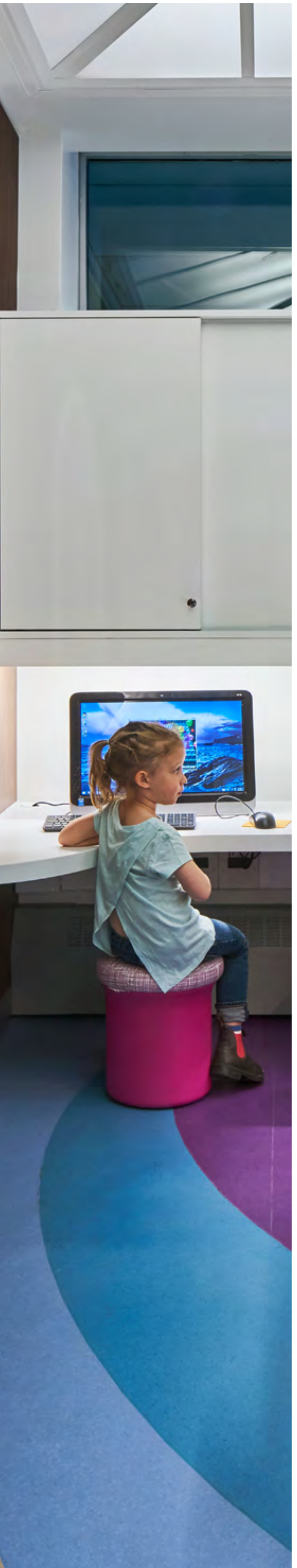
Energy Conservation & Demand Management Plan

Prepared for
The Hospital for Sick Children (SickKids)

Stantec Architecture Ltd. June 28, 2024



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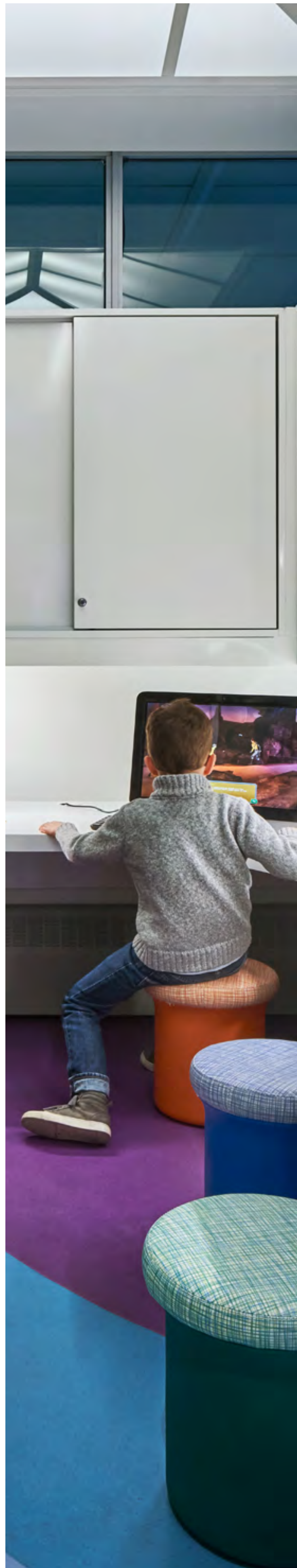


1.

Introduction

1.1 The Hospital for Sick Children (SickKids)

The Hospital for Sick Children (SickKids) was founded in 1875 and is dedicated to advancing children's health by integrating patient care, research, and education. Affiliated with the University of Toronto, SickKids is one of Canada's most research-intensive hospitals. Through discoveries that have helped children globally, SickKids is now recognized as one of the world's foremost pediatric health-care institutions.

SickKids owns multiple properties and facilities; however, most of the energy consumption and emissions come from three main facilities on the downtown campus: the main hospital, the Patient Support Centre (PSC), and the Peter Gilgan Centre for Research and Learning (PGCRL). High level information on these three facilities is presented in the box on the right.

Main hospital, which consists of multiple interconnected additions and renovations housed within two buildings:

Atrium, 170 Elizabeth Street, approximately 953,000 sq. ft., constructed 1989–1993

Annex, 555 University Avenue, approximately 1,035,000 sq. ft., includes three wings: Burton Wing on Elm Street (built in 1949), Black Wing on University Avenue (built in 1964), and Hill Wing on Gerrard Street (built in 1972)

Patient Support Centre (PSC), 175 Elizabeth Street, approximately 523,000 sq. ft., constructed in 2023

Peter Gilgan Centre for Research and Learning (PGCRL), 686 Bay Street, approximately 898,000 sq. ft., constructed in 2013

1.2 Climate Change

Over the past century, artificial greenhouse gas (GHG) emissions going into the Earth's atmosphere have led to drastic changes in climate. Catastrophic climate events have claimed lives, displaced tens of thousands from their homes, disrupted livelihoods, and dampened economic potential, leading to substantial impacts on mental health and overall well-being. The financial toll for recovery efforts has soared into the billions of dollars. As climate-induced transformations amplify existing stressors, such as aging infrastructure, gaps are being revealed in emergency preparedness and response systems. Hospitals and health-care systems are particularly at risk.

Scientists and policy makers from around the world agree that societies need to take dramatic steps to reduce the impact of climate change, typically recognized as limiting global warming to 1.5°C above pre-industrial levels. This can be accomplished by reducing global GHG emissions and achieving science-based targets (SBTs), like net zero, by 2050 or earlier.[1]

Over 1,000 companies worldwide—representing a combined $23 trillion in market value—have committed to setting SBTs to improve energy efficiency in buildings. To achieve their SBTs, these companies will adopt more sustainable practices and implement measures to reduce both energy consumption and GHG emissions. These measures could involve implementing deep energy retrofits, transitioning to 100% renewable electricity, managing fuel more responsibly, and converting fleet vehicles to electric and biofuels.

On climate change, the science is clear—we must take action now to protect our planet and secure our children's future.

2030 Emissions Reduction Plan—Canada's Next Steps for Clean Air and a Strong Economy

[1] https://sciencebasedtargets.org/news/more-than-1000-companies-commit-to-science-based-emissions-reductions-in-line-with-1-5-c-climate-ambition

1.3 SickKids' Commitment

Addressing climate change and reducing GHG emissions has long been a priority for SickKids. In 2016, SickKids established its 2030 Goals, which committed the organization to fostering a socially responsible work environment that promotes a safe, healthy, and ecologically efficient setting and contribute to a sustainable low-carbon future.

To safeguard the environment, reduce GHG emissions, and model responsible stewardship, SickKids prepared this Energy Conservation and Demand Management (ECDM) Plan. This plan outlines how SickKids will reduce its overall energy consumption, operating costs, and GHG emissions. SickKids' ECDM Plan meets the requirements of Ontario Regulation 25/23 (O. Reg. 25/23), Broader Public Sector: Energy Reporting and Conservation and Demand Management Plans. O. Reg. 25/23 requires municipalities and the broader public sector—including hospitals—to develop, implement, and make available an ECDM Plan.

SickKids prepared its first ECDM Plan in 2014 and updated it in 2019, fulfilling regulatory obligations. This current 2024–2029 ECDM Plan builds on SickKids' previous plans and the experience gained in energy conservation over the last decade. This 2024–2029 ECDM Plan contains:

- A description of current and proposed measures to reduce GHG emissions by conserving energy, reducing energy consumption, and managing its demand for energy.
- A revised energy and GHG forecast of the expected results based on the current and proposed measures.
- A summary of the actual results achieved since the implementation of the 2019 ECDM Plan.
- A description of the updates made to energy and GHG related targets.

1.4 Vision and Targets to Conserve Energy

Through each revision of its ECDM Plan, SickKids re-evaluates its energy consumption and GHG emissions to check how they may have changed over time. This is also a good opportunity for SickKids to compare corporate targets to short-term and long-term forecasts while considering two scenarios: one where energy reduction initiatives are implemented and the other where these initiatives are not implemented.

The ECDM Plan builds upon the hospital's sustainability goals. Implementing this plan will enable SickKids to become one of the most energy-efficient children's hospital in Canada through cost-effective, innovative, and integrated solutions. To achieve this vision, SickKids is:

- Investing in energy, water, and infrastructure upgrades to reduce energy use, water use, and GHG emissions.
- Investing in alternative energy sources, and renewable and clean energy technologies
- Designing buildings and health-care services that are resilient to the impacts of climate change.
- Reducing the use of natural resources and toxic substances by continuously improving processes.
- Forming partnerships to promote a socially responsible work environment.
- Promoting socially responsible behaviour through campaigns, training, and departmental accountability.
- Participating in provincial, national, and international environmental performance benchmarking, awards, and challenges.
- Participating in electrical demand management strategies.

SickKids developed an Environmental Sustainability Strategy that aligns with its 2020–2025 Strategic Plan (SickKids 2025) and its vision to being an environmentally-friendly organization. The hospital's long-term sustainability goals are as follows:

- GHG net zero by 2050
- GHG emission intensity by 2040: less than 40.09 kg CO_2e/m^2/year
- Water use intensity by 2040: less than 1.99 m^3/m^2/year
- Waste diversion by 2040: greater than 80%

This ECDM Plan supports the long-term goals of SickKids' Environmental Sustainability Strategy to help the hospital move towards its 2030 Goals.

GHG Net Zero

by 2050

< 40.09kg CO_{2e}/m²/year

GHG emission intensity by 2040

< 1.99m³/m²/year

Water use intensity by 2040

> 80%

Waste diversion by 2040

1.5 Scope of ECDM Plan

An ECDM Plan needs to include an inventory of energy consumption and GHG emissions that meets the requirements defined in the following documents:

- World Resource Institute (WRI) / World Business Council on Sustainable Development (WBCSD) Greenhouse Gas Protocol: Corporate Accounting and Reporting Standard (the Protocol)[2]
- GHG Protocol Scope 2 Guidance[3]
- ISO 14064-1 Greenhouse gases — Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals[4]

Based on the GHG Protocol, SickKids' energy and GHG boundary follows the "operational control" approach. SickKids therefore tracks energy and GHG emissions of an asset when:

- SickKids owns the asset
- SickKids is responsible for maintenance and capital upgrades to the asset

This ECDM Plan therefore presents the energy consumption and GHG emissions from existing buildings owned by SickKids: the main hospital (both Annex and Atrium), PSC, and PGCRL.

1.6 ECDM Plan Development

The ECDM Plan forecasts energy consumption and GHG emissions based on corporate data available for 2023, trends from 2014 to 2023, as well as anticipated growth to 2050. The ECDM Plan identifies initiatives that were developed by engaging staff, reviewing best practices implemented by other hospitals, and seeking input from internal and external subject matter experts. The ECDM Plan covers a 5-year horizon, from 2024 to 2029.

[2] Companies and Organizations | Greenhouse Gas Protocol (ghgprotocol.org)

[3] Scope 2 Guidance | Greenhouse Gas Protocol (ghgprotocol.org)

[4] ISO - ISO 14064-1:2006 - Greenhouse gases — Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals

2.

Campus Description

SickKids recently launched Project Horizon: a campus redevelopment project that will fully transform the downtown campus within approximately 15 years. Project Horizon will require extensive consultation with patients and families, staff, architects, consultants, and our project team. Project Horizon consists of three major phases, as shown in Figure 1.

Construction of the PCT will be facilitated by separating Burton Wing and Atrium from Black Wing and Hill Wing. Operations from Black Wing and Hill Wing will be moved to other locations on campus.

As Black Wing and Hill Wing are progressively vacated, heating, ventilation, and air conditioning (HVAC) needs will be reduced, but temporary heating and cooling may be needed. Since Black Wing and Hill Wing are being decommissioned, energy and emission reduction measures for these two wings are not considered in this ECDM Plan.

The potential energy and emissions associated with the future PCT are also not considered in this ECDM Plan. As a modern facility, the PCT is expected to have better energy performance and lower operational emissions than the two wings it is replacing; however, it will still contribute to the overall energy consumption and operational emission of the site. The level of energy consumption and emissions that will be produced by the PCT is unknown at this time.

The new PSC is also excluded from this ECDM Plan. Although it is a significant asset, because it was recently constructed and occupied in 2023, opportunities for energy and emissions reductions are expected to be minimal.

Figure 1: Three Major Phases of Project Horizon

Phase 1: Patient Support Centre

Construction completed in 2023

22-storey education, training, and administrative tower that consolidates all core administrative services

Phase 2: Demolition and Renovations

Timeline: 2025–2035

Demolition of Black Wing and Hill Wing to make way for the Peter Gilgan Family Patient Care Tower (PCT)

Renovation and expansion of Burton Wing to accommodate outpatient services in the new Ambulatory Care Tower (ACT)

Phase 3: New Hospital

Timeline: 2035

PCT to house acute care and core clinical services

ACT to house ambulatory and outpatient services

Both towers will be connected

2.1 Overview of Utilities and System Design

Each of the three main facilities operates independently, with dedicated utility connects, distinct system design, and separate building automation systems (BAS).

All facilities have natural gas connections to the Enbridge network. However, natural gas is only used for food preparation and accounts for less than 0.1% of SickKids' energy use. Therefore, natural gas is excluded from this ECDM Plan.

2.1.1 Main Hospital: Atrium and Annex

The main hospital receives steam from the Enwave district energy network through two steam connections: one for Atrium and one for Annex. This district steam is used to generate heating water, domestic hot water (DHW), and humidification. Chilled water is produced by two plants on site: one in Burton Wing (Annex) and the other in Atrium. The plants are interconnected and distribute load based on overall system efficiency to supply chilled water. The Atrium plant also contains heat recovery chillers that provide heating water to the facility when there is a simultaneous need for heating and cooling. A few pending projects will improve the efficiency of these two chilled water plants:

- Extend the capabilities for the two plants to share energy
- Increase heat recovery during renovation of Burton Wing and reactivation of the Atrium's expanded heat recovery system

The temperature of the heating water system varies by addition and renovation. Most systems in the main hospital are designed for low temperature heating water, so they currently operate at 60°C (140°F). While this temperature is below the design point of the high temperature system (82°C / 180°F), it satisfies the needs of the critical high temperature system zones, which is only required for a few zones.

The main hospital's current low temperature heating water is too high for some systems, and the return water is too hot for the heat recovery chillers to operate efficiently. To provide return water at the correct temperature, the returning heating water is circulated through the cooling tower. While this strategy improves the operational efficiency of the heat recovery chiller, it leads to wasted heating energy and additional emissions.

The main hospital has two electrical services provided by Toronto Hydro. Based on electrical demand, SickKids decided to opt-in the Atrium as a Class A customer and Annex as a Class B customer.

The main hospital has four water services: three for Annex and one for Atrium.

2.1.2 Patient Support Centre (PSC)

PSC is the newest building and is provided with chilled and hot water from the Enwave district energy network. PSC has a dedicated electrical service from Toronto Hydro as a Class B customer, and a domestic water connection from Toronto Water. As a new building, PSC has all the typical modern energy and emission reduction features, like air and water heat recovery.

2.1.3 Peter Gilgan Centre for Research and Learning (PGCRL)

PGCRL is provided with district steam from the Enwave district energy network. PGCRL uses steam to generate heating water, DHW, and humidification. The heating water system is a cascade design: the return heating water from zones with higher heating water temperatures supplies the zones with the next highest heating water design temperature. This process continues for multiple layers until the heating water is returned to the heating water plant where the cycle starts again. The maximum heating water temperature for PGCRL is 82°C (180°F).

Chilled water is generated at PGCRL for both comfort use—like air conditioning—and process cooling (such as a direct chilled water connection to support equipment like data centres and lab equipment). A dedicated process heat recovery chilled water system was installed in 2023.

PGCRL has a dedicated electrical service from Toronto Hydro (as a Class A customer), and a dedicated domestic water connection from Toronto Water.

3.

2023 Energy and GHG Emissions

Before committing to reducing energy consumption and GHG emissions, SickKids first needs to estimate current values and forecast these same values to 2050, assuming that no changes are made to current practices (also referred to as "business as usual" assumptions). This section presents SickKids' current energy and GHG emissions profile.

3.1 Current Energy and GHG Emissions (Scope 1 and 2)

For the purposes of this ECDM Plan, SickKids considers the three following buildings in the estimation of its corporate energy consumption and GHG emissions: Atrium, Annex, and PGCRL. The PSC is excluded from this section because 12 months' worth of energy consumption data are not currently available for analysis.

Energy consumption refers to the quantity of energy in various forms—such as electricity, steam, natural gas, or oil—needed to operate all the equipment and systems within a building.

GHG emissions represent the amount of greenhouse gases produced and released into the atmosphere from the production and consumption of various forms of energy mentioned above, commonly referred to as Scope 2 emissions. Scope 1 emissions refers to GHG generated on site. The quantity of Scope 1 emissions is negligible and therefore excluded.

In 2023, SickKids' corporate energy consumption was 352,852 gigajoules (GJ) and GHG emissions were estimated at 20,077 tonnes of carbon dioxide equivalent (tCO_2e).

As shown in Figure 2, 49% of energy consumed was derived from electricity while 51% came from steam.

Despite electricity accounting for half of SickKids' energy consumption, Figure 3 reveals that it only contributes to 9% of GHG emissions, with the remaining 91% coming from steam. This is because of the low emissions intensity of Ontario's electricity grid. In contrast, steam from the Enwave district energy network is generated by burning natural gas, which has a high emissions intensity. Additionally, while the Atrium is the next highest energy consumer, it has a lower GHG emissions profile and intensity compared to the Annex because the Atrium uses more electricity.

A summary of energy and GHG emissions by building is presented in Table 1.

Each SickKids building exhibits a similar energy and GHG emissions profile, as shown in Figure 4 and Figure 5. The PGCRL has the highest energy and GHG emissions footprint. While the Atrium consumes more energy than the Annex, the Annex has a higher GHG emissions footprint because it consumes more steam than the Atrium.

Want to learn more about emissions factor

Click Here.

Table 1: Summary of 2023 Energy and GHG Emissions by Building

Building	Energy (GJ)		GHG (tCO_2e)	
Atrium	171,286	34%	6,277	31%
Annex	148,954	29%	6,829	34%
PGCRL	189,133	37%	6,971	35%
Total	509,374	100%	20,077	100%

Figure 2: Energy Use by Fuel Type

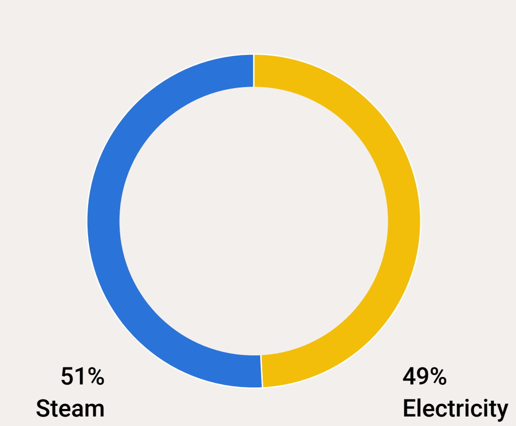


Figure 3: GHG Emissions by Fuel Type

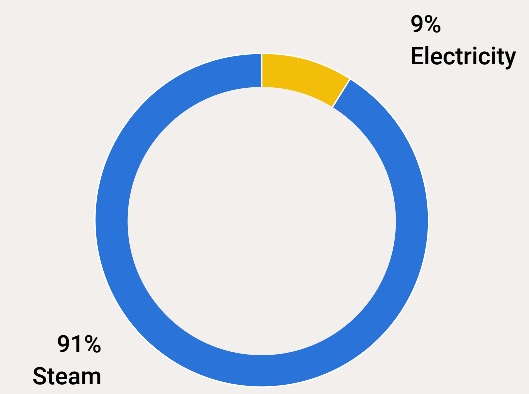


Figure 4: Energy Use by Building

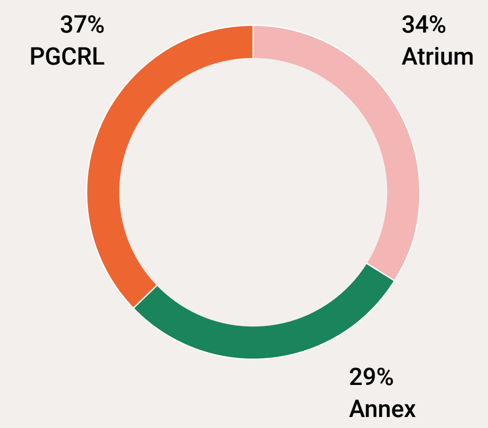
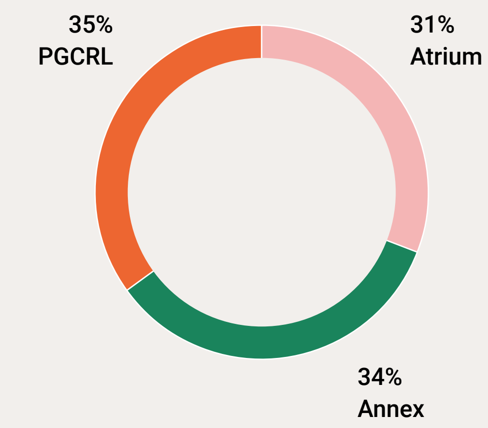


Figure 5: GHG Emissions by Building



3.2 Historical Trends

3.2.1 Energy and GHG Trends

SickKids has been tracking its energy consumption and GHG emissions since issuing its first ECDM Plan in 2014. Figure 6 illustrates energy consumption profile from 2014 to 2023, and Figure 7 presents GHG emissions for the same period.

Acute health-care facilities have specific ventilation rates that require them to be directly connected to the outdoors. The fluctuations in energy consumption shown in Figure 6 are related to variations in the number of heating and cooling days: colder winters increase energy use for heating while hotter summers increase energy use for cooling. The rise in energy use in 2018 is attributed to renovations in the Burton Wing, where a floor was converted into a pharmacy space. The new pharmacy has stringent requirements for temperature, humidity, and airflow, leading to increased consumption of both electricity and heating energy.

The emission factor for Ontario's electricity grid varies each year, depending on the electricity generation mix, as summarized in Appendix A. For example, the GHG emissions shown in Figure 7 was lower in 2017 due to a lower grid emission factor that year.

Figure 8 presents the energy profiles for each building from 2014 to 2023.

Figure 9 and Figure 10 respectively present energy consumption and GHG emissions intensity trends for each building. Both figures indicate that PGCRL has the highest energy and GHG emissions intensity, as well as the highest fluctuation in energy consumption and, consequently, GHG emissions. PGCRL's high energy consumption is attributed to the high ventilation rates mandated by code and regulation for a medical research laboratory.

Figure 6: Energy Consumption (2014–2023)

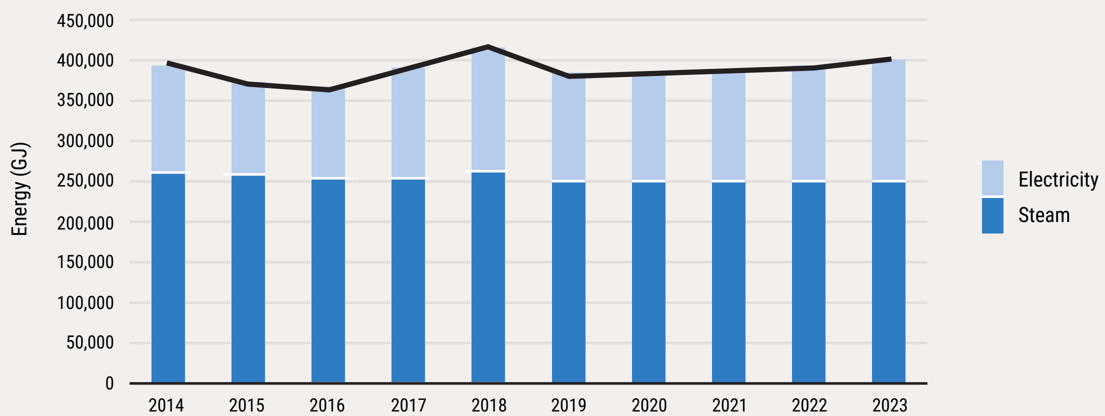


Figure 7: GHG Emissions (2014–2023)

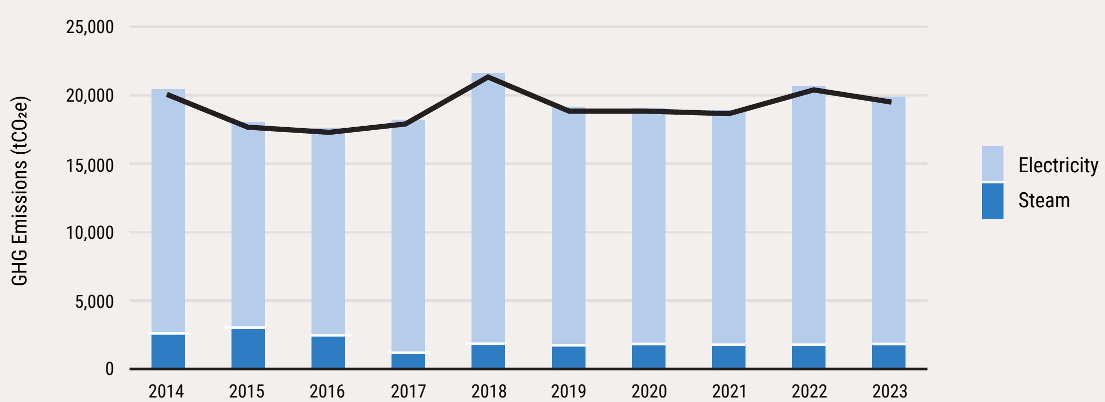


Figure 8: Building Energy Consumption by Energy Type (2014–2023)

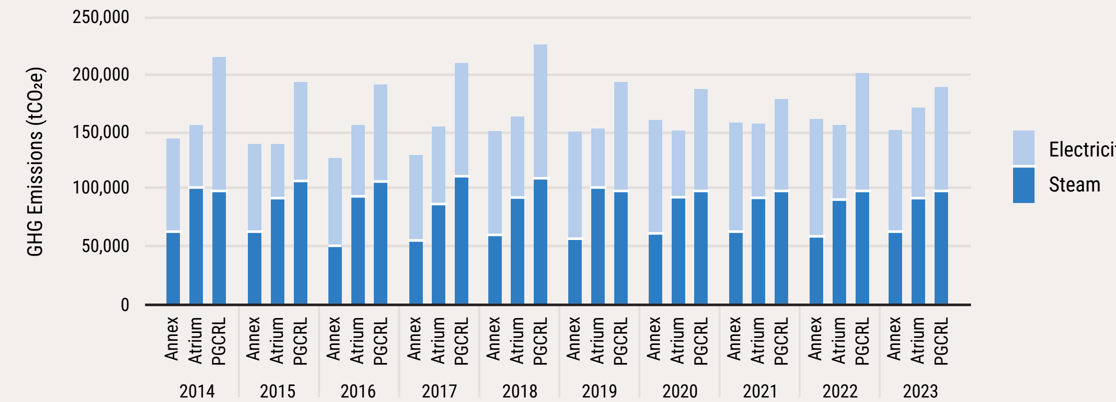


Figure 9: Building Energy Intensity (2014–2023)

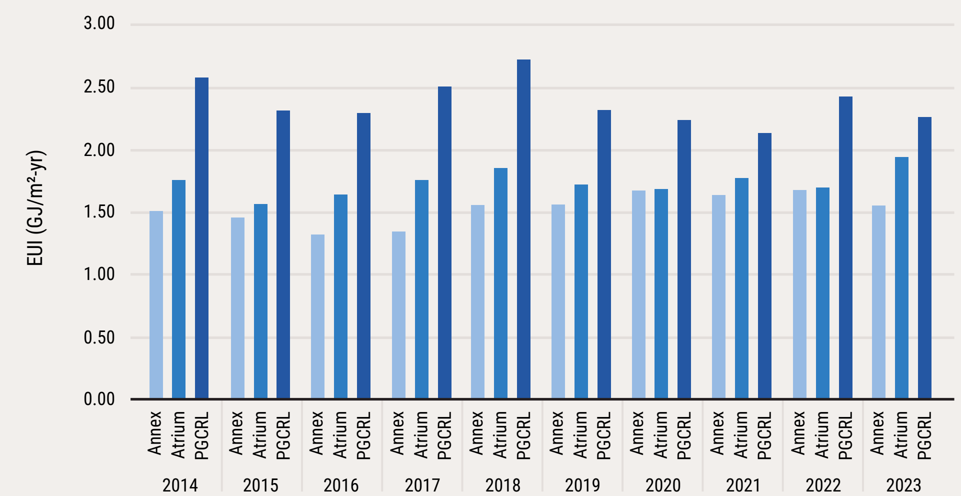
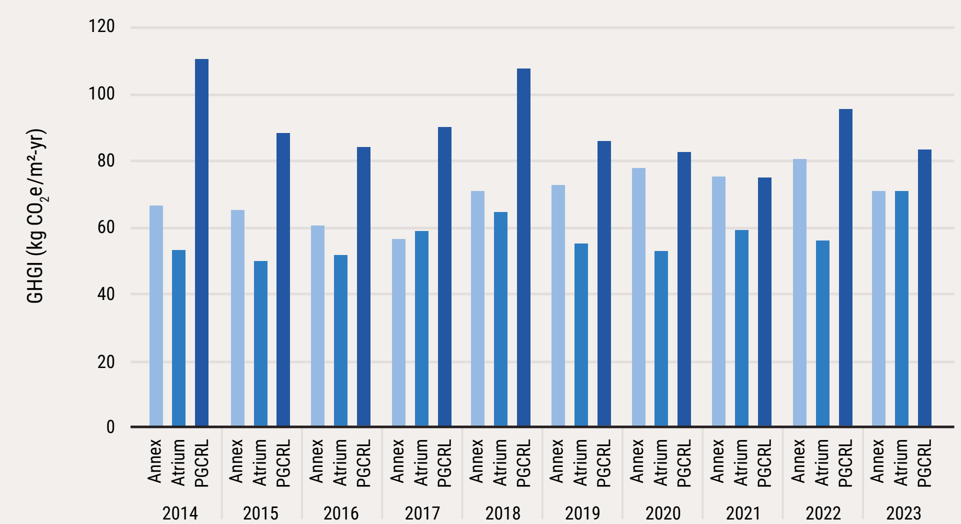


Figure 10: Building GHG Emissions Intensity (2014–2023)



3.2.2 Benchmarking Energy Performance

The main hospital outperforms the average health-care facility in Ontario, with an average EUI over the last five years of 1.8 GJ/m²/year for the Atrium and 1.6 GJ/m²/year for the Annex. According to Natural Resources Canada's (NRCan) Office of Energy Efficiency Statistics[5], the average energy use intensity (EUI) for health-care facilities in Ontario was 3.58 GJ/m²/year in 2021 (the most recent year available). PGCRL's EUI is 2.3 GJ/m²/year, outperforming the average laboratory in a similar climate zone in North America. Based on Lab21 statistics[6], the average EUI for laboratories with similar operations and climate zones in North America is 3.645 GJ/m²/year.

3.2.3 Demand Management Trends

Ontario's Industrial Conservation Initiative (ICI) program provides incentives for large electricity consumers to shift their electricity use to off-peak hours to help reduce the province's peak electricity demand. SickKids has participated in the ICI program since 2017, using forecasting and identification tools to determine periods when electricity demands are likely to be highest and applying load reduction strategies to lower the peak. Table 2 summarizes SickKids' Demand Management trends since 2017. **This program has enabled SickKids to save between $0.5 million to $1 million in electricity costs per year.**

Table 2: Historical Demand Management Trends for Class A Facilities

History	Atrium		PGCRL	
Billing Period	Peak Demand Factor (PDF)	PDF Change	PDF	PDF Change
2017	0.00017877	Baseline	0.00022935	Baseline
2018	0.00015397	0.0000248	0.00021624	0.00001311
2019	0.00015505	0.00002372	0.00022443	0.00000492
2020	0.00017443	0.00000434	0.00021433	0.00001502
2021	0.00017443	0.00000434	0.00021433	0.00001502
2022	0.00014379	0.00003498	0.00018485	0.0000445
2023	0.00016308	0.00001569	0.00018825	0.0000411

[5] Commercial/Institutional Sector Ontario Table 17: Health Care and Social Assistance Secondary Energy Use and GHG Emissions by End Use | Natural Resources Canada (nrcan.gc.ca)

[6] LBT: Buildings (i2sl.org)

3.2.4 Water Consumption Trends

SickKids has been tracking water consumption since preparing its first ECDM Plan in 2014. Figure 11 shows the total water consumption from 2014 to 2023 for Annex, Atrium, and PCGRL.

The total water consumption for 2014 is estimated because water billing data for PCGRL crossed over two years. The total water consumption for 2023 is estimated because the water meter connected to Annex failed.

The water consumption for each building (i.e. Annex, Atrium, and PGCRL) from 2014 to 2023 is shown in Figure 12.

3.2.5 Water Conservation Trends

SickKids is committed to conserving water to provide a socially responsible and ecologically conscious work environment. Consuming water (delivery, discharge and treatment)—especially heated water—contributes to energy use and GHG emissions.

Since 2017, SickKids has reduced water use through various projects and programs, such as installing low-flow fixtures, repairing leaks, installing closed-loop cooling system, reusing rainwater, reusing water through reverse osmosis filter backwash, upgrading cooling tower and water treatment, and more.

These changes have reduced SickKids' water use from 410,000 cubic metres (m³) in 2017 to 280,000 m³ in 2020, a difference of about 30%. **That is equivalent to a reduction of more than 50 Olympic-sized swimming pools per year!**

Figure 11: Total Water Consumption (2014–2023)

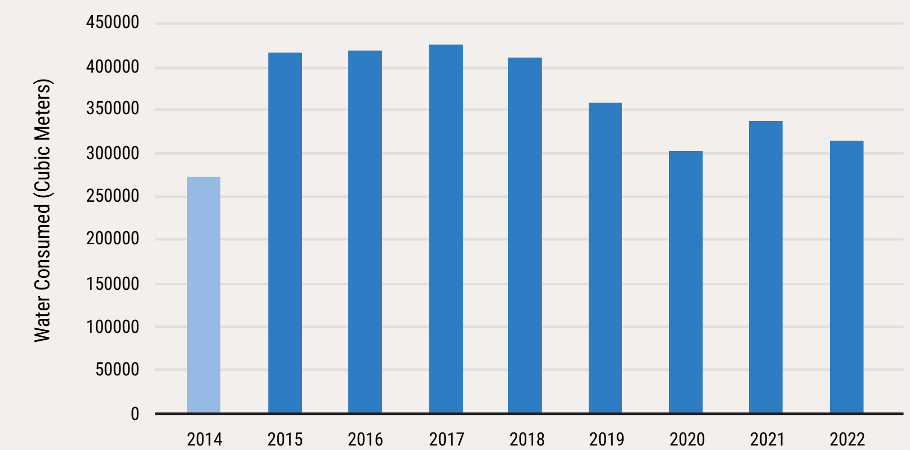
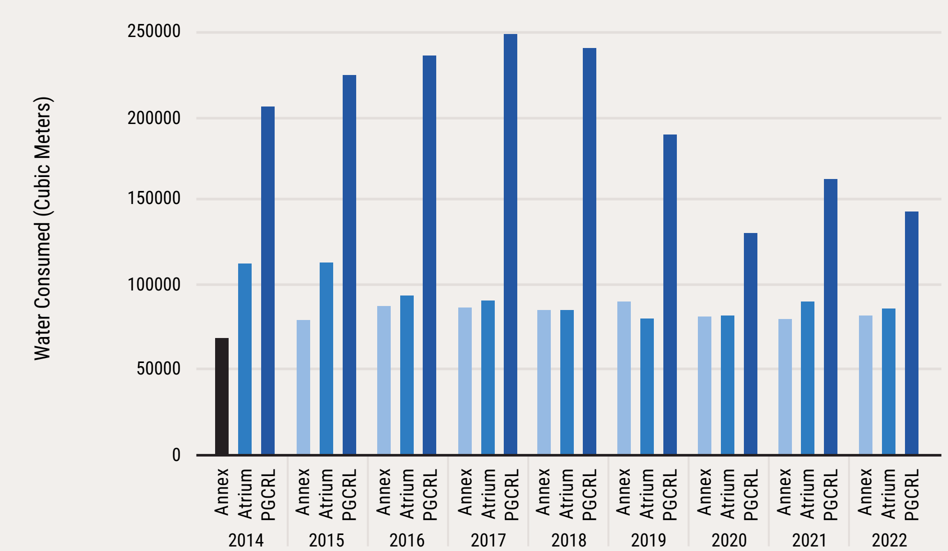


Figure 12: Building Water Consumption (2014–2023)



3.3 Weather Normalized Data and Baseline Year

Heating and cooling energy greatly depends on the weather. Normalizing energy use is an analysis technique that allows heating and cooling energy to be compared over different years. This technique can also be used to generate a typical energy year profile. A regression analysis can correlate utility bill data to the main variables that influence consumption. For steam and electricity consumption, the primary variable is weather. For water consumption, the primary variables are weather and billing period.

To normalize the data, the difference between the actual weather and billing period and the typical values were fed into the regression analysis equation to generate a correction. This correction was added to—or subtracted from—the billed consumption. This weather normalized value represents the energy consumption without the effects of weather variations from year to year. The resulting energy use should be similar between years, if nothing unexpected happened to change energy consumption, such as equipment failure, equipment replacement, or significant schedule changes.

Figure 13 presents the normalized energy consumption for the campus for the last 10 years.

Figure 13: Normalized Energy Consumption

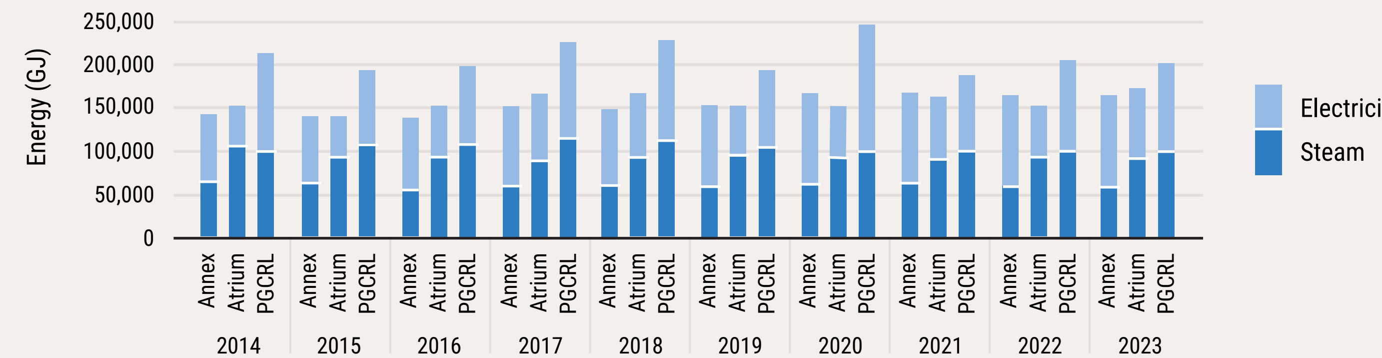
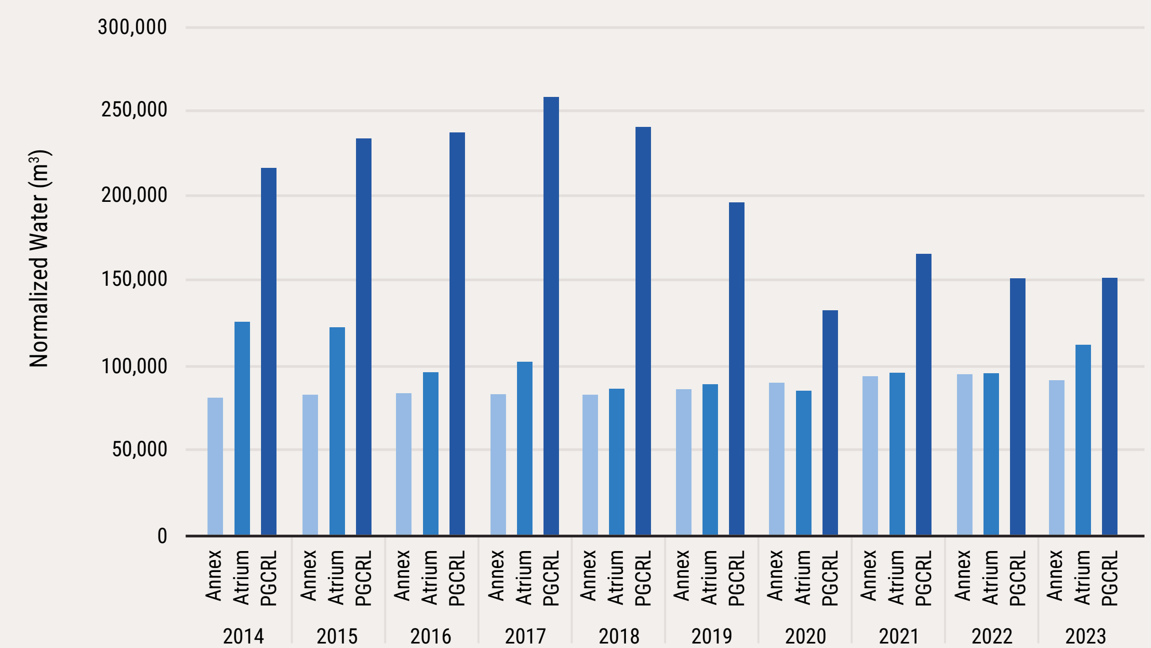


Figure 14 presents the normalized water consumption data for the campus for the last 10 years.

Figure 14: Normalized Water Consumption



The water consumption for the Annex and PGCRL is fairly stable. The water consumption for the Atrium decreases in 2019 due to the decommissioning of water-consuming cooling equipment. The data also show a decrease in water consumption in 2020 due to the COVID-19 pandemic. From 2021 onwards, water consumption appears to stabilize to levels slightly lower than the 2019 values. This is likely due to changes in operations brought on by the COVID-19 pandemic.

Future regression analysis will more accurately capture this change in consumption.

3.4 Past Initiatives

The 2019 ECDM Plan identified program and project initiatives for SickKids, most of which have been implemented. Table 3 summarizes the program initiatives and their implementation status.

Table 3: Summary of 2019 ECDM Program Initiatives Status

Measure Type	Measure	Status Update
Behaviour	Assess energy savings from increasing ultra-low freezer temperature.	Completed
	Assess energy savings from turning off medical/research equipment when not in use.	Established, ongoing
	Expand the Lights Out Initiative across hospital and PGCRL.	Completed
	Review energy performance regularly and identify energy and water savings opportunities with building operation team.	Established, ongoing
	Adjust ventilation temperature settings and schedules to support staff, equipment, and services.	Ongoing
Organizational	Assess the climatic resiliency of SickKids existing buildings.	Ongoing, just starting
	Assess the feasibility of SickKids becoming carbon neutral.	Ongoing, just starting
	Establish policies and processes (procedures) to systematically: • Purchase the most energy efficient building system equipment during replacements, renovations, and new constructions. • Purchase the most energy efficient office and medical/research equipment. • Consider the most energy efficient system design during upgrades, renovations, and new constructions.	Completed
Atrium/Annex	Implement deep lake water cooling.	Investigation stage
	Refurbish The atrium solar water heating.	Postponed due to funding (designed)
	Implement heat integration: low temperature water distribution system.	In progress: multi-year project
	Implement solar air heating (Burton Wing).	Postponed due to funding (designed)
PGCRL	Increase peak demand shaving.	Implemented
	Upgrade LEDs: Energy savings.	Completed
	Upgrade LEDs: Replace existing.	In progress
	Retrofit process chiller plant.	Chiller upgraded; working to maximize heat recovery
	Integrate lab fume hood exhaust fan VFD control.	Not completed: payback too long
	Implement demand control ventilation.	In progress: exploring options for lab demand control

4.

Initiatives

A workshop was held on January 31, 2024, with key project associates to discuss priorities and potential projects. From this workshop, the individual projects developed by project associates were grouped into general themes. This grouping of projects was reviewed by the project associates on February 21, 2024, to generate feedback on the groupings, and what projects should move forward. As previously mentioned, Project Horizon and its related early works will lead to the demolition of the Black and Hill wings. Therefore, any projects and initiatives associated with these two wings are excluded from this study.

Given the scale of Project Horizon and its associated early works, measures were chosen, where possible, to integrate with the proposed Project Horizon project and/or to consider the potential impact of the new tower.

4.1 Campus-wide Initiatives

4.1.1 Maintenance Backlog

The facilities within the SickKids campus vary in age, with some mechanical and electrical systems dating back to the original construction of the buildings and having been in service for several decades. As systems age, a minimum level of maintenance is required to maintain functionality and operational efficiencies. Generally, the level of required maintenance will increase as the systems age. If maintenance is deferred, then system efficiencies will decrease. Typically, there is also a risk that the system reliability will be impacted and the potential cost to resolve the maintenance backlog may be more than the sum of annual deferred maintenance.

SickKids representatives have advised that, historically, annual maintenance funding has not been sufficient and, as a result, the maintenance backlog has been increasing annually. This maintenance backlog has resulted in the energy performance of the main systems deteriorating year after year. Based on industry averages, a decrease in performance of approximately 1.5 % per year could be assumed if required maintenance is not performed.

It is recommended that the maintenance budget for major building energy consuming systems is increased to meet annual maintenance needs and to resolve the maintenance backlog.

4.1.2 Commissioning and Recommissioning

Building commissioning involves verifying building systems are functioning efficiently and to their design intent after installation. While commissioning is often associated with mechanical and electrical systems, building envelopes can also be commissioned.

Recommissioning is the process by which systems are returned to their design intent, realigned to meet owners' needs and the efficiency of the systems is restored. Typically, recommissioning is recommended every 4–5 years and yields paybacks within 2–3 years.

Over time, system efficiencies tend to decrease due to factors such as:

- Sensors drifting out of alignment
- Leaks and worn components due to deferred maintenance
- Change in space use

While independently these factors may seem like minor inefficiencies, due to interconnection between systems and system components they can have an overall significant impact on energy performance.

For example, variable flow pumping loops rely on pressure and temperature sensors to operate. Failure of either sensor could result in the loop reverting to a constant flow operation due to loss of the control point.

SickKids has been conducting unofficial recommissioning over the past few years as resources and budgets permit. Although this has allowed some systems to be realigned, the program's scale is limited compared to its potential savings.

It is recommended to establish a recommissioning program with sufficient resources to handle multiple systems across the campus. As part of the start-up of this program, systems to be recommissioned should be ranked in order of priority.

During the prioritization process, the program should consider the impacts of Project Horizon and the associated early/enabling works. If parts of systems are replaced for these projects, the recommissioning effort should focus on the remaining portions of the system.

It is further recommended that a formal policy to commission all new systems be established.

As part of the policy, a holistic design approach should be adopted to ensure that when systems are renovated, all connected elements outside the renovation areas continue to function as intended. For example, if an air handling unit (AHU) services four zones and one zone is renovated, traditionally, only the air flow and function of the controls within the renovated zone is verified. One common mistake is not considering the impact on the other three zones served by this AHU. Often, the airflow to the non-renovated zones is adversely impacted, or the associated zones are not compatible with the renovation, such as switching recirculated air zones to 100% outdoor air (OA).

4.1.3 Metering, Sub-Metering and BAS Trending

There are currently three independent building automation systems (BAS) on campus, each varying in ages, functionality, and capabilities:

- Main hospital: JCI Metasys
- PSC: Niagara Tridium
- PGCRL: Honeywell EBI

There is a project underway to develop a sub-meter network; however, this project is still in the design phase.

During the investigation and analysis phase of this project, trend data from the BAS was requested to estimate how energy is consumed within the campus. It was identified that the relevant trend data is stored on their respective BAS and not in a central source.

Each BAS also has different capabilities to trend, retrieve and download data and a different data format. For example, the PGCRL BAS outputs an Excel file with a single date and time column followed by trend data for different BAS points. The main hospital BAS outputs an Excel file with one date and time column per BAS point. While the difference may seem minor, from an analytical point of view it is significantly more time consuming to process trend data when each data point has a time stamp than when there is one time stamp for multiple data points. When one time stamp is provided for multiple data points, the data is in a format that allows for direct analysis or export of the data for analysis. When each data point has a timestamp, further processing is needed of the data to analyze data or export data. In addition, the time required to download trend data from the main hospital BAS was significantly longer and labour intensive than required to download similar trend data from PGCRL.

In reviewing trend data from the main hospital, two types of discrepancies were identified:

1. Values for points within the trend data appeared to be incorrect. In one instance, this was traced to an incorrectly mapped point. Other instances of these issues could be related to sensor calibration, sensor condition, or points being mapped incorrectly.

2. Points are offline or not trending. For example, the BAS was not recording trend data for VFD drives despite the BAS appearing to trend these points. The cause of this issue is unknown.

In both cases, the discrepancies affect the resolution at which the trend data could be reviewed. Without accurate metering and trending of energy consumption, it is impossible to effectively manage energy use or gather the necessary information to build business cases for larger-scale retrofits.

It is recommended that:

- The BAS for the main hospital is recommissioned.
- All BAS are upgraded to allow for automated retrieval of trend data.
- All trend data appears in a standard format.
- All trend data is routinely archived in a central location.
- A submeter system is installed.
- Information from the submeters is routinely archived and stored in the same central location as the BAS trend data.
- Standard regular reporting for all systems based on trend data and sub-meter information is developed. This reporting should be automated to ensure repeatability and timely completion.
- Reports should be reviewed by key associates at regular intervals and anomalies in the data identified and investigated.

While the BAS for the PGCRL appears to be functioning as intended, as a best practice it is recommended that this BAS is also recommissioned.

It is also recommended to repeat recommissioning at 5-year intervals or establish an ongoing commissioning program.

4.1.4 Energy Sharing and Heat Recovery

SickKids has projects currently in progress to increase the amount of energy transfer between the two chiller plants and exploit further opportunities for heat recovery within the main hospital.

Based on best available information (past studies and equipment capacity reviews), it appears that SickKids has more chiller capacity than required. The two projects to increase the heat recovery capacity are two independent projects and it is assumed that SickKids has coordinated the projects and verified there is sufficient heat recovery chiller capacity available.

Once these two projects are completed, it is recommended that SickKids verify the remaining available capacity for heat recovery within the chiller plants and looks for opportunities for further heat recovery.

Recovery of waste heat is just one aspect of decarbonization. Finding a sink for the recovered heat is another challenge. Heat recovered from the exhaust air can be used for both building heating and water heating for domestic water (see Section 4.1.5).

It is recommended that once the new heat recovery systems are online, a study be conducted to determine the spare capacity within the plant systems to recover more energy, identify additional heat recover source, and find sinks for recovered heat.

4.1.5 Low Carbon DHW Heating

Currently, DHW on the campus is generated using steam-based instant hot water generators, a common practice in health-care facilities. In general, older facilities utilize steam-based generators while newer ones use high-temperature hot water based generators.

For most health-care applications, DHW needs to be heated to at least 60°C (140°F). This temperature requirement poses challenges for reducing GHG emissions. While effective, both methods are intensive in GHG emissions.

One solution to address this challenge is to utilize low-temperature heating water, generated by heat recovery as in this facility, to produce DHW. The low-temperature heating water can be used to either pre-heat make-up water, or to generate DHW using dedicated high-temperature heat pumps.

It is recommended that once the current heat recovery projects are completed, the feasibility of using the low water temperature loop to generate DHW is reviewed.

4.1.6 Plug Load Management

Plug loads refer to the electricity consumed by equipment and devices (e.g. computers) that are plugged into electrical outlets. Managing these loads is often challenging for building operators since they are controlled by the users. However, through education, engagement, and the use of technology (e.g. timers and automatic shut-off systems), it is possible to reduce the energy consumption associated with plug loads

SickKids is currently running an energy conservation campaign to reduce plug loads. Initiatives under this campaign include adding timers to control lab equipment and reducing ghost loads. It is recommended to maintain and expand this campaign.

4.1.7 Adiabatic Humidification

The Ontario Building Code requires that health care facilities be designed in compliance with Canadian Standards Association (CSA) Standard Z317.2, titled Special Requirements for Heating, Ventilation, and Air Conditioning (HVAC) Systems in Health Care Facilities. Under the current CSA Z317.2 standard, the only acceptable form of humification for clinical spaces is steam. There is a pending update to the CSA Z317.2 standard that will allow for adiabatic humidification for health-care facilities. The update is expected in the summer of 2024 and would allow for high pressure spray humidification systems (a form of adiabatic) to be operated within health-care facilities. This technology has significant emissions reduction potential as such it is recommended that SickKids where explores the feasibility and where feasible implements adiabatic humidification.

Based on information from the public review version of the standard update, the requirements for the high-pressure spray humidification system would mirror what is required within ASHRAE 170. These requirements

include use of reverse-osmosis (RO) water only and ensuring that there is no standing water within the unit. While the use of copper silver ionization as a disinfectant for the spray water is not a requirement, it is a best practice and is integrated into many of the systems available in the market.

In a new build application, the implementation of this technology is easy. In a retrofit or replacement application, there can be challenges linked to available space (adiabatic humidification units are longer that steam injection units) and heating capacity (these units require larger heating coils since energy for evaporation is shifted to the heating coil).

The adiabatic humidification process still requires energy input to evaporate water, but low temperature heating water can be used as a source of energy. Low temperature heating water can be generated by low-carbon sources such as a heat recovery chiller. This results in the potential for significant emissions saving.

From an energy perspective, the amount of energy needed to evaporate water is the same regardless of fuel source. If the thermal energy is generated more efficiently than the current energy from the district steam, there will be an energy savings. However, the magnitude of potential energy savings is small compared to the potential emission savings. Low temperature heating water conversion should be a pre-requisite for implementation of adiabatic humidification.

4.1.8 Low Temperature Water Heating Conversion

Both the main hospital and the PGCRL have high temperature heating water systems. Typically, only a small number of zones require the design heating water temperature due to factors like ventilation rates and perimeter heat loss. In a typical facility, most zones can operate with a significantly lower heating water temperature. In the case of the main hospital, there are even zones which are already designed for a lower heating water temperature.

SickKids current use of high temperature heating water is being driven by the needs of some critical zones. A strategy which could be used to convert to low temperature heating water would be to identify the critical zones in each building which require higher heating water temperatures and only provide these zones with high temperature heating water. This higher temperature heat water for these small number of zones could be generated by either water source heat pumps or dedicated electric boilers or a cascade system.

Implementation would require reconfiguration of piping and space for either a dedicated electric boiler or water source heat pump.

SickKids has indicated that a cascade heating water system conversion is being contemplated for the main hospital. As a first step, a detailed study will be completed soon to determine the feasibility of implementing a cascading heating water system in the main hospital.

It has also been reported that:

- The Atrium AHUs were designed to utilize low temperature hot water; and,
- PGCRL was designed for a low temperature heating water system which was not deployed. As a result, the heating water system is currently using a cascading design where heating water flows from the higher heating water temperature systems to the lower heating water systems. This makes the heating water system within the PGCRL essentially low heating water temperature-ready.

4.1.9 Low Carbon District Energy

In downtown Toronto, multiple low emission district energy solutions are available. Both offer efficient heating and cooling solutions, reducing GHG emissions.

These renewable district energy systems require a dedicated supply network for SickKids. SickKids will need to sign a long-term energy purchase agreement with the utility provider to enable the construction of this network before they can utilize the renewable district energy system.

These agreements ensure that SickKids receives heating and chilled water at specified flow rates, temperatures, and guaranteed efficiency. The system's cost is recovered over a set period through a fixed connection charge, while energy consumption costs are recovered via a pass-through charge, subject to an energy efficiency guarantee.

These agreements also define SickKids' obligations, typically requiring them to maintain return water temperatures and flows within a specified range and not switch to other energy providers, which could affect supply amounts.

In both options, SickKids would have less direct control over energy producing equipment. The utility costs and indirect GHG emission of using thermal energy could be influenced by the larger district energy system and its thermal energy source.

These systems should be reviewed from both commercial and technical perspectives. It is recommended that SickKids carefully consider their options and select a provider based on economics, contract flexibility, and the potential for emissions reductions.

4.1.9.1 Wastewater Heat Recovery System

Wastewater heat recovery systems harness thermal energy from wastewater in sewers to provide heating during the heating season and to dump heat for cooling during cooling season. The energy transfer system connects to a main municipal sewer line, ensuring a constant flow of sewage for heat transfer. To facilitate this, typically a local energy plant, owned and operated by an independent service provider, is required on or near the serviced site, including a wet well and heat recovery equipment.

An alternative form of this technology recovers heat from sewage from the building before the wastewater is discharged to the sewer. To ensure a stable supply of energy this system would require an on site storage to create a buffer for periods of lower wastewater generation. The challenge with this approach is that the capacity of the system will be linked to the size of the buffer tanks. The potential size of the buffer tanks to make a significant impact on emissions pose an implementation challenge. In the longer term these tanks will require maintenance which can pose challenges.

SickKids will need to sign a long-term energy purchase agreement with the utility provider to enable the local plant's construction. The construction cost, which depends on the contract capacity, will eventually be passed on to SickKids through utility bills. Since energy use varies throughout the year, contracting for 100% peak demand is not cost-effective. An optimal capacity is typically around 80% of the building's demand, satisfying 95% of annual energy consumption. The remaining 20% of peak demand and 5% of energy consumption will be supplemented by other energy sources.

4.1.9.2 Deep Lake Water Cooling System

Enwave's Deep Lake Water Cooling (DLWC) system in Toronto uses cold water from Lake Ontario to cool buildings. Water is drawn from a depth of 85 m, transferred through heat exchangers, and circulated in a chilled water loop, reducing the need for energy-intensive chillers and lowering GHG emissions. The system can also provide heating by using equipment that extracts heat from the low-temperature water loop and boosts it to a higher temperature for building use.

Similarly, SickKids will need to sign a long-term agreement before connecting to the DLWC system, with utility costs largely depending on the signed demand capacity and annual consumption. Enwave agreements typically offer flexibility to create a win-win situation. For instance, SickKids can transfer ownership of their chiller plant to Enwave, providing Enwave with supplementary energy-producing nodes on their network. For SickKids, this means being freed from maintenance and lifecycle replacement of the chilled water plant.

Compared to WET systems, Enwave's system is more efficient during the cooling season but less efficient during the heating season. This is due to the temperature difference in the working media: WET systems use city municipal wastewater, which has a higher temperature, making it easier to extract heat but less efficient for dumping heat. These efficiency differences will impact utility bills.

4.1.10 Geo-Exchange

A geo-exchange system is another low carbon source of heating and cooling, utilizing heat pumps to store energy in the earth. During the summer, waste heat from cooling is deposited into the ground and this heat is retrieved for use during the winter.

There are multiple variations of this technology. However, a conventional closed loop geo-exchange system is the most common configuration in the Toronto area. In this variation, energy is transferred to the earth via circulating a glycol/water mixture through a series of vertical wells. Each well consists of a tube encased in thermally conductive grout, typically between 244–259 m (800–850') in depth. To prevent thermal interference and for installation reasons, the wells are spaced at between 6–9 m (20–30') apart in a grid. For redundancy reasons, the wells are typically clustered into smaller sub-groups, each containing the same number of wells.

An alternative variation on a closed loop vertical geo-exchange system is a borehole thermal energy system (BTES). A BTES uses shallower wells in a spiral pattern instead of a grid and will operate at a higher temperature. The theory behind the spiral pattern is that the heat will be better contained within the field which, along with the higher operational temperature, will allow for a more compact field.

A conventional closed loop vertical geo-exchange system design, operations and construction is addressed in the CSA 448 standard series. CSA 448 does not address BTES. There are many working examples of BTES in operation in Canada; however, because the system is not addressed in CSA 448, there are potential risks linked to procurement of a BTES over a conventional design.

Modern closed looped geo-exchange systems regardless of configuration are typically located under buildings. The tubing used for construction of geo-exchange systems typically carries a 50-year warranty. However, the industry considers the service life to be significantly longer. As a result, modern geo-fields are often located under buildings. This prevents sterilization of land that could be used for future expansion and decreases the potential for damage to the field due to excavations.

Potential locations for a geo-exchange system for SickKids would be the underground below parking area, under the new hospital tower and angularly drilled wells along the perimeter of the interface between the new addition and the existing facility.

4.1.11 Demand Management

SickKids participation in the IESO's ICI program started in 2017 and continues today, when the Atrium and the PGCRL buildings were switched to Class A customers. The ICI is a program that enables large customers to lower their global adjustment charges on their electricity bills by adjusting or decreasing their electricity usage during the top five peak hours of the year. Forecasting and identification tools are used to determine the peak hours when the electricity demands are likely to be the highest, and then load reduction strategies are applied to lower the peak. This program allows annual savings between $0.5 million to $1 million in electricity costs.

Measures and strategies for demand management include reductions in AHU air flow, adjustments AHU supply air temperature and space temperature, temporary disablement of the heat recovery operation on heat recovery chillers, and sending public notifications (daily news, screensavers) to encourage occupants to shut down equipment reduce cooling load.

While the above measures satisfy current needs, the journey towards GHG reduction will introduce changes that impact electricity use profile and challenge demand management, such as building electrification and additional electric vehicle chargers. To maintain financial and environmental benefits, additional measures should be considered, including energy storage and an EV charging management system.

4.2 Main Hospital Initiatives

4.2.1 Lighting and Control Upgrade

The lighting systems and associated controls vary in age, technology, and control strategies. Newer buildings feature modern, energy-efficient LED fixtures and IP-addressable lighting controls. In contrast, older buildings like the Atrium and Annex use a mix of LED and outdated fluorescent lighting, with no centralized lighting controls in place.

About seven years ago, an LED upgrade was carried out in the Atrium and Annex, replacing around 70% of the fluorescent bulbs/tubes with LEDs. Due to budget constraints, the chosen LEDs were compatible with the existing fluorescent ballasts, meaning only the bulbs/tubes were replaced, not the entire fixtures. As a result, these LED bulbs/tubes depend on the fluorescent ballasts to function. The remaining 30% of lights still use fluorescent bulbs/tubes. At PGCRL, approximately 30% of the lights are also fluorescent bulbs/tubes.

Recently, the Canadian federal government announced a ban, through its "Products Containing Mercury Regulations", on the import and manufacture of most common mercury-containing lamps for general lighting purposes. This ban will take effect on December 31, 2025. After the ban is enforced, the availability of mercury light bulbs/tubes and the ballasts will gradually phase out from the market. Depending on the type of technology, some mercury bulbs/tubes will stop being produced and sold in January 2026 or January 2028.

This means that almost all the lighting fixtures in the Atrium and Annex (except for the recently renovated areas), whether they are LEDs using fluorescent ballasts or the remaining fluorescent fixtures, will need to be replaced. The fluorescent fixtures at PGCRL will also need to be replaced.

Currently, there is no central lighting control in the Atrium and Annex. When replacing the mercury-containing light fixtures, a lighting control system compatible with new technologies should be installed.

Upgrading to LED will not result in significant GHG reduction because the GHG intensity of Ontario's electricity grid is low compared to other areas. However, it offers another environmental benefit by reducing pollution from the mercury used in fluorescent bulbs. Additionally, LEDs last longer, which reduces maintenance costs. Not to mention, it is essentially mandated due to federal policy. Therefore, the lighting and control upgrade should be treated as a top priority.

4.2.2 CAV to VAV Conversions

Currently the HVAC system is primarily a constant air volume (CAV) design where space temperature set points are achieved by altering the supply air temperature. This is typical for a conventional hospital design.

The air flow rates to each space are dictated by CSA Standard Z317.2. Normally the air flow rates required by CSA Z317.2 will exceed the air flow rates needed for peak cooling and heating. As such, even if the space was a variable air volume (VAV) design it would not modulate due to code requirements for air changes.

The exception to this rule is clinical spaces, which are allowed to be setback afterhours as long as requirements around relative pressurization and temperature setpoints outlined in CSA Z317.2 are achieved. The only way to allow scheduling is through the conversion of zones to a VAV design.

Conversion from CAV to a VAV design within a clinical space is a highly disruptive exercise. As a result, it is recommended that SickKids explore the feasibility to convert zones to a VAV design as spaces are renovated. In general, this would apply to clinics which operate on a schedule and administrative areas. There are operational advantages to implementing VAV systems within 24/7 clinical spaces; however, the economic savings typically are not significant. As such, it is recommended that SickKids focus on the spaces with the greatest economic savings potential.

It is strongly recommended that SickKids establish a policy that whenever a space is renovated, the HVAC system is upgraded to a VAV configuration and that the ability to schedule the space is considered within the design process. Non-24/7 hour spaces will have the greatest energy savings potential; however, there will be operational advantage to even 24/7 hour spaces. As such it is recommended that this policy is applied to all spaces being renovated.

4.2.3 AHU Renewal

The main hospital has undergone multiple renovations. As a result, AHUs service zones that are fundamentally different than at the time of construction.

For example, a former patient room may now serve as an office. However, AHU operations might not have been updated to reflect this new usage. A patient room requires significantly more air changes per hour than an office, or some clinical spaces require a significantly higher amount of outdoor air than an office. Failure to adjust AHU operations to new space uses will result in unnecessary additional energy consumption and potentially comfort challenges for occupants. Building operations staff have observed that these conditions have occurred at SickKids, and Stantec's experience on past projects is that these situations are common.

Another concern arises when dissimilar spaces are serviced by a single AHU. For example, the Building Operations staff noted an AHU that serves both office spaces and DI equipment space. The heat load from the DI equipment space, which requires much colder air, dictates the supply air temperature for both areas. Consequently, the office becomes too cold, leading to unnecessary additional energy consumption and occupant comfort challenges

Typically, within facilities of this age, there will also be zones where AHU operations do not meet current CSA ventilation requirements. Correction of air flow rates to these zones will increase energy consumption and emissions related to the zones.

Correcting AHU zoning and operations can be challenging. For instance, reconfiguring zones can be an intrusive and disruptive process. Additionally, new supply ductwork may be necessary to meet current air change rate requirements.

Duct leakage is another issue within the facility, often due to the age of the ductwork and past reconfigurations. There are products available that use an aerosol sealing method to reseal the ductwork. While this process is disruptive, it is less so than replacing the ductwork. However, if the ductwork is in very poor condition, replacement may be required instead of resealing.

It is recommended that SickKids conduct an audit to identify problematic zones and develop strategies to address these challenges. The study should also determine whether the challenges can be addressed in isolation or if the level of disruption necessitates implementation during a renovation.

4.2.4 BAS Upgrades

The BAS for the main hospital is a hybrid system, consisting of original pneumatic control components and new DDC control components that have been gradually updated over the past 10 years. The central computer and supervisory controllers of the BAS are digital, while the field-level actuators are primarily pneumatic.

Pneumatic control is an obsolete technology that is no longer available on most new major equipment. While replacement parts and terminal equipment (such as VAV boxes) with pneumatic controls are still available, their availability is becoming increasingly limited. From a maintenance perspective, ongoing maintenance of pneumatics is also labor-intensive.

Pneumatic systems offer less control capability compared to DDC systems. This lower level of control leads to inefficiencies in maintaining the operation and function of other systems, as well as increased energy usage and emissions. It is worth noting that the upcoming update to CSA Z317.2 includes provisions recommending that hospitals be equipped with DDC controls instead of pneumatics.

Conversion from pneumatics to DDC can be a complicated and capital-intensive process due to factors like the number of pneumatic control devices within the system, access restrictions to these devices (i.e. in concealed ceilings) and the need for larger equipment removal required to replace pneumatic controller (i.e. removal of radiator to change valve from pneumatic to DDC). As a result, pneumatic to DDC conversion generally occurs through renovation projects and life cycle replacements. The exception is when there are a small number of controllers remaining then there could be a dedicated pneumatic to DDC conversion program.

It is recommended that SickKids implements a policy the pneumatics are replaced with DDC during all renovations and life cycle replacements.

4.3 Economic Considerations

4.3.1 Future Utility Costs Uncertainties

Canada is a signatory to the United Nations Paris Accord, which requires economy-wide operational net-zero emissions by 2050. Net zero is not gross zero, which means that some use of fossil fuels will be allowed beyond 2050. At this time, while they may disagree on how to get there, all major federal political parties are committed to net zero.

This transition to net zero will have implications on energy costs in the future. While the magnitude of the impact of these changes in cost is unknown, it is probable that energy will cost significantly more in the future.

Some of the key unknowns and drivers related to electricity are summarized below:

- The Government of Canada has announced a plan to decarbonize all electricity grids across Canada by 2035.[7] This is likely to necessitate replacement of existing fossil-fuel fired generation assets.
- Electrification in Ontario has resulted in rapid changes in the projected electrical demand within the province. This will necessitate additional generation assets being brought online and improvements in the electrical distribution system.
- Electrification is a global movement meaning that the cost of critical materials required for construction of electrical generation assets and electrical distribution are increasing in demand which is resulting in increased costs

The result of the above factors is that a significant capital outlay will be required to meet Ontario's current and future electrical needs. It is unknown if the Provincial government will absorb a portion of these costs directly or through a subsidy to rate payers, but it is very probable that electrical rates will increase in the future, and potentially significantly.

[7] Government of Canada. 2030 Emissions Reduction Plan. Environment and Climate Change Canada.

Some key unknowns and drivers related to natural gas are summarized below:

- Natural gas is a global commodity. The ultimate cost is determined by global political and economic factors outside of Canada. As a result, there is potential for swings in the costs of natural gas.
- Currently there is a shift in the historic supply chain for natural gas as Europe shifts the source of their natural gas supply. This may impact the price of natural gas as more expensive production is brought online.
- In 2018, the Government of Canada passed the Greenhouse Gas Pollution Pricing Act, enacting a price on carbon, and increasing it each year. Currently, the price of carbon until 2030 has been announced codified in the Act. It is unknown if the price of carbon will continue to increase beyond 2030. Further increases are likely, to continue to incentivize transition to net zero.
- Low to zero emission fuels such as renewable natural gas and hydrogen will be a critical element in the eventual transition to net zero. To generate these fuels, a significant capital outlay will be required to develop generation and distribution infrastructure. It is unknown how these costs will be recovered.
- Ontario's electricity generation mix includes natural gas fired generation. The IESO's published pathway to net zero includes maintaining these generators but transitioning them to low or zero emissions fuels. As a result, the cost of carbon and fossil fuels does have an impact on the price of electricity.
- District steam currently used by the facility is generated through combustion of fossil fuels such as natural gas. As such the increasing cost of carbon will impact the cost of district steam

The results of the above factors will be there are unknowns related to the future prices of both natural gas and low or zero emissions fuels in the future. In addition, these fuels are global commodities which are subject to potential price instability due to supply and demand. Natural gas and potential low to zero emissions fuels are used to generate electricity which will impact future electrical costs.

While the potential magnitude of future increases in utility costs is unknown, it is a risk that should be considered in asset planning. As a result, it is strongly recommended that SickKids consider energy efficiency

as key goal and considers the energy savings potential as a key deciding factor in project approvals.

4.3.2 Third Party Financing

The drive to net zero has led to the creation of multiple firms that offer financing to assist organizations with the capital needed for the retrofits for the transition to net zero. Many of these firms are part of the Canadian Infrastructure Bank's (CIB) aggregator program.

The CIB is a bank that was created by the Canadian Federal Government to provide funding to organizations for retrofits needed to transition existing buildings to net zero. Direct funding from the CIB is geared towards larger scale capital projects. Many organizations and projects will not qualify for direct CIB funding. To solve this issue the aggregator program was created.

In the aggregator program, CIB will provide funding to aggregators who will assist smaller organizations with retrofit projects. By bundling the saving of all the projects completed by an aggregator, the sum will meet the requirements of direct CIB funding and smaller projects will be completed.

There are many CIB aggregators on the market today, each offering a different project execution model, varying in flexibility and project ownership terms and structures.

At one end of the spectrum, there are aggregators with highly flexible models, allowing clients to choose vendors, construction partners, projects, and the level of service during the operations period. At the other end, some aggregators take full ownership of the project, giving the end client minimal input on construction partners while the aggregator plays a significant role during the operations period.

There are also aggregators with programs that fall between these extremes. If SickKids considers the third-party financing model, it is recommended to carefully review the commercial terms and prioritize aggregators that offer the most flexibility.

4.4 Next Steps

While reviewing BAS trend data, it was identified that data gaps and data quality made it challenging to determine how energy is used within the main hospital. As a result, energy end-uses for the main hospital were estimated based on a high-level review of utility data, assumptions on operations and typical energy end-uses within peer facilities.

Based on the findings of this report, it is recommended that SickKids immediately proceeds with the following initiatives:

- Enabling measures such as BAS, metering and sub-metering
- Lighting upgrades as opportunities present
- Re-commissioning, retro-commissioning and commissioning program

For measures such as lighting upgrades and recommissioning the potential for energy savings have been proven in multiple facilities as such the value in developing a SickKids specific business case has less value. It can be challenging to retrieve meaningful trend data to allow for analysis of existing systems. As enabling measures such as BAS, metering and sub-metering is required to develop the business cases for more complex projects. As such it is recommended SickKids implements these proven or needed measures in the immediate to near term without further business case development.

For the more capital-intensive measures, more detailed studies are needed to develop a business case to support implementation and define appropriate scopes of work.

Within the current market these types of studies are typically based on ASHRAE Energy Audit Standard 211-2018. While the ASHRAE Energy Audit Standard focuses on the entire building, the levels of rigor can be used to define the scope of work for more targeted studies.

The ASHRAE 211-2018 standard describes three levels of energy audits. The typical levels of effort are summarized below.

- **Level 1:** This level of study is based on observations, and analysis is based on typical values. This level of study is intended as a first step in developing energy and emission management plans. Concepts for energy conservation and emissions reduction are identified and described in general terms. This ECDM Plan is in alignment with, and in some respects exceeds, the Level 1 standard.
- **Level 2:** This level of study involves more rigorous analysis using commercially available software or spreadsheet calculations and is based on weather data. Analyses are based on facility information gathered during site visits and available design and operational parameters. Calibration of the energy analysis to utility bills is not required, but best practices include a general comparison of energy analysis results to utility bills. Energy and emission reduction strategies are developed to a concept level of engineering. Further study is required to refine the business case; however, Level 2 energy audit completes an initial level of screening.
- **Level 3:** These are the most detailed, rigorous studies. The energy analysis must be calibrated to utility bill data at minimum; however, it is common practice to further calibrate the energy analysis against measured data (sub-metered or BAS trend data). Energy conservation and emission reduction measures are developed to an early schematic design level. A cost consultant is typically involved to prepare opinions of probable costs.

Within the Canadian marketplace, the most commonly executed energy audit is a Level 2 audit with elements of a Level 3 audit. Depending on the risk tolerance of an organization, follow-up studies of specific systems more aligned with the Level 3 standard may be completed.

It is recommended that SickKids complete further targeted studies at an ASHRAE Level 2 or 3 Level for the following heating, cooling, humidification and ventilation measures:

- Energy Sharing and Heat Recovery
- Low Carbon DHW heating
- Low Temperature Water Heating Conversion
- Low Carbon District Heating
- Geo-Exchange
- Adiabatic Humidification

The recommended heating, cooling, humidification, and ventilation measures have a large degree of interaction: the potential savings from implementing all measures is not the sum of the savings potential from the individual measures. Therefore, it is recommended that bundles of measures are developed, and studies are completed to establish a business case the bundles of measures.

4.5 Summary of Initiatives

A summary of the initiatives and high-level estimates potential energy and GHG saving potential and level of effort is included in Table 4.

Potential energy savings where estimated based on typical savings ranges for the measures.

Based on analysis of utility data, information from SickKids and typical facility energy consumption an energy end use breakdown was estimated for each building. Emission savings ranges where calculated based on applying energy savings ranges to the estimated energy end use breakdown.

Effort/costs where estimated based on typical cost ranges for measures or for more capital-intensive measures the maximum budget range which would align with a 10 year simple payback.

Table 4: Summary of Initiatives

#	Measure	Energy Savings Potential (2024-2029)	GHG Reduction Potential (2024-2029)	Effort / Cost	Comments
Campus-wide Initiatives					
	Metering, Sub-Metering and BAS trending	N/A	N/A	$1 to 1.5M	Ongoing, as soon as possible
	Recommissioning & retro-commissioning	4–8%	4.5–9%	$0.6–1.2M	Ongoing, as opportunities present generally in 5 year cycles
	Energy Sharing and Heat Recovery	3–10%	5–20%	$5–8M	Need to study and understand more (paired low carbon DHW heating)
	Low Carbon DHW heating	1–3%	6–8%	$3–5M	Need to study and understand more (paired with energy sharing and heat recovery)
	Adiabatic Humidification	3–5%	6–10%	$10–15M	Need to study and understand more
	Low Temperature Water Heating Conversion	8–20%	15–40%	$10–15M	Need to study and understand more
	Low Carbon District Heating	0 to up to 20%	10–40%	Connection fees of up to $8–12 million a year. Target is 30 year life cycle cost will be neutral with onsite heating and cooling plant. Proposal pending from potential suppliers.	Conduct a feasibility assessment
	Geo-Exchange	0 to up to 20%	0 to up to 40%	Up to $23M	Conduct a feasibility assessment
Main Hospital Initiatives					
	Lighting Control Upgrade	2–4%	0.1–0.5%	Lighting controls 100–150 $/m²	As opportunities present themselves
	CAV to VAV Conversions	5–15%	8–20%	100–200 $/m² for CAV to VAV conversion	Renewal/renovations, as opportunities present themselves
	Airflow and Thermal Comfort Assessment; Duct Refurbishment and Air Distribution Corrections	TBD	TBD	500–1000 $/m²	Renewal/renovations, as opportunities present themselves
	BAS Upgrades	3–10%	3–10%	300–600 $/m² depending on complexity	Ongoing, as opportunities present themselves
	AHU Replacement: HVAC System Renewals	TBD	TBD	2,000,000 CFM AHU $26/CFM = $52M 52 $/ft, about 5.2 m², 4–6 $/m²	Currently ongoing AMP

5.

Corporate Leadership

Meeting the 2030 and 2050 greenhouse gas (GHG) reduction targets necessitates a dual approach. First, SickKids must implement conservation-focused actions, such as building decarbonization plans. Simultaneously, SickKids must shift internal priorities to embed climate-mitigation actions into policies, programs and projects while ensuring the well-being of occupants in indoor spaces. This section discusses best management corporate actions that have been identified by staff and subject matter experts.

5.1 Initiatives

The following proposed corporate initiatives are discussed in detail in this section:

- C1: Complete a Climate Risk and Resilience Assessment
- C2: Update Asset Management Policy and Plans
- C3: Update Purchasing Policy
- C4: Develop an Internal Cost of Carbon Policy
- C5: Install Electric Vehicle (EV) Chargers
- C6: Provide Staff With Active and Sustainable Transportation Options
- C7: Provide More Spaces to Help Staff and Families De-Stress

5.1.1 Complete a Climate Risk and Resilience Assessment

A Climate Risk and Resilience Assessment (CRRA) involves evaluating SickKids vulnerability to climate-related risks and developing strategies to enhance resilience. This assessment considers the projected changes in the local climate (e.g. changes in temperature, precipitation) and how these changes might affect assets, programs, operations, and staff. By identifying climate related impacts and assessing through the CRRA, SickKids can then identify resilience measures (e.g. design, program, operational, and policy) to reduce the consequences when climate events occur (e.g. backflow values to reduce the risk of sewer backups due to intense precipitation, building HVAC systems accommodate a higher range of external temperatures, shading on windows, cool roofs).

5.1.2 Update Asset Management Policy and Plans

With the climate expected to undergo significant changes in the coming decades, it is recommended that SickKids update its Asset Management Policy and Capital Asset Management Plans (CAMPs) to include the objective of investing in and upgrading assets to mitigate and adapt to climate change. For example, having decarbonization plans will align or accelerate endof-life rehabilitation initiatives for individual building components (e.g. roof, windows, mechanical equipment) which will align with the expected updates in the CAMPs. This initiative would be implemented after a CRRA has been completed.

5.1.3 Update Purchasing Policy

SickKids has supported the purchase of environmentally friendly products and services in principle and as set out in its Purchasing Policy. However, the policy does not directly prioritize low- to no-GHG emission products and services. It is recommended that in support of this ECDM Plan, SickKids update its Purchasing Policy to prioritize the procurement of goods and services that have a low to no-carbon footprint.

5.1.4 Develop an Internal Cost of Carbon Policy

Although the social and environmental benefits of reducing energy and GHG emissions are well established, their recognition or importance in decision making processes are often underrepresented. Applying an internal cost of carbon (ICC) allows organizations to better account for these benefits and is a key component to moving an organization towards its energy and GHG reduction targets. To support many of the proposed initiatives in this Plan, it is recommended that SickKids establish an ICC which would be used to calculate the value (expressed as a cost) of GHG emissions associated with capital project decision-making. It is recommended that the policy require that SickKids staff internalize the cost of corporate GHG emissions in their respective budgets and pay into an internal carbon reserve fund that can be used to support climate mitigation and adaptation projects at both the corporate and community level.

While it is simple enough to commit to an ICC policy, establishing the actual cost of carbon is difficult. As there is no true global benchmark, the price of carbon typically can range anywhere between CAN $1–50 per tonne of CO_2e if the cost is associated with a voluntary or regulatory GHG program, or between CAN $200–400 per tonne of CO_2e if the cost is based on a more comprehensive assessment of the cost of carbon and its associated damages. While a high ICC of $400 per tonne of CO_2e is the preferable route, starting with an ICC that is significantly higher than current provincial policy without adequate education and change management is likely to stall the implementation of the policy. It is therefore recommended that SickKids use Canada's 2030 carbon tax value of $170/t$CO_2$e and increase this value annually.

5.1.5 Install Electric Vehicle (EV) Chargers

To encourage the transition to low/no-carbon forms of transportation, there is an opportunity for SickKids to install electric vehicle (EV) charging stations within its parking lots. This would not only support environmental goals, but would also enhance the company's image, employee satisfaction, and overall workplace experience. This initiative would be implemented opportunistically (e.g. major renovations, new construction).

5.1.6 Provide Staff with Active and Sustainable Transportation Options

Active transportation and other sustainable transportation options, like electric vehicle car share, e-bikes, virtual meetings, and alternative work arrangements, can play a key role in reducing GHG emissions that occur in the community. SickKids can expand active transportation programs by providing employee transit programs, dis-incentivizing staff parking and providing protected bike parking.

5.1.7 Provide More Spaces to Help Staff and Families De-Stress

By designing environments that reduce stress and enhance overall well-being, SickKids staff and patient families can benefit from improved mood, productivity, resilience, and recovery. Wellness rooms, for instance, have shown positive outcomes in health systems.[8] Where there is a major renovation or new construction of a building, the opportunity to incorporate wellness rooms should be considered by staff and designers. Key characteristics of wellness rooms tend to include minimalist aesthetics, soundproof walls and calming colors, the use of natural and adjustable lighting, the incorporation of partitions or screens, comfortable seating, plants, and a small fridge stocked with fruits, vegetables, yogurt, and natural juices. This initiative would be implemented opportunistically (e.g. major renovations, new construction).

[8] Health systems create new spaces for employee well-being | Health Facilities Management (hfmmagazine.com)

5.2 Summary of Corporate Initiatives

A summary of the corporate initiatives is presented in Table 5.

Table 5: Summary of Corporate Initiatives

Initiative		Carbon Potential: 2024-2050	Effort / Cost	Estimated Completion Year
C1	Complete a Climate Risk and Resilience Assessment	C		2025
C2	Update Asset Management Policy and Plans	C	Staff Time $$	2025/26
C3	Update Purchasing Policy	C	Staff Time $	2025/26
C4	Develop an Internal Cost of Carbon Policy	C	Staff Time	2025/26
C5	Install Electric Vehicle (EV) Chargers	CCC	Staff Time $$	As opportunities present themselves.
C6	Provide Staff with Active and Sustainable Transportation Options	C	Staff Time $$	2024
C7	Provide More Spaces To Help Staff and Families De-Stress	C	Staff Time $$$	As opportunities present themselves.

LEGEND

GHG Emissions:	Financial Resources:
C: Lays the foundation for other efforts, though by itself may not reduce GHG emissions measurably	$: $0–$25,000
CC: Reduces total annual carbon emissions by 0 to 50 tCO_2e	$$: $25,000–$100,000
CCC: Reduces total annual carbon emissions by 50 to 500 tCO_2e	$$$: Over $100,000
CCCC: Reduces total annual carbon emissions by more than 500 tCO_2e	$$$$: Over $1,000,000

6.

ECDM Plan Implementation and Decarbonization Roadmap

6.1 Governance and Collaboration

SickKids' Sustainability Office and Governance Committee is currently responsible for leading the implementation of the ECDM Plan. This responsibility includes:

- Checking that SickKids meets all energy related regulatory requirements
- Serving as a primary point of contact for all energy related matters
- Generating and distributing reports to council and staff
- Monitoring and verifying energy performance
- Promoting energy education and awareness
- Supporting the planning, development, and implementation of energy efficient projects

Projects are implemented on a case-by-case basis and brought to senior management's attention for consideration and approval as necessary.

6.2 Monitoring Existing and Evaluating New Initiatives

This ECDM Plan lists initiatives to be completed over the next five years that will enable SickKids to meet its energy and GHG emissions reduction targets. The intention of the ECDM Plan is to integrate energy conservation, energy demand management, and GHG emissions to SickKids' normal course of business for asset retrofits, renewals, and life cycle replacement projects. A successful ECDM Plan requires conservation and demand management options to be incorporated at the initial design stages. Early adoption allows SickKids to assess and measure energy-efficient options by considering their overall life cycle costs, including initial, maintenance, and energy costs, as well as GHG reductions and other benefits.

Future initiatives—also referred to as projects—should be evaluated using the following checklist:

- Project base case
- Energy efficient options
- Project costs (i.e. base case vs. energy efficient case)
- Project savings (i.e. in terms of energy, maintenance, avoided GHG emissions)
- Maintenance savings
- Financial benefits
- Environmental benefits
- Social benefits
- Incentives/funding available
- Recommendations from a life cycle analysis

This ECDM Plan will be in place for five years until it needs to be updated, as required by O. Reg. 25/23. As part of the strategic operations planning process, representatives from various SickKids departments will collaborate to evaluate the initiatives described in this ECDM Plan. This is an opportunity to review and prioritize potential strategies based on resources and emerging technological opportunities.

6.3 Monitoring and Reporting

The ECDM Plan is continuously improved and maintained as a living document through deliberate use of the Deming Cycle, an ongoing feedback loop. The Deming Cycle enables SickKids to regularly reassess and refine its energy and GHG reduction targets, GHG emission forecasts, and prioritization of initiatives. The four components of the Deming Cycle, shown in Figure 15, are "plan, do, check, and act." SickKids intends to review progress on its ECDM Plan annually by applying the Deming Cycle. This review will align with the budget planning cycle to properly allocate each year's capital and operating budgets based on ECDM Plan initiatives.

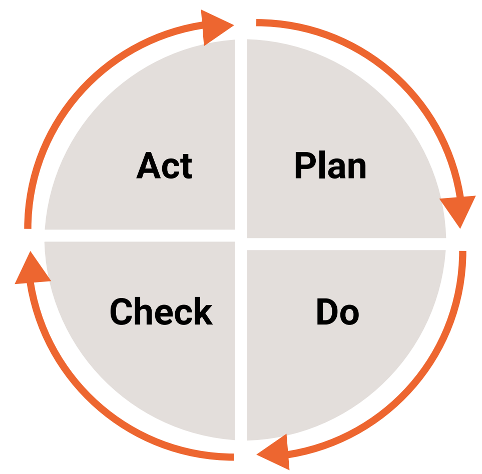
A monitoring framework—the "check" component of the cycle—provides SickKids with a list of items to track over time that will help re-assess the effectiveness of initiatives, GHG emissions, and other activities contained within the ECDM Plan. Monitoring includes two components:

1. Monitoring the ECDM Plan initiatives: what is being done, who is doing it, what is the activity funded, etc.

2. Compiling the energy and GHG emissions inventory to monitor the success of the ECDM Plan initiatives.

To maintain momentum for change, it is essential to track, measure, and share progress towards the GHG emission reduction targets and the initiatives identified in the ECDM Plan. The success of the ECDM Plan is measured based on the results achieved relative to prior reporting years.

Figure 15: The Deming Cycle (Plan-Do-Check-Act)



An energy and GHG emissions report should be prepared annually and should include, at a minimum, the following information:

- Current energy and GHG emissions profile, showing combined data (e.g. all assets) and broken down by asset.
- Change in energy and GHG emissions from the prior year and the baseline.
- Follow up actions from the prior year's report.
- A description of the work completed.
- Extent to which GHG emissions reduction have been met.
- Identification of any issues or challenges faced in making progress for each initiative.
- An indication of progress toward achieving each initiative, using the following scale:
  - » Not Started: The initiative has not been implemented.
  - » On Track: The initiative has been implemented. For various initiatives, progress will be measured through quantitative and qualitative primary indicators (Table 6) and secondary indicators (as identified).
  - » Outstanding: An issue, barrier, and/or challenge is preventing the initiative from being implemented.
  - » Delayed: The initiative has been delayed or placed on hold.
  - » Completed: The initiative has been completed.
  - » List of new initiatives to address issues, barriers, and challenges.
  - » Timing and assigned responsibilities for the initiatives.

Table 6: ECDM Plan Key Performance Indicators

Key Performance Indicator (KPI)	Measurement
Building Energy Intensity	Energy use per unit area
Building Emissions Intensity	GHG emissions per unit area
Building Energy Cost Intensity	$ per unit area

Implementing the ECDM Plan is covered by the "plan" and "do" components of the Deming Cycle. To best identify which actions to focus on annually, implementation can be guided by a work plan. The annual work plan should tie into departmental business plans and budgets to properly allocate responsibilities and resources. Progress is then reported to identified stakeholders, as noted in Section 6.4.

6.4 Communication Strategy

The overall goal of the communication strategy is to outline tools and techniques to help SickKids communicate details of the ECDM Plan internally, including implementation and progress towards the targets. This communication strategy is not designed to be public as it focuses on internal communication for SickKids staff and council. The key objectives of the strategy are:

- Communicate the existence and importance of the ECDM Plan.
- Share progress towards the GHG emission reduction targets.
- Motivate multiple internal audiences about what they can do to reduce SickKids's energy use and GHG emissions.
- Communicate changes in business practices to support the ongoing implementation of the ECDM Plan.

Table 7 identifies proposed tactics that support the communication strategy.

Table 7: Proposed Communication Tactics

Tactic	Description/Rationale
Host quarterly ECDM Plan meetings	The intent of these meetings is to: • Share best practices between departments • Provide status/progress updates on energy conservation and GHG emission reduction strategies across all departments • Prioritize work • Share funding opportunities • Collaborate on shared initiatives that flow into annual work plans and budgets Annually, the team will review the ECDM Plan and document progress towards its goals.
Develop an annual corporate Energy and GHG Emissions Progress Report	The Environmental Initiatives Division will: • Gather information from all departments and report annually on energy and GHG emissions • Develop a one-page, graphic summary that can be used to communicate results with a wide range of audiences, including internal staff and council
Increase awareness of the ECDM Plan and implement general energy skills training for all staff	Develop (or adopt) a stand-alone webinar that would be suitable for all SickKids staff. The webinar could cover: • The existence of the ECDM Plan • The role of all staff in contributing to energy conservation and GHG emission reductions • Quick tips and reminders for routine corporate energy conservation and GHG emission reductions
Integrate key messaging into existing communications	Work with Human Resources to share tips and reminders about energy conservation and GHG emission reductions with all staff.
Create (and publicize) a "Bright Lights" program	Create a staff-based program to celebrate success. Suggest working with Human Resources to develop a staff recognition program. This could include: • Seek nominations for staff that have made a difference with energy efficiency • Develop vignettes • Circulate stories and photos
Facilitate open lines of communication	Provide staff across the organization with access to an ECDM Plan information-sharing portal. This portal might be used to: • Share innovative ideas • Identify areas of concern • Provide feedback or solutions

Table 8 presents supporting details for these communication tactics.

Table 8: Timing and Responsibility of Suggested Communication Tactics

Tactic	Audience	Level of Effort				Timing
		Very Low	Low	Medium	High	
Host quarterly ECDM Plan meetings	Senior leaders representing key departments	■	■			Quarterly, Ongoing
Develop an annual corporate Energy and GHG Emissions Progress Report	Council All staff	■	■			Annually
Increase awareness of the ECDM Plan and implement general energy skills training for all staff	All staff	■	■	■		End of Year Two
Integrate key messaging into existing communications	All staff	■	■			End of Year One
Create (and publicize) a "Bright Lights" program	All staff	■	■			End of Year One
Facilitate open lines of communication	All staff	■				End of Year One

6.5 Decarbonization Roadmap

Decarbonization of the built environment is one of the largest challenges of our time and requires a long-term plan to be successful. A decarbonization roadmap lays out projects and timelines to help an organization achieve its long-term emissions reduction goals. For a decarbonization roadmap to provide the greatest value to an organization, it must be a living document that evolves as projects are implemented and experience is fed back into the plan.

The projects identified in this ECDM Plan serve as a starting point for SickKids' decarbonization roadmap. The roadmap will be periodically updated, as follows:

1. Update/refine energy end use baseline created for this ECDM Plan based on new sub-meter data and/or additional BAS trends.
2. Update energy savings, GHG savings, and implementation costs based on further studies.
3. Re-evaluate and update project sequencing.
4. Repeat steps 1–3.

Once the decarbonization process begins and more data are available, the roadmap updates can be further informed by a sensitivity analysis. This sensitivity analysis involves adjusting unknown variables, like utility costs, within a specific range to observe their impact on the overall ranking of initiatives. Sensitivity analysis is highly informative as it helps account for the potential effects of uncertainties.

The projects are prioritized for implementation based on the following factors:

- **Quick wins**, such as "Recommissioning and retro-commissioning". They are typically easy-to-implement, mature technologies that do not require detailed studies to support, and usually achieve quick financial returns. These measures should be completed first to generate potential cost savings that can then be re-invested in future projects.
- **Enabling works for future projects**, such as "Metering, sub-metering, and BAS trending". Although these projects do not yield direct energy or GHG savings, they can provide valuable information that helps in identifying inefficiencies and opportunities, and inform future business cases, design decisions, and updates to the decarbonization roadmap.
- **Connection to pending renewals and renovations**, such as "CAV to VAV conversions". They should be implemented during end-of-life equipment renewals or renovations of building areas. When doing so, they should be upgraded to current standards and improved for better energy efficiency, rather than simply being replaced as is.
- **Greatest potential for GHG reductions**, such as "Low temperature water heating conversion". The heating system in a building is typically the largest source of emissions, as heating energy accounts for half of the total energy use and is usually generated by burning GHG-intensive fuel sources. Therefore, heating-related conservation measures have the potential to achieve the most significant emissions reductions.
- **Sequencing of interconnected projects**, such as "Low carbon district heating" and "Geo-exchange" should be evaluated and implemented after the completion of "Energy sharing and heat recovery". SickKids is working on multiple projects to increase waste heat recovery, which can significantly change the energy use profile. The initial costs and effectiveness of "Low carbon district heating" and "Geo-exchange" are highly dependent on future building energy use profiles.

Table 9 shows the implementation year and sequences that were developed based on these factors.

Table 9: Summary of Initiatives

#	Measure	Energy Savings Potential (2024-2029)	GHG Reduction Potential (2024-2029)	Effort / Cost	Estimated Completion Year
Campus					
	Metering, sub-metering, and BAS trending	N/A	N/A	$1 to 1.5M	2025–2026
	Recommissioning and retro-commissioning	4–8%	4.5–9%	$0.6–1.2M	2025–2050
	Energy sharing and heat recovery	3–10%	5–20%	$5–8M	2025–2027
	Low carbon DHW heating	1–3%	6–8%	$3–5M	2028–2030
	Adiabatic humidification	3–5%	6–10%	$10–15M	2030–2050
	Low temperature water heating conversion	8–20%	15–40%	$10–15M	2025–2030
	Low carbon district heating	0 to up to 20%	10–40%	Connection fees of up to $8-12 million a year. Target is 30 year life cycle cost will be neutral with onsite heating and cooling plant. Proposal pending from potential suppliers.	2030+
	Geo-exchange	0 to up to 20%	0 to up to 40%	Up to $23M	2030+
Main Hospital					
	Lighting control upgrade	2–4%	0.1–0.5%	Lighting controls 100–150 $/m^2	2025–2030
	CAV to VAV conversions	5–15%	8–20%	100–200 $/m^2 for CAV to VAV conversion	2025–2050
	Airflow and thermal comfort assessment; duct refurbishment and air distribution corrections	TBD	TBD	500–1000 $/m^2	2025–2050
	BAS upgrades	3–10%	3–10%	300–600 $/m^2 depending on complexity	2025–2035
	AHU replacement: HVAC system renewals	TBD	TBD	2,000,000 CFM AHU $26/CFM = $52M 52 $/ft, about 5.2 m^2, 4–6 $/m^2	2025–2050

Based on the implementation sequence and the years presented in Table 9, Figure 16 shows the potential savings for the periods 2024–2030 and 2030–2050. The measures listed indicate an energy savings potential of 15–40% and a GHG savings potential of 25–65% for the 2024–2030 period. For the long-term plans (2024–2050 period), there is an energy savings potential of 20–50% and a GHG savings potential of 40–80%.

Figure 16: Potential Energy Savings

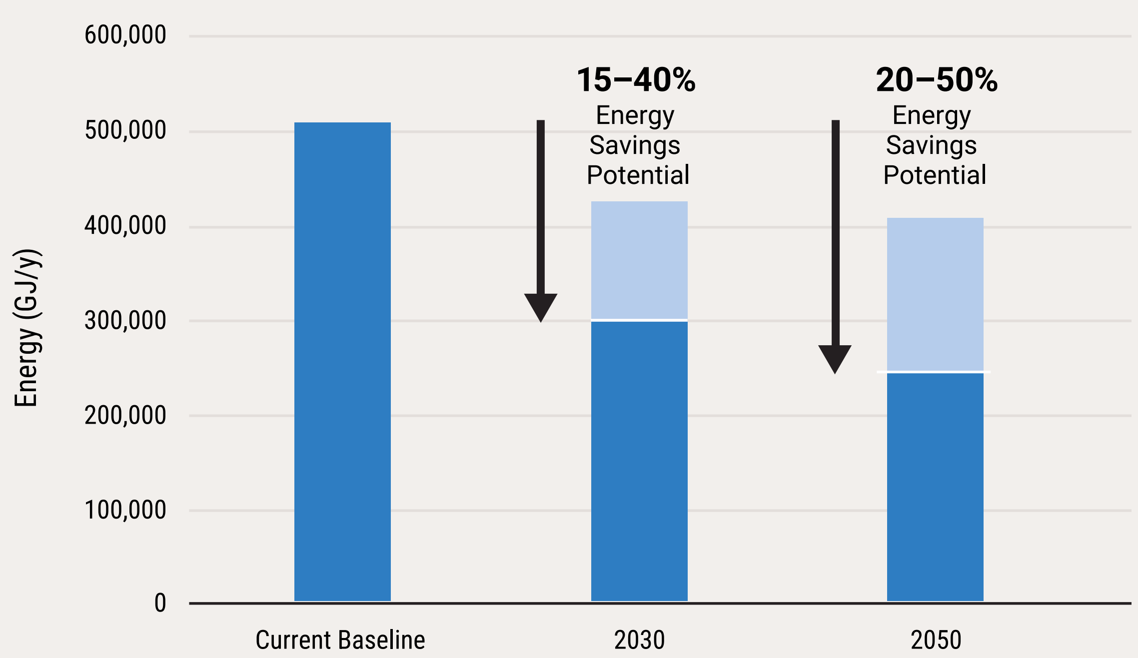


Figure 17: Potential GHG Savings

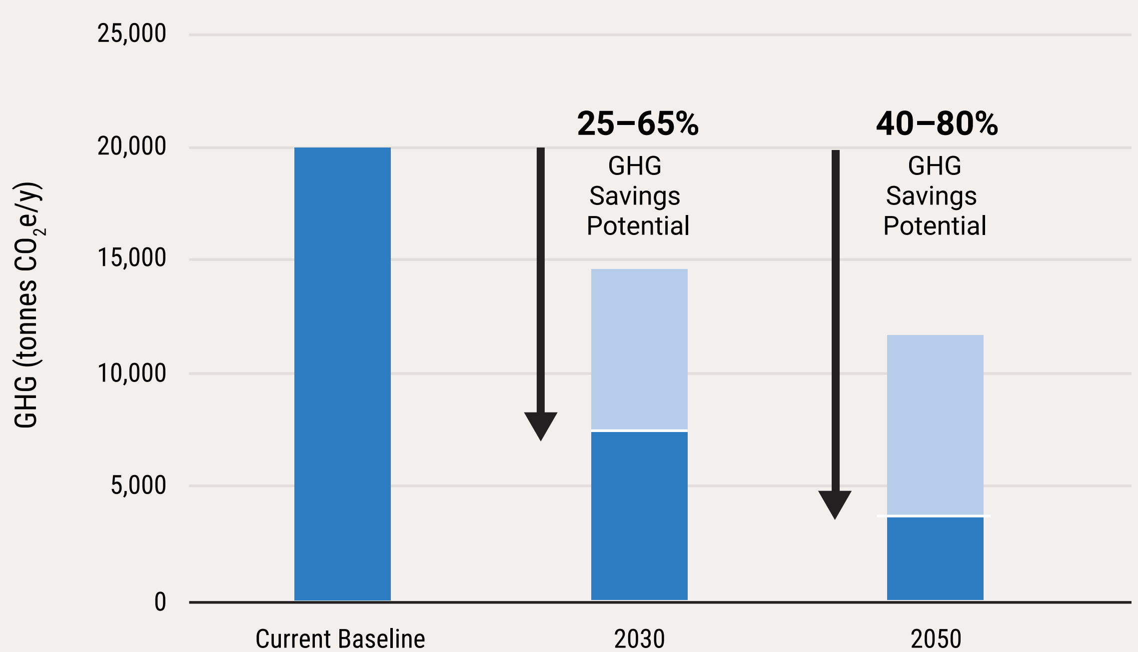


Table 9 and Figures 16 and 17 only include major measures that will result in significant savings, selected from a larger list of identified measures. For visual clarity, similar measures have been grouped together. When implementing the decarbonization roadmap, measures not listed will also need to be properly sequenced, and grouped measures will need to be split and phased based on constraints such as financial availability and workforce capability.

The objective of every ECDM Plan is to optimize measures to achieve energy and emissions reduction goals while lowering capital costs and leveraging necessary renewals and pending projects. However, many plans fall short due to the challenges posed by the highly interactive nature of building systems, where changes in one system can have cascading effects on others.

To address these challenges, Stantec developed a unique parametric analysis tool and has been using it during workshops to successfully help organizations. The parametric analysis was used to develop SickKids' decarbonization roadmap. However, due to the uncertainty in the requirement inputs, it cannot provide SickKids with precise turn-by-turn guides. Stantec therefore explored SickKids' vision for the tool to enhance its functionality. Based on SickKids' feedback and functional expectations, the following additional tasks will be completed to customize the tool so it meets SickKids' specific requirements:

- **Create more precise energy use profiles for buildings and major systems.** Currently, these profiles are primarily based on monthly utility bills, supplemented by some parameters from the BAS. Once the recommended measures are implemented (e.g. metering, sub-metering, and BAS trending), this task will be tremendously improved.
- **Enhance the accuracy of cost savings and GHG reduction potential, especially for short-term measures.** This can be achieved through energy audits and detailed engineering studies. For more information, refer to Section 4.4: Next Steps.
- **Evaluate the internal and external factors influencing project selection and sequencing.** Internal factors include the Project Horizon long-term plan, which shapes SickKids' future, and any planned infrastructure renewal and renovation of the current campus. External factors encompass changes in codes and regulations, utility cost outlook, and more.
- **Incorporate SickKids' expectations for the tool's inputs.** Include decision-making criteria and their respective weights (e.g. GHG reduction, system resiliency, utility cost savings, and financial constraints) and specify the expected outputs (e.g. project sequencing, project progress, and achieved results).

Appendix

Appendix A: Emission Factors

Steam GHG Emission Factor: 73.8 gCO_2e/lb*

Ontario's grid electricity emission factor:

Ontario Grid Emission Factor (t CO_{2e}/GWh)	
2013	64
2014	35.3
2015	41.6
2016	35.9
2017	16.4
2018	25.6
2019	25
2020	25.8
2021	26.2
2022	26.2
2023	26.2

Note: The electricity grid intensities are calculated from Canada's greenhouse gas and air pollutant emissions projections.

** This is calculated from Energy Star may change number as of current year*

Appendix B: Glossary

The following definitions and abbreviations should be considered during the review of this report.

Air Handling Unit (AHU)	A piece of equipment used to condition and circulate air as part of a heating, ventilating, and air-conditioning system.
Building Automation System (BAS) Alternate term: Building Management System (BMS)	A distributed control system that is a computerized, intelligent network of electronic devices designed to monitor and control the mechanical, electronics, and lighting systems in a building. BAS core functionality keeps the building climate within a specified range, provides lighting based on an occupancy schedule, and monitors system performance and device failures and provides email and/or text notifications to building engineering/maintenance staff. The BAS functionality reduces building energy and maintenance costs when compared to a non-controlled building. A building controlled by a BAS is often referred to as an intelligent building.
Opinion of Probable Cost Alternate term: Estimated Capital Cost	Opinions of probable costs identified in this report include costs including the following phases of work: design, equipment and materials, construction/installation, project management, construction administration, and commissioning.
Cabinet Heater	A type of terminal unit that provides heating to the space. They typically utilize electric or hydronic heating coils.
Conservation and Demand Management (CDM)	Conservation and demand management is the process of conserving energy and moderating the demand of a facility. A CDM Plan documents this process for a specific facility or municipality and provides guidelines to carry out the process.
Compact Fluorescent Lamp (CFL)	A fluorescent lamp that is compressed into the size of stand-issue incandescent light bulb designed to replace it.
Constant Air Volume (CAV)	A type of air distribution system where the temperature of air is varied while the volume of air delivered is held constant depending on the heating or cooling needs of each space.
Cooling Degree Days (CDD)	Cooling degree days is a measure of how hot a location was over a period, relative to a base temperature. The base temperature is 18.0°C and the period is 1 year. If the daily average temperature exceeds the base temperature, the number of cooling degree-days for that day is the difference between the two temperatures. However, if the daily average is equal to or less than the base temperature, the number of cooling degree-days for that day is zero. Cooling degree days are typically summed for a given location and provided on an annual basis.
Demand Control Ventilation (DCV)	A type of outdoor air control strategy where indoor contaminant sensors, such as CO2 sensors, are used to control the outdoor air dampers on air handling units in order to match the amount of incoming outdoor air to the contaminant levels in the space. This strategy is used for both energy savings and to maintain adequate indoor air quality.
Direct Digital Control (DDC)	Automated control of conditions or processes by a digital device.
Direct Expansion (DX)	A type of cooling system where the refrigerant is prepared to absorb heat from a space by passing through an expansion valve before it is delivered directly through the conditioned air stream (via a cooling coil).
Discounted Payback	Provides a payback period while taking the time value of money into account. This is achieved by discounting future cash flows by a specified amount. For this report, a discount rate of 4% and an energy escalation rate of 2% were used.
Domestic Hot Water (DHW)	Hot water provided for potable uses, such as handwashing or laundry.
Energy Conservation Measure (ECM) Alternative terms: Energy Conservation Opportunity (ECO) Energy Efficiency Measure (EEM) Energy Management Opportunity (EMO) Facility Improvement Measure (FIM)	Any type of project conducted or technology implemented to reduce the consumption of energy in a building. Energy can come in a variety of forms: water, electricity and gas being the main three (3) for industrial and commercial enterprises. The aim of an ECM should be to achieve a saving, reducing the amount of energy used by a particular process, technology or facility.
Exterior Insulation Finishing System (EIFS)	A general class of non-load bearing cladding systems that provide exterior walls with a layer of exterior insulation.
Fan Coil Units (FCUs)	A fan coil unit is a simple device consisting of a heating and/or cooling heating exchanger or coil and a fan.
Energy Efficiency Ratio (EER)	The EER is a measure of an air conditioner's efficiency. It is the ratio of the cooling capacity (in British thermal units [Btu] per hour) to the power input (in watts).
Energy Utilization Index (EUI)	Energy utilization index is a normalized comparison of the energy performance of facility where the normalizing factor is floor area. The units for the EUI are ekWh/m^2 or GJ/m^2.
Greenhouse Gas (GHG)	Greenhouse gases (GHGs) primarily comprise carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulfur hexafluoride (SF_6), perfluorocarbons (PFCs), and hydrofluorocarbons (HFCs).
Greenhouse Gas (GHG) Carbon Dioxide Equivalence (CO_{2e})	GHGs are typically expressed in terms of kilograms or tonnes of carbon dioxide equivalent (CO_{2e}). Since different GHGs exhibit differences in the amount of global warming they can potentially cause, this allows emissions of different GHGs to be combined into a common unit of measure.

Heating, Ventilation, and Air-conditioning (HVAC)	This term collectively refers to the process of conditioning air for use in a built environment for the comfort of occupants.
Heating Degree Days (HDD)	Heating degree days is a measure of how cold a location was over a period, relative to a base temperature. The base temperature is 18.0°C and the period is 1 year. If the daily average temperature is below the base temperature, the number of heating degree-days for that day is the difference between the two temperatures. However, if the daily average temperature is equal to or higher than the base temperature, the number of heating degree-days for that day is zero.
High Intensity Discharge (HID)	A family of lamps that utilize an electrical current to excite a gas and release light once the gas returns to its normal state. Typically used in applications where there are large distances between the lamp and illuminated surface.
Independent Electricity System Operator (IESO)	An independent, non-profit crown corporation responsible for the real-time procurement of electric power in the province of Ontario. The IESO merged with the Ontario Power Authority (OPA) on January 1, 2015; the OPA was the former administrator of the saveONenergy program.
Internal Rate of Return (IRR)	The internal rate of return (IRR) is a capital budgeting metric used by firms to decide whether they should make investments. It is an indicator of the efficiency of an investment, as opposed to net present value (NPV), which indicates value or magnitude. The IRR is the annualized effective compounded return rate which can be earned on the invested capital, i.e. the yield on the investment. A project is a good investment proposition if its IRR is greater than the rate of return that could be earned by alternate investments (investing in other projects, buying bonds, even putting the money in a bank account). Thus, the IRR should be compared to any alternate costs of capital including an appropriate risk premium.
Light Emitting Diode (LED)	An LED lamp passes electrical current through a diode designed to produce visible light. This is a relatively new technology that exhibits exceptional color rendering and very low energy use.
Low Cost/No Cost Measures	Low cost/no cost measures are defined as measures that can be implemented within the operations and maintenance (O&M) budget. Low cost/no cost measures typically include such initiatives as: schedule adjustment, set-point adjustment, and fluid flow-rate adjustment.
Motor Control Centre (MCC)	An assembly of motor control units, typically housed in one (1) or more vertical metal cabinets. MCCs are generally located in a facility's electrical or mechanical rooms.
Make-up Air Unit (MUA)	An MUA is a type of air handling unit designed to supply 100% outdoor air to a facility's spaces.
Net Present Value (NPV)	Net present value (NPV) is a standard method for the financial appraisal of long-term projects. Used for capital budgeting, and widely throughout economics, it measures the excess or shortfall of cash flows, in present value (PV) terms, once financing charges are met. It is also called net present worth (NPW).
Office of Energy Efficiency (OEE)	The Office of Energy Efficiency (OEE) is Canada's centre of excellence for energy, efficiency and alternative fuels information. The OEE is mandated to strengthen and expand Canada's commitment to energy efficiency in order to help address the Government of Canada's policy objectives.[9]
Outdoor Air (OA)	The ambient air outside of a building.
Outside Air Damper (OAD)	Is a valve or plate that regulates airflow to control the minimum amount of outside air in ducts or HVAC equipment.
Outdoor Air Temperature (OAT)	The temperature of the ambient air outside of a building.
Relative Humidity	The amount of water vapor present in air expressed as a percentage of the amount needed for saturation at the same temperature.
Simple Payback (SP)	Simple payback is the ratio of capital investment cost to the energy cost savings. It indicates how long a capital investment pays back. SP = (Capital Cost) / (Energy Cost Savings)
Unit Heater	A type of terminal unit typically equipped with a fan and either hydronic heating coils or a natural gas burner to provide space heating.
Uninterruptible Power Supply (UPS)	An electrical device that provides backup power to a load when the regular power source fails or voltage drops.
Variable Air Volume (VAV)	A type of air distribution system where the temperature of air is held constant while the volume of air delivered is varied depending on the heating or cooling needs of each space.
Variable Frequency Drive (VFD)	A type of adjustable-speed drive used in electro-mechanical drive systems to control AC motor speed and torque by varying motor input frequency and voltage.

[9] Natural Resources Canada. Office Energy Efficiency. Accessed May 27, 2019. http://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/showTable.cfm?type=CP&sector=com&juris=on&rn=6&page=0

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