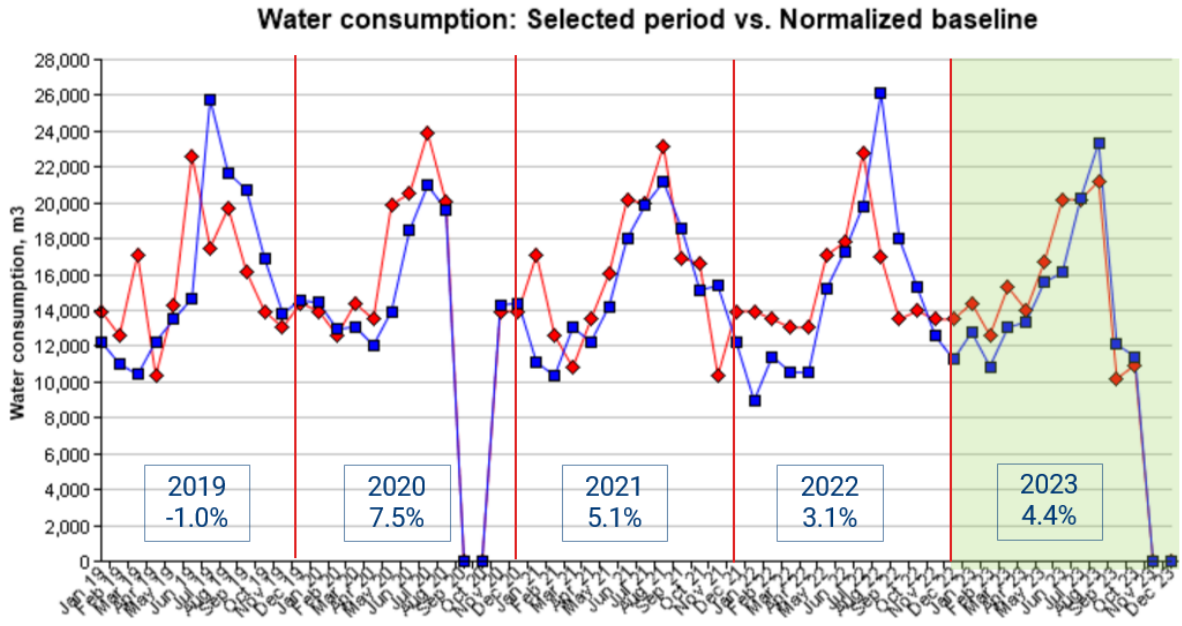

Figure 4 KGH: Water consumption (m^3) in 2019-2023 vs 2018 baseline

1.2 Hôtel Dieu Hospital

The 2019 target electricity savings was 10% for Hotel Dieu. Table 3 lists the hospital's energy savings in the 2023 calendar year compared to the 2018 baseline, which resulted in net utility savings of $73,682.

Table 3 HDH: Energy and water savings vs 2018 baseline

	2019 Plan Target savings				Actual savings (2023 vs 2018 baseline)[2]			
	Units	**%**	**$**	**GHG (tonnes eCO_2)**	**Units**	**%**	**$**	**GHG (tonnes eCO_2)**
Electricity (kWh)	1,734,000	10.0%	$277,000	-	417,579	4.0%	$66,813	13
Natural Gas (m^3)	-	-	-	-	20,815	1.4%	$6,869	40
Total Energy (ekWh)	**-**	**10.0%**	**$277,000**	**-**	**-**	**2.5%**	**$73,682**	**52**
Water (m^3)	-	-	-	-	-	-	-	-
Total			**$277,000**	**-**	**-**	**-**	**$73,682**	**52**

As shown in Figure 5 electricity consumption between 2019 to 2023 had savings in each of the 5 years. The 5-year cumulative savings were 2,871,674 kWh worth $459,468.

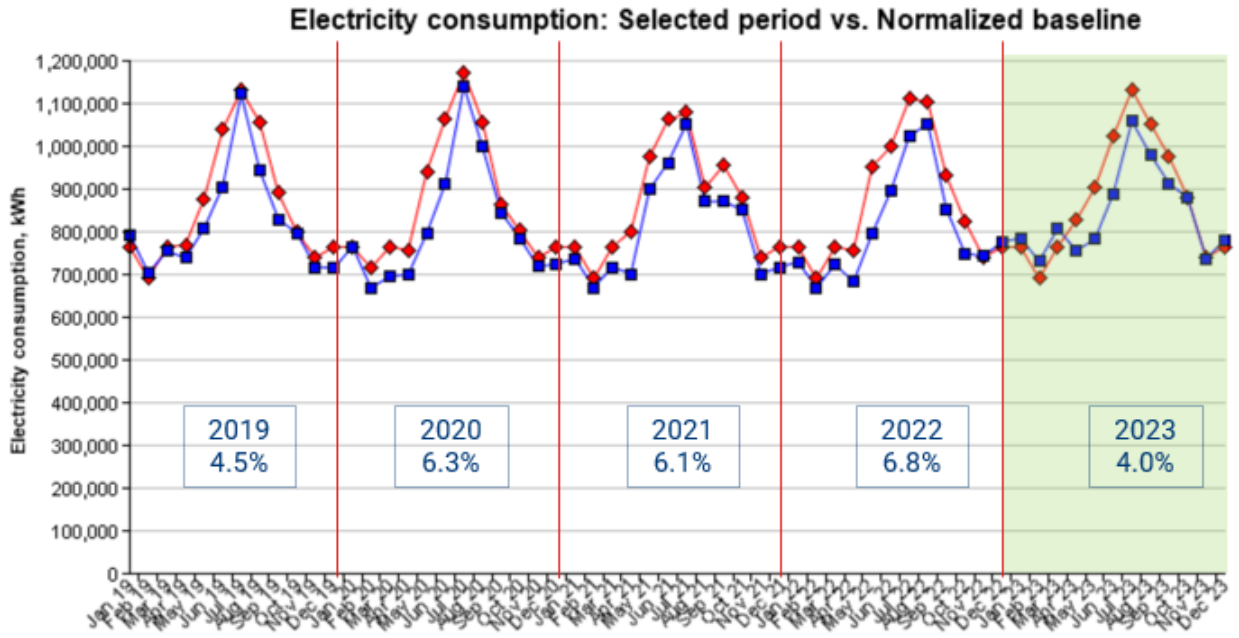

Figure 5 HDH: Electricity consumption (kWh) in 2019-2023 vs 2018 baseline

[2] Using 2024 utility rates: Electricity $0.16/kWh, gas $0.33/$m^3$, water $4.30/$m^3$.

Natural gas consumption presented in Figure 6 shows substantial increases in 2019 through 2022. The increases were followed by minimal savings in 2023. The 5-year cumulative increase was 582,308 m³ valued at $192,162.

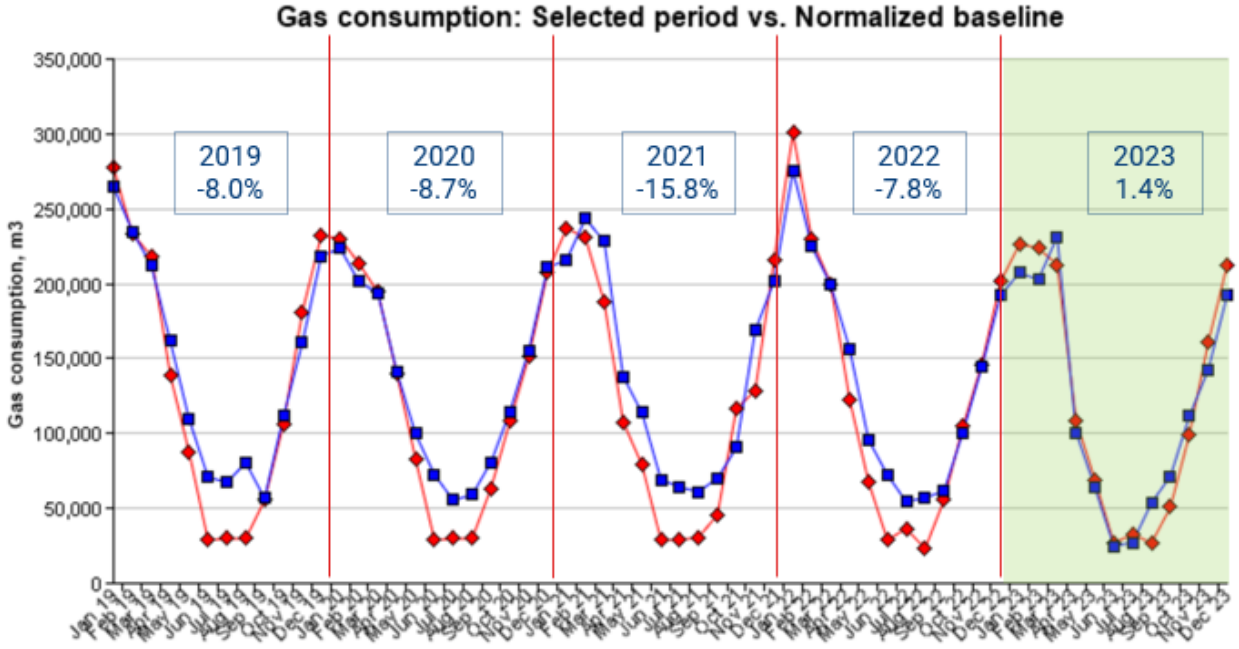

Figure 6 HDH: Natural gas consumption (m³) in 2019-2023 vs 2018 baseline

2. Measures implemented in 2019-2023

Kingston Health Sciences Centre did not complete the projects as planned in the 2019 ECDM plan. Starting early in 2020 and continuing into late 2022, COVID-19 impacted the implementation of most projects. As a result, KHSC implemented fewer projects. This included lighting retrofits to LED across both sites and some equipment scheduling adjustments.

Of the measures proposed in the 2019 report, the following were implemented.

Kingston General Hospital

We have been systematically upgrading lighting to LED and now about 90% of the lighting has been completed. At the 2019 report, only 20% of the lighting had been upgraded. Some of the planned thermal improvements took place including the chiller optimization and some rebalancing.

Hotel Dieu Hospital

Similarly, lighting has been upgraded to LED with about 90% completed. The peak shaving projects did not take place and are not envisioned as future projects. The planned chiller and air handling unit set backs did not occur but will be implemented in the upcoming years.

3. Project successes and lessons learned

Over the past five years, there have been successes, along with lessons learned, which will help make future progress and have informed the Plan.

Some of the lessons learned include:

- Prioritization changed with COVID-19, as it impacted the project implementation.
- Facility and operations staff are fully employed already with facility maintenance, and upkeep. Any new projects should be straightforward and managed with current staff.
- Any proposed ventilation system alterations need to be proven to comply with the latest CSA regulations regarding air flows and pressurization before implementing them.

4. Renewable Energy Generation

KHSC does not currently generate energy from renewable sources. The hospital is open to exploring cost effective options for renewable energy generation but no immediate plans for renewable energy.

Part 3: The plan for the next 5 years (2024-2029)

KHSC has the potential to improve the energy efficiency of its hospitals and is working towards top-quartile positioning in the Greening Health Care energy efficiency benchmark charts. The targeted energy use reduction is 4.7% and 9.1%, for KGH and HDH respectively by 2029 compared with the 2023 baseline. The projects and measures described below are designed to achieve this goal along with utility cost savings worth approximately $272,701/year at 2024 rates and GHG emissions reduction of 824 tonnes eCO_2/year.

1. 2023 energy and water use

Table 4 below presents the 2023 baseline energy and water use, costs, and emissions for both KHSC hospitals.

Table 4 KHSC 2023 energy and water use

Site	Energy Type	2023 Use	2023 Costs ($)	Greenhouse Gas Emissions (tonnes eCO_2)
Kingston General Hospital	Electricity	25,615,675 kWh	$ 3,842,351	1,675
	Thermal	3,821,558 m^3	$ 1,181,159	7,340
	Water	-	-	-
Hôtel Dieu Hospital	Electricity	10,048,756 kWh	$ 1,507,313	657
	Thermal	1,425,031 m^3	$ 470,715	2,737
	Water	-	-	-
Total	Electricity	35,664,431 kWh	$ 5,349,664	2,332
	Thermal	5,246,589 m^3	$ 1,651,874	10,077
	Water	-	-	-

2. Energy and water intensity benchmarks and targets

Greening Health Care sets energy and water intensity targets for its 69 member hospitals based on the average of top-quartile performance of comparable buildings in the Greening Health Care database and adjusted for weather and material site specific variables. Top-quartile is considered good practice, requiring no special technology, just consistent application of good design and operational practices which are already in wide use. Figure 7Figure 7 shows the relative energy intensity of the KGH site in 2018, 2023 and at the target 2029 performance level, which is the goal for the Plan.

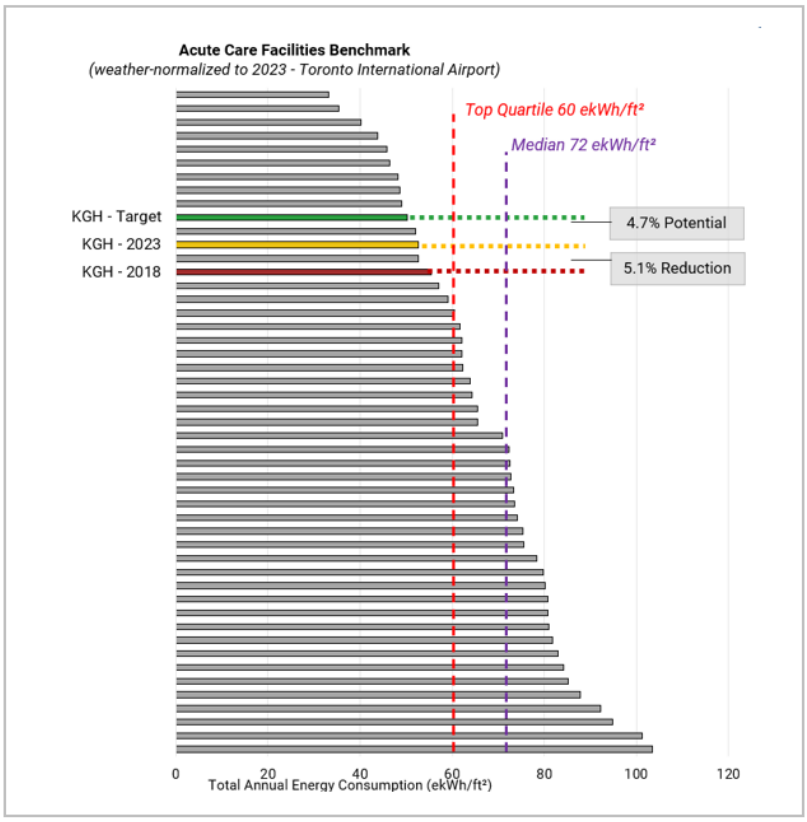

Figure 7 Annual energy intensity benchmarks for 2018, 2023, and 2029 target for Kingston General Hospital

Table 5 below presents KHSC's current and target energy intensities once the measures included in this Plan are implemented. The energy intensities are broken down by energy components, which indicates where the greatest savings are to be found and helps direct efforts to the building systems with the biggest opportunities. The energy components and associated potential opportunities for savings are as follows:

- Base electricity systems consist of fans, pumps, equipment, and lighting. The savings potential lies mostly in fans and pumps.
- Electric cooling is air conditioning plant and equipment, with some further savings potential in how the equipment is controlled.

- Base thermal energy is primarily used for reheat in ventilation systems, along with domestic hot water and kitchens and heating distribution losses. Optimization measures will help reduce base thermal energy use.
- Heating thermal systems are space and ventilation heating and humidification, with further targeted savings potential through improved control of ventilation and scheduling optimization.

Table 5 Hospital energy and water targets

Site	Energy Component	Energy Usage Intensity (ekWh/ft^2)		Annual Savings Potential	
		Actual	Target	%	$
Kingston General Hospital	Base Electricity	17.4	16.9	2.8%	$44,429
	Electric Cooling	3.3	3.1	6.2%	$18,979
	Base Thermal	19.6	19.2	1.8%	$13,760
	Heating Thermal	12.4	11.0	11.6%	$56,915
	Total Energy	**52.6**	**50.2**	**4.7%**	**-**
	Water (liters/ft^2)	146.7	146.7	0.0%	$0
	Total	-	**-**	**-**	**$134,084**
Hôtel Dieu Hospital	Base Electricity	14.8	14.1	4.6%	$ 67,213
	Electric Cooling	1.3	1.2	12.0%	$ 15,900
	Base Thermal	7.1	6.3	12.0%	$ 17,000
	Heating Thermal	16.6	14.6	11.7%	$ 38,503
	Total Energy	**39.9**	**36.3**	**9.1%**	-
	Water (liters/ft^2)	-	-	-	-
	Total	-	**-**	**-**	**$ 138,617**

3. Energy efficiency measures

Table 6 and Table 7 summarize the proposed energy efficiency measures for each site together with their estimated costs, savings, and payback. No water efficiency measures are recommended at this time, as both sites have seen water savings and are meeting the water target. The energy efficiency measures are described in more detail in the following section.

Table 6 Energy efficiency projects summary – KGH

Measures	Costs		Savings			Incentives	Payback (with incentives)	GHG emissions reductions (tonnes eCO_2/year)
Ventilation								
Schedule air handling units	$50,000	$233,750	430,827 kWh	114,981 m³	$106,876	$71,828	1.5	249
Canadian Standards Association's air change rates validation	$41,250							
Testing and re-balancing	$45,000							
Outdoor air % control and optimization	$52,500							
Optimize control sequence of operations	$45,000							
Building Automation and Lighting Controls								
System upgrade/expansion	$15,000	$35,000	53,853 kWh	0 m³	$8,617	$5,385	3.4	3.5
Re-programming	$20,000							
Heating plant								
Add new variable frequency drive on pumps	$54,000	$139,500	53,853 kWh	99,188 m³	$41,348	$30,182	2.6	194
Field Investigate and test differential pressure sensors setpoints	$37,500							
Pump testing and upgrades	$22,500							
Pump triple duty valve investigation, testing and optimization	$25,500							

Cooling Plant								
Add new variable frequency drive on pumps	$54,000	$142,000	306,906 kWh	0 m³	$49,105	$30,691	2.3	20
Field Investigate and test differential pressure sensors setpoints	$40,000							
Pump testing and upgrades	$22,500							
Pump triple duty valve investigation, testing and optimization	$25,500							
Total	**$550,250**		**845,440 kWh**	**214,168 m³**	**$134,084**	**$138,086**	**3.1**	**467**

Table 7 Energy efficiency projects summary - HDH

Measures	Costs		Savings		Incentives	Payback (with incentives)	GHG emissions reductions (tonnes eCO_2/year)
Ventilation							
Schedule air handling units	$60,000	$210,000	360,911 kWh	72,923 m³	$81,810	$54,322	1.9	164
Canadian Standards Association's air change rates validation	$30,000							
Testing and re-balancing	$60,000							
Outdoor air % control and optimization	$30,000							
Optimize control sequence of operations	$30,000							
Heating plant								
Add new variable frequency drive on pumps and differential pressure sensors	$70,000	$115,000	42,008 kWh	95,269 m³	$38,160	$28,018	2.3	186
Pump testing and upgrades	$25,000							
Pump triple duty valve investigation, testing and optimization	$20,000							
Heating plant investigation	TBD							

Cooling Plant								
Add new variable frequency drives on pumps and differential pressure sensors	$56,000	$84,000	116,541 kWh	0 m³	$18,647	$11,654	3.9	8
Pump Testing and Upgrades	$18,000							
Cooling plant sequence optimization and controls	$10,000							
Total	**$409,000**		**519,460 kWh**	**168,192 m³**	**$138,617**	**$93,994**	**2.3**	**357**

3.1 Ventilation system

- Kingston General Hospital and Hôtel Dieu Hospital:
    - Optimize air handling unit (AHU) scheduling to align operating hours with departmental hours. For AHUs serving 24/7 zones, schedule variable air volume boxes in unoccupied zones to match space occupancy and adjust the AHU fan based on static pressure sensor feedback. Ensure AHU variable frequency drive (VFD) speed aligns with expected unoccupied turn-down levels during off-hours.
    - Test space air change rates to ensure compliance with Canadian Standards Association's recommended levels. Reduce air change rates in areas where over-ventilation is identified.
    - Test and rebalance air handling unit airflows, refurbishing ductwork, and dampers as necessary to enhance system performance and resiliency.
    - Test AHU outside air percentages, comparing them against CSA Z317.2 requirements. Then, adjust damper positions and/or balance return and supply air to ensure airflow aligns with CSA Z317.2 recommendations.
    - Investigate economizer, supply air temperature, mixed air temperature control and implement new sequences to optimize operations.

3.2 Building Automation System and Lighting Controls

- Kingston General Hospital:
    - System upgrade/expansion – retrofit control devices including actuators, control valves and sensors as needed to achieve savings.
    - Re-programming – update BAS programming to implement new optimized sequences of operations.

3.3 Heating Plant

- Kingston General Hospital:
    - Add new variable frequency drives (VFDs) on pumps: convert constant flow pumps variable flow, open triple duty throttling valves reducing overall system pressure drop and improving efficiency and reducing energy consumption.
    - Field investigate and test differential pressure sensors setpoints: Field test differential pressure sensors setpoints to avoid any excessive pipe pressure losses resulting from over pumping. Reset differential pressure sensor setpoint to match with field investigation.
    - Pump testing and upgrades: test pumps flow and head requirements, match with design and field test static pressure setpoints to reduce overall system pressure drops.
    - Pump triple duty valve investigation, testing and optimization: open triple duty balancing valves completely and rebalance by modulating the variable frequency drive speed.

- Hôtel Dieu Hospital:
    - Add new VFDs on pumps and differential pressure sensors.
    - Pump testing and upgrades.
    - Pump triple duty valve investigation, testing and optimization.
    - Heating plant investigation -conduct investigation to determine underperforming heating pumps and causes for low flow conditions.

3.4 Cooling Plant

- Kingston General Hospital:
    - Add new VFD on pumps
    - Field Investigate and test differential pressure sensors setpoints
    - Pump testing and upgrades
    - Pump triple duty valve investigation, testing and optimization
- Hôtel Dieu Hospital:
    - Add new VFD's on pumps and differential pressure sensors
    - Pump testing and upgrades
    - Cooling plant sequence optimization and controls

4 Organization role and impact

Kingston Health Sciences Centre has been undergoing a number of renovations and energy services contracts. These have been the focal point of facility and capital staff efforts beyond day-to-day operations. As a result, the plan focuses on straightforward, small scale operational improvements that can be implemented by current staff and service contractors. Measures were designed to minimize disruption of hospital operations. This approach provides the most likely path to successful implementation and improved facility performance.