Energy Conservation and Demand Management Plan

2024-2029

Contributors

Adenike	Adeiga
Patricia	Escobar
Sinthuja	Kanageswaran
Jeff	Miller
Johnny	Ravindran
Hoorik	Yeghiazarian

Table of Contents

List of Figures

List of Tables

Introduction

Message **From Director**

As per Ontario Regulation 25/23, Ontario Broader Public Sector (BPS) organizations are required to publish Energy Conservation and Demand Management (CDM) plans in 2024, with mandatory updates every five years.

The three campuses at the University of Toronto are on a mission to develop and promote a culture of sustainability and a broad range of initiatives that align with broader regional initiatives and the UN Sustainable Development Goals. These initiatives are tailored to each campus.

The University of Toronto Scarborough (UTSC) CDM plan covers the period from 2024 to 2029. It aims to understand and manage energy consumption & identify energy conservation and efficiency goals and objectives in compliance with the regulation.

UTSC collectively helps support Ontario in meeting its future energy needs by reducing greenhouse gas (GHG) emissions, identifying energy and cost saving opportunities while measuring improvements over time, continuing its journey in leadership in sustainability.

The UTSC CDM plan has been approved by UTSC senior management and can be accessed on the UTSC Sustainability Office Website.

Sincerely,

Jeff Miller

Director, Facilities Management and Capital Projects

UNIVERSITY OF TORONTO SCARBOROUGH

INSPIRING INCLUSIVE EXCELLENCE

UTSC Institutional Priorities, Goals, Objectives

The University of Toronto has been named the most sustainable university in the world by the QS World University Rankings: Sustainability 2024, out of 700 post-secondary institutions globally.

The University of Toronto is committed to positive climate action across all three campuses; University of Toronto Mississauga, the University of Toronto St. George Campus and UTSC. To specifically address carbon emissions, all three campuses signed a Tri-Campus Climate Positive Commitment in 2023.

"To expand the climate positive goal across our entire institution, all three of our campuses pledge to achieve a climate positive operating model by 2050. This is an extension of our 2019 Low-Carbon Action Plan (LCAP) commitment to reduce our GHG emissions by 37% relative to 1990 levels by 2030. LCAP and this new climate positive pledge is in the spirit of our University Climate Change Coalition (UC3) commitments, which include climate resilience and just transitions; and our U7+ commitment under Principle 3, recognizing the role of universities to lead by example on our own campuses to address sustainability challenges of climate change, biodiversity, and energy transition."

Summary of UTSC CDM Plan and Goals

The University of Toronto is committed to being at the forefront to tackle climate change and promote energy transition. U of T's tri-campus goal of reducing GHG emissions by 37% from 1990 baseline levels by the year 2030, was published in 2019 and aligns with the Province of Ontario's target emissions reduction.

At UTSC, efforts are underway to fortify this goal by optimizing our energy production and consumption. This commitment will set the university on the path to becoming a net-zero and climate positive institution by 2050.

UTSC's Organizational Goals

- Demonstrate leadership in sustainable energy transition and decarbonization. Ensure sustainable campus growth.[1]
- Strengthen the institution's local and global networks and partnerships to advance UTSC's sustainability goals.[2]
- Lead transdisciplinary research that aligns with the UN Sustainable Development Goals.
- Integrate sustainability into campus engagement and operations, fostering a culture of environmental stewardship, inclusivity and positive wellbeing.

Objectives for this 2024-2029 CDM Plan

- Tracking our progress towards the LCAP and our Tri-Campus Climate Positive Commitment to reduce absolute carbon emissions by at least 80% before 2050.
- Reduce Scope 1 and Scope 2 GHG emissions by reducing natural gas consumption and optimizing building energy efficiency.
- Implement renewable energy solutions to meet the remaining balance of net-zero carbon emissions.
- Develop cross functional working groups (staff, faculty, students) to integrate decarbonization opportunities into campus renovations and upgrades.

Target to Achieve Goals and Objectives

- Reduce Scope 1 and Scope 2 annual operating GHG emissions by 37% below a 1990 baseline by 2030. Meeting our target of 6900 annual tonnes eCO_2 by 2030.
- Reduce absolute carbon emission by at least 80% before 2050; annual consumption of <2000 tonnes eCO_2.
- Develop Sustainable Building Design Standards for campus development.

---

[1] The University of Toronto is a signatory to the UC 3 Commitment, Principle 3: 47 Universities from 18 countries commit to 6 principles and take concrete action related to the G7 agenda themes - Espace Presse Sciences Po

[2] From UTSC's 2020-2025 Strategic Plan, "Inspiring Inclusive Excellence: A strategic vision for the University of Toronto Scarborough", Mission Number 3: "To strengthen, grow and sustain local and global networks and partnerships that advance our mission." Mission, Vision and Values | Strategic Plan (utoronto.ca)

UTSC Campus Planning and History

The UTSC campus has undergone substantial transformations and expansion since its establishment as an undergraduate campus of the University of Toronto in 1964. Over the years, the campus has evolved both structurally and operationally, increasing our building gross floor area by over 50% and becoming a hub for transdisciplinary research focused on sustainability and climate action. While steadily growing our campus; increasing spaces for cutting edge laboratories, world class research and student living and learning, UTSC is committed to reduce campus GHG emissions past net-zero.

In 1964 when the campus first opened, fuel oil and natural gas were the primary sources of heating, serviced from a central steam plant. As the demand for research activities increased along with student enrollment and in support of the double co-hort of Ontario high-school students graduating in 2003, UTSC added five new academic facilities and one new student residence between 2000 and 2010 and extended its operational hours to 24/7. In 2010 to 2020, two new academic building and one new research facility were added to the campus as well as the Toronto Pan Am Sports Centre which operates as an ancillary to the university. UTSC continues to expand as it grows alongside its community and delivers teaching, learning and research services to a growing eastern GTA and global community.

UTSC Campus GHG Emissions Reduction Planning

In 2018, UTSC participated in the Greenhouse Gas Reduction Program (GGRP) which focused on projects for the UTSC South Campus and the energy-intensive Science Wing Building. These projects included installing and integrating a ground-source heat pump system (geo-exchange) and replacing original 1960’s mechanical infrastructure, converting the Science Wing heating source from steam to a high efficiency hot water system.

Following the success of these projects, in 2023 an Energy and Carbon Performance Study was conducted for the Humanities Wing Building, identifying key opportunities for mechanical system optimization, building envelope improvements and renewable energy integration.

Figure 1 below identifies the location of these GHG emission reduction measures on the UTSC South Campus and future planned energy retrofits including the expansion of the geo-exchange system.

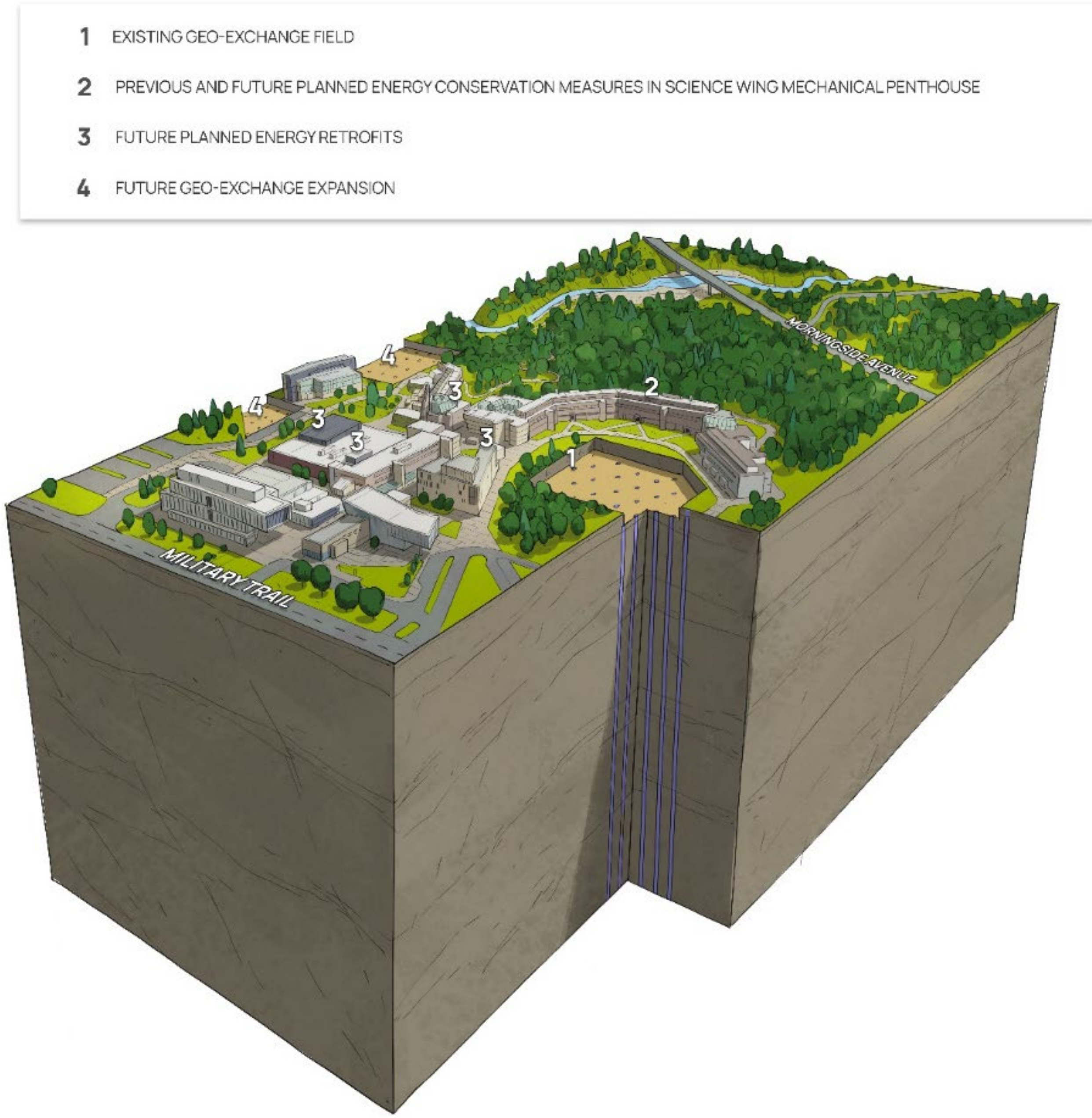


Figure 1: UTSC South Campus Current and Proposed GHG Reduction Measures

UTSC Campus Expansion

UTSC has begun another phase of campus expansion focused on the North Campus, located on the north side of Ellesmere Road, prioritizing sustainable, high-efficiency buildings. North Campus development between 2010-2015 is summarized below:

- 2011: Instructional Centre (IC), roof-installed solar photo-voltaic (PV) array
- 2014: Toronto Pan Am Sports Centre (TPASC) roof-installed solar PV array and ground source heat pump (geo-exchange) system, achieved LEED Gold Certification
- 2015: Environmental Science and Chemistry Building (ESCB) ground source heat pump (geo-exchange) and Earth Tubes system achieved LEED Gold certification

In 2020, the University of Toronto published a Tri-Campus Energy Modelling & Utility Performance Standard to ensure that all U of T campus development meets stringent performance requirements for energy, greenhouse gas emissions and thermal energy demand.

Figure 2 below represents the historical and planned increases to the UTSC Campus by building gross floor area (square meters).

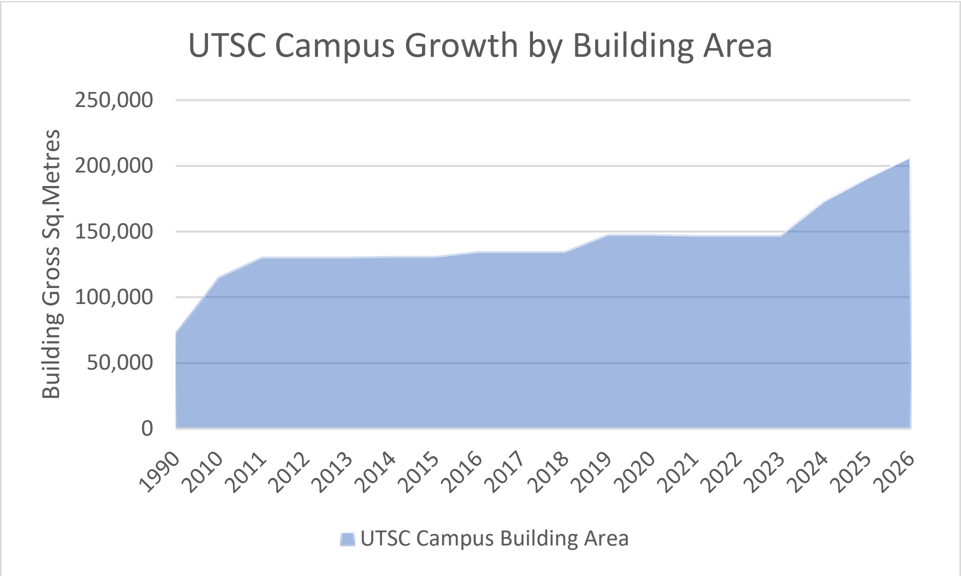
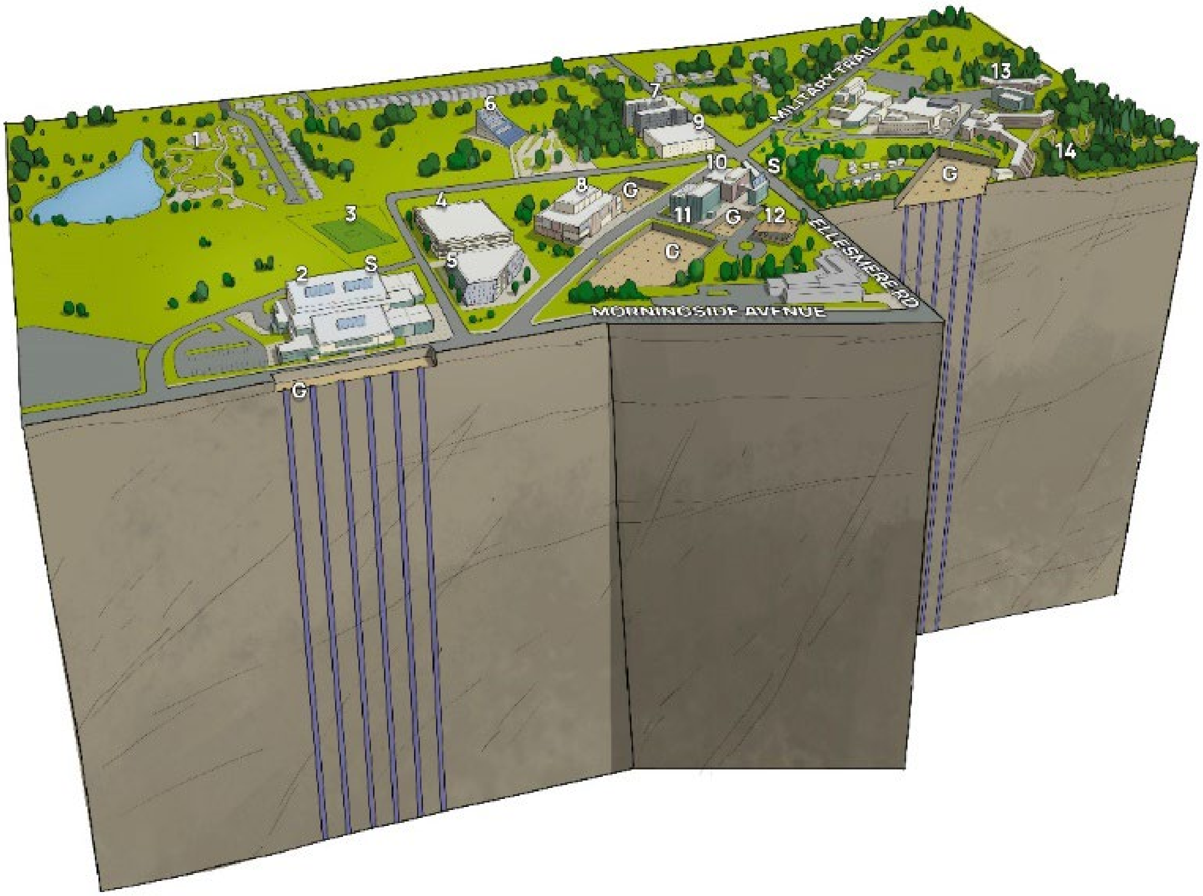


Figure 2: Historical and Projected UTSC Campus Size by Building Gross Floor Area

New campus buildings will be built to strict energy standards and continue to support our energy and climate action goals. Figure 3 illustrates UTSC's proposed campus expansion plans. Below is a summary of the projects included in the next phase of UTSC's campus development:

- 2023: Harmony Commons, 746 bed student residence designed to Passive House Standards
- 2024: Sam Ibrahim Building
- 2025: Indigenous House
- 2026: Retail and Parking Commons, Scarborough Academy of Medicine and Integrated Health (SAMIH), both with Renewable Solar PVs.
- 2026-2030: EaRTH, Centre for Literatures, Arts, Media and Performance (LAMP), Field House



1	CAMPUS FARM	9	UTSC / SCARBOROUGH CENTRE FOR LITERATURES, ARTS, MEDIA AND PERFORMANCE (FUTURE DEVELOPMENT)
2	TORONTO PANAM SPORTS CENTER	10	ENVIRONMENTAL SCIENCE AND CHEMISTRY BUILDING
3	FIELD HOUSE (FUTURE DEVELOPMENT)	11	INSTRUCTIONAL CENTER
4	RETAIL AND PARKING COMMONS (2026)	12	INDIGENOUS HOUSE
5	SCARBOROUGH ACADEMY OF MEDICINE AND INTEGRATED HEALTH (2026)	13	SOUTH CAMPUS
6	EARTH (FUTURE DEVELOPMENT)	14	MA MOOSH KA WIN VALLEY TRAIL
7	HARMONY COMMONS	S	SOLAR PANELS
8	SAM IBRAHIM BUILDING	G	GEO-EXCHANGE SYSTEM

Figure 3: Current and Future Proposed Campus Development and Renewable Energy Projects

Benchmarking and Previous Measures

UTSC's annual GHG emissions have fluctuated around 10,000 tonnes eCO_2 over the past 5 years, impacted by both campus expansion and investment in energy optimization initiatives. Over 80% of UTSC's GHG emissions are produced by natural gas, primarily used for space heating (Figure 4).

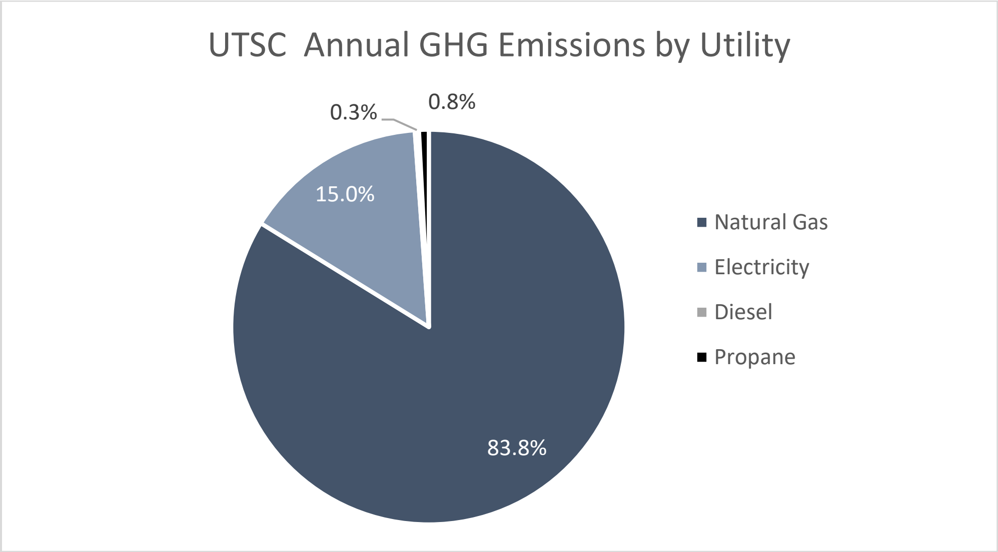


Figure 4: UTSC 2023 Annual GHG Emissions by Percent Contribution for Each Utility.

For the most part, utility consumption has increased as the campus building area has expanded. A summary of UTSC's past GHG emissions and utility consumption is referenced in Appendix A.

2018-2019

The most recent addition to the UTSC campus was the construction of Highland Hall in fall 2018 (13,500 total square meters) which replaced the original 1973 Recreation Wing (8,000 square meters). The addition contributed to increased natural gas and electricity consumption over 2018 and 2019. At this time as well, project planning to reduce campus GHG emissions were accelerated, in part from UTSC's projects for the Greenhouse Gas Reduction Program (GGRP) which included upgrades and retrofits to existing buildings.

2020-2023

Utility consumption was impacted as a result of the COVID-19 pandemic and the disruptions to standard operations. Campus utility consumption and annual emissions reduced over 2020 to 2021 but returned to full capacity and increased operations between 2022 to 2023. The pandemic delayed planned energy reduction measures, including some of those from the GGRP that were intended for 2018 to 2023. Now in 2023, UTSC is beginning to realize the results of these reduction measures which have accelerated and have evolved into more intensive measures. As of 2023, approximately 50% of the heating loads from the original campus have been converted from steam to hot water, improving the efficiency of our heating systems and reducing the total natural gas consumption. Figure 5 shows the reduction of both natural gas and electricity in 2023 while maintaining campus operations.

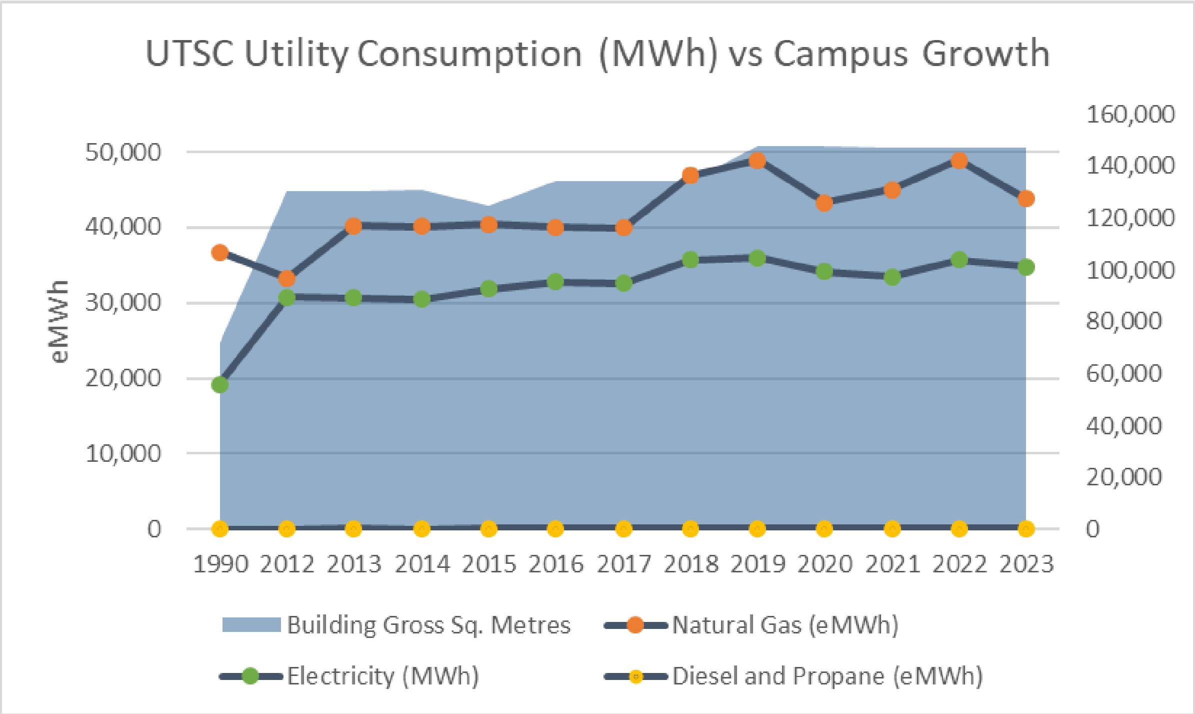


Figure 5: Annual Utility Consumption vs Campus Growth

Report on Results: 2019-2024

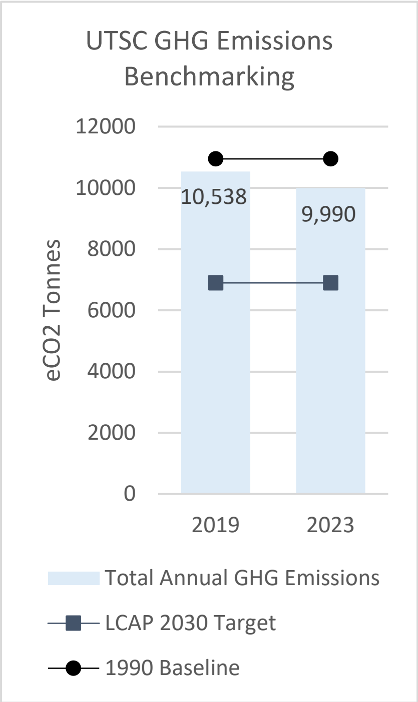
UTSC has implemented energy conservation measures following previous CDM Plans, the 2018 Greenhouse Gas Reductions Program and the University of Toronto's 2019-2024 Low Carbon Action Plan (LCAP). A description of previous CDM and energy reduction measures have been included in Appendix B.

Table 1 provides a breakdown of the GHG emission and utility consumption results from the previous reporting period. The 2019 calendar year is used as a benchmark year because is aligns with both the beginning of the last reporting year and the LCAP and it is also the most recent year before the COVID-19 pandemic where UTSC was operating at typical conditions for the current total building floor area.

Table 1: UTSC Annual Energy and Emissions: Report on Actual Results

UTSC GHG Emissions Comparison from Previous Reporting Period (tonnes eCO_2)			
	2019	**2023**	**2019 vs 2023 Changes**
Scope 1: Natural Gas	9,355	8,373	-982 tonnes
Scope 2: Electricity	1,067	1,502*	+435 tonnes
Scope 1: Diesel and Propane	115	114	-1 tonne
Total	**10,538**	**9,989**	**-549 tonnes**
UTSC Utilities Comparison from Previous Reporting Period			
	2019	**2023**	**2019 vs 2023 Changes**
Natural Gas (m^3)	4,737,844	4,240,418	-10.5%
Electricity (MWh)	35,982	34,784	-3.3%
Propane (L)	32,215	28,972	-10.1%
Diesel (L)	9,765	12,652	+29.6%

*GHG emissions are calculated using emissions factors in Appendix C



Resulting from energy conservation measures between 2019 and 2023, both natural gas and electricity consumption have reduced and GHG emissions from natural gas have reduced by 982 tonnes eCO2.

Although electricity consumption has modestly reduced despite increased electrical load from ground-source heat pumps, GHG emissions from electricity have increased. This increase is a result of the changes in GHG intensity for Ontario's electricity grid, as reported by the Independent Electricity System Operator (IESO).

Since 2019, UTSC's total annual GHG emissions have reduced to 9,990 tonnes eCO_2, approximately 1,000 tonnes below the 1990 baseline (Figure 6).

Figure 6: Benchmarking Progress Towards 2030 GHG Emissions Target

Current and Proposed CDM Measures: 2024-2029

The goals outlined in this CDM plan are to support sustainable campus development and to achieve targeted reductions in GHG emissions. The proposed Technical, Organizational and Behavioural CDM measures outline how UTSC plans to achieve these goals and objectives.

UTSC's 2030 LCAP Target for annual GHG emissions is to produce less than 6,900 tonnes eCO_2 by 2030 which is 37% below our estimated 1990 baseline. Table 2 below outlines the planned and proposed technical measures that will achieve this goal. A description for each measure is provided in Appendix D.

Table 2: Technical CDM Measures 2024-2029

No.	Conservation Measure	Cost	Anticipated Savings	Timeline
CDM 1	Environmental Science and Chemistry Building (ESCB) Energy Audit & Commissioning	$10K	1094 tonnes eCO_2	2023-2024
CDM 2	Science Wing Green Building Migration, Existing Building Commissioning & Kitchen Demand Control Ventilation (DCV)	$300K	781 tonnes eCO_2	2023-2024
CDM 3	LED Lighting Conversion	$5.1M	50% electricity consumption per fixture	2023-2029
CDM 4	ESCB Fumehood DCV	$28K	35 tonnes eCO_2	2024
CDM 5	Science Wing Mechanical Penthouse Heat Reclaim	$20K	49 tonnes eCO_2	2024
CDM 6	Central Plant Heat Recovery Chiller	$2.8M	70 tonnes eCO_2	2024-2025
CDM 7	Science Wing 1st Floor Fumehood DCV	$55K	28 tonnes eCO_2	2024
CDM 8	Humanities Wing Carbon and Energy Performance Study ECMs	$86K	9 tonnes eCO_2	2024-2025
CDM 9	Humanities Wing & KW Building Heat Pump Phase 2	$7.4M	455 tonnes eCO_2	2025-2026
CDM 10	Science Wing AHU 8, 14, 15 Replacement	$3.8M	12 tonnes eCO_2	2024-2026
CDM 11	Humanities Wing AHU Replacement	$5M	55 tonnes eCO_2	2025-2026
CDM 12	ARC, Bladen, Highland Hall Heat Pump Phase 3	$12M	721 tonnes eCO_2	2026-2029
CDM 13	Science Wing & SRB Heat Pump Phase 4	$6.5M	508 tonnes eCO_2	2026-2029

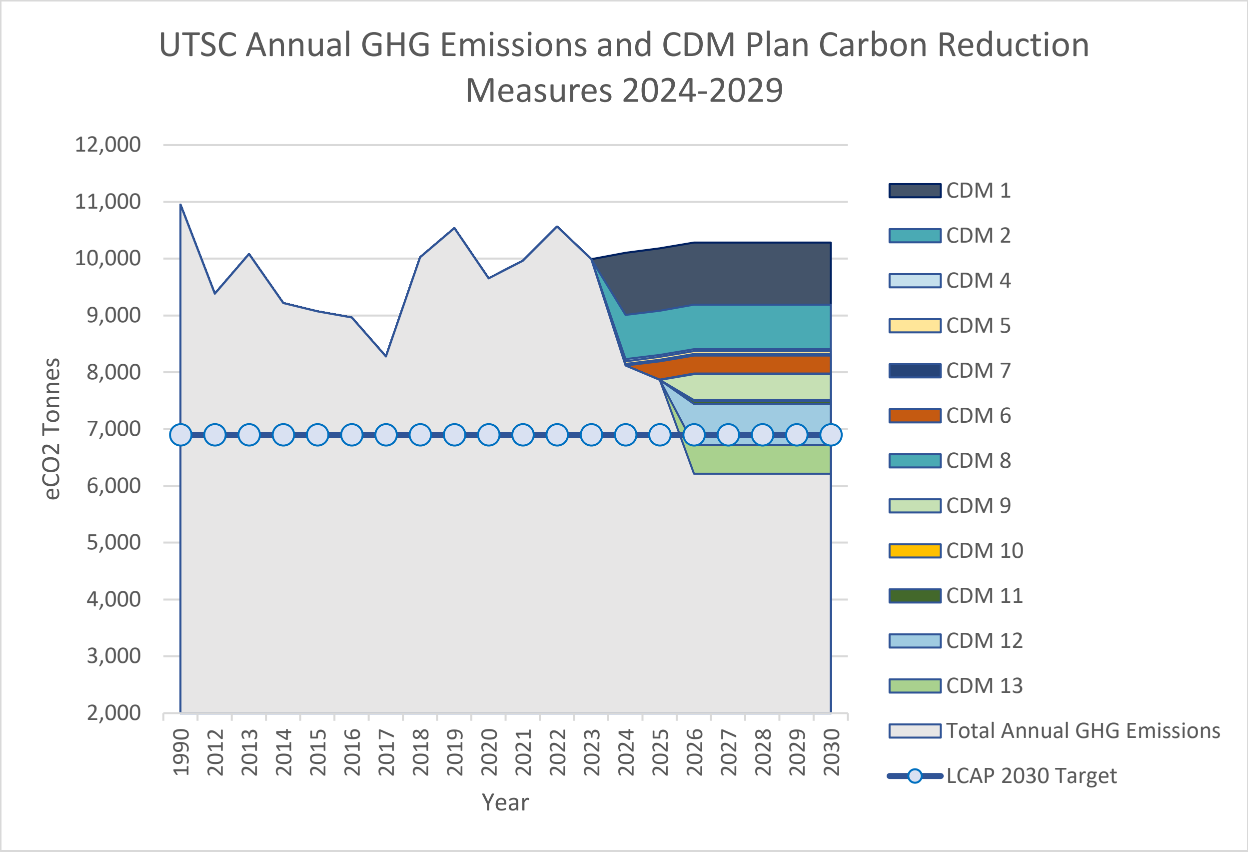


Figure 7: UTSC Total Annual Emissions with CDM Plan Measures vs LCAP Target

To support the Technical CDM measures and additionally contribute to UTSC's organizational goals, the current and proposed Organizational & Behavioural CDM measures are described in Table 3.

Table 3: Organizational and Behavioural CDM Measures 2024-2029

Type of Measure	Description	Impact
Organizational	Tri-Campus Sustainable Building Design Standards	New buildings will be designed to achieve specified sustainability performance, improving the indoor environment, operating efficiency and utility consumption of the building and minimizing negative environmental impacts from construction and operations.
Organizational	Key Plans for Lighting Conversion and Demand Control Ventilation Areas	Coordinate the plans for mechanical and lighting upgrades to identify areas opportunities where the upgrades to existing systems can be streamlined to accelerate the projects timelines and minimize disruptions to building occupants.
Organizational	Cross Departmental Sustainability Working Groups	Increase knowledge sharing across departments, find opportunities for integrated sustainability initiatives, set intentional sustainability goals and embed processes into existing workflows across the organization so they are supported year over year and resilient to organizational changes.
Behavioural	Fumehood Sash Closing Campaign	Reduce the energy use of laboratory buildings by educating occupants on the energy intensity of labs and the impact of reducing the volume of air exhaust by properly closing fumehood sashes.
Behavioural	Sustainability / Waste Ambassadors Program	Peer-to-peer education to engage and inform the campus community on sustainable behaviours and how their actions positively reinforce UTSC's organizational goals and the UN SDGs.

Renewable Energy on Campus

UTSC's renewable energy and sustainable development strategy is focused on fuel switching technology using geo-exchange systems, expanding solar photo-voltaic (PV) systems, and developing new buildings to stringent energy efficiency standards.

Solar

Currently there are two solar PV arrays at UTSC; the Instructional Centre (2011) and the Toronto Pan Am Sports Centre (2014).

In 2011 UTSC installed 80kW of photovoltaic capacity on the roof of the Instructional Centre (IC) building. Since installation there have been challenges bringing the system online, however due to the advancements in technology over the years and in line with campus decarbonization, there are current plans to operationalize the IC solar panels.

In 2014, the Toronto Pan Am Sports Centre (TPASC) opened to the public, constructed to host events for the 2015 Pan Am Games. The facility is co-owned by the UTSC and the City of Toronto and is LEED Gold certified. Installed on the roof is 530 kW of photovoltaic capacity.

As part of UTSC's future developments, both the Retail and Parking Commons and the SAMIH building will be built in 2026 to add an additional 900 kW of photovoltaic capacity to our campus (400 kW and 500 kW respectively).

Ground Source Heat Pumps (Geo-Exchange System)

UTSC has been implementing ground source heat pumps for energy efficient heating and cooling of our buildings since 2014. Both the TPASC and the ESCB were built with ground source heat pumps, followed by the South Campus integration to the Science Wing as part of the GGRP. The Sam Ibrahim Building, opening in fall 2024, will also include a ground source heat pump system.

The system reduces the consumption of natural gas from heating by storing excess heat and reusing it when required. During the summer, excess heat from the building is pumped into a series of underground boreholes. In the winter, it is pumped back into the building, reusing the stored heat instead of relying solely on heating from natural gas sources. Currently, there are over 350 boreholes at UTSC that are part of ground source heat pump systems; 100 at the TPASC, 60 at the ESCB[3], 100 in the Science Wing field and 90 at the new Sam Ibrahim Building.

Earth Tubes

UTSC has one of the largest earth tubes systems in Canada. In addition to using ground source heat pumps, the ESCB has 6 earth tubes which contribute to passive heating and cooling of the building. The tubes take advantage of the stable temperature of the earth, drawing in air from the surface and sending it underground in massive tubes that modulate its temperature. Consequently, the air is delivered into the building, providing ventilation at a stable ambient temperature, reducing the energy required to deliver adequate heating and cooling to the building[4].

There are very few earth tube systems in Canada. Research from the UTSC earth tubes system will contribute to published design guidelines, since no well-defined parameters currently exist for earth tubes. These guidelines will help accelerate the adoption of earth tubes in buildings across the country[5].

[3] https://www.utsc.utoronto.ca/projects/escb/ "Beneath the building is a ground source heat pump loop consisting of over 60 boreholes, extending 210 metres deep".
[4] https://www.utsc.utoronto.ca/projects/escb/
[5] https://www.nrcan.gc.ca/simply-science/new-energy-efficient-way-heat-and-cool-buildings/20319

Appendix A: Summary of UTSC Annual Utility Consumption and GHG Emissions

UTSC Annual Utility Consumption Summary				
Year	**Natural Gas (m^3)**	**Electricity (kWh)**	**Diesel (L)**	**Propane (L)**
1990	3,557,941	19,179,500	-	-
2015	3,913,108	31,804,453.91	5763	9001.2
2016	3,879,007	32,765,773.31	14421.2	25011.3
2017	3,862,370	32,552,668.64	6891	25667.5
2018	4,537,486	35,690,547.90	5532	30718.4
2019	4,737,844	35,982,356.75	9765	32215.1
2020	4,191,753	34,177,574.42	11318.7	33135.6
2021	4,361,742	33,448,675.89	13846.4	27653.5
2022	4,730,277	35,689,417.94	13927.7	32,058
2023	4,240,418	34,784,459.09	12652.3	28972.3

UTSC Annual GHG Emissions Summary (Tonnes eCO_2)					
Year	**Natural Gas**	**Electricity**	**Diesel**	**Propane**	**Total Emissions**
1990	6,727.00	4,219.00	-	-	10,946.00
2015	7,726.91	1,303.63	15.48	24.86	9,070.89
2016	7,659.58	1,198.61	38.73	69.09	8,966.01
2017	7,626.73	563.98	18.51	70.90	8,280.11
2018	8,959.83	967.22	14.86	84.86	10,026.76
2019	9,355.46	1,066.86	26.23	88.99	10,537.54
2020	8,277.13	1,252.10	30.40	91.53	9,651.16
2021	8,612.80	1,237.60	37.19	76.39	9,963.97
2022	9,340.52	1,101.29	37.40	88.56	10,567.77
2023	8,373.23	1,502.47	33.98	80.03	9,989.71

Notes

- Utility consumption is sourced from utility bills for each calendar year.
- The 2023 calendar year does not include data from Harmony Commons (Sept 2023) as it has not been in operation for a full calendar year. It will be updated during reporting for the 2024 calendar year.
- Emission Factors to calculate the GHG emissions are consistent with Appendix C.
- The 1990 Baseline is recalculated from the following assumptions:
    - Electricity consumption based on the most historical electricity consumption available for buildings on the UTSC campus in 1990 (2006-2007 fiscal year data).
    - Natural Gas consumption is sourced from steam logs from 1990 (71,704,700 lbs)
    - 69% Total heating plant efficiency used (79% boiler efficiency x 85% evaporation efficiency). Verified in peer review as part of GGRP studies for the Science Wing geo-exchange system.
    - Enthalpy of Steam: 1188 lb/BTU. Verified in peer review as part of GGRP studies for the Science Wing geo-exchange system

Appendix B: Description of CDM Measures 2019-2024

Science Wing Heating Plant: Steam to Hot Water Conversion (2019)

The conversion of the central plant from a steam to a hot water system represents a strategic initiative aimed at reducing GHG emissions and improving overall energy efficiency. This transformation involves a fundamental shift in the heating infrastructure. The central plant's transition to a hot water system is driven by the recognition of the environmental impact associated with traditional steam-based heating.

The hot water system offers improved efficiency in heat distribution, providing a more precise and controlled method of delivering warmth throughout the facility. This optimization results in a more cost-effective and reliable heating solution for the institution.

Ventilation Renewal, Science Wing AHU Replacements (2019)

The Science Wing underwent a significant upgrade, focusing on improving energy efficiency and operational effectiveness by replacing the existing air-handling units (AHUs). The upgraded units incorporated cutting-edge technology that utilized low-temperature hot water systems, marking a notable shift towards sustainability and reduced energy consumption.

The integration of these new units contributed to a substantial reduction in the overall carbon footprint associated with heating and air conditioning processes in the Science Wing as we were able to offload the steam plant. Beyond energy efficiency, the enhanced AHUs delivered precise temperature control and improved air quality. Lastly, the spaces have been retrofitted with demand control ventilation that delivers only the amount of air required to maintain the appropriate CO_2 levels.

Science Wing Geo-Exchange System Installation (2021)

The geo-exchange system at the Science Wing quad represents a sustainable approach to heating and cooling within the facility. Installed beneath the quad, the geo-exchange system comprises of a network of boreholes/pipes circulating a heat transfer fluid through the ground. This fluid extracts or releases heat from the building, depending on the season, providing an efficient and consistent source for heating in the winter and cooling in the summer.

The system's reliance on a heat pump contributes to a significant reduction in energy consumption, making it a sustainable alternative to traditional heating and cooling methods.

Science Wing Mechanical Penthouse & Geo-Exchange System Optimization (2022 – 2023)

Optimizing the geo-exchange system in the Science Wing involves implementing various measures to enhance its efficiency and performance. This process begins with a commissioning agent conducting a thorough analysis of the existing geothermal system and Science Wing loads to identify inefficiencies. This analysis led to piping rearrangements, sequencing adjustments, and software upgrades from the heat pump manufacturer.

The system's overall loads were expanded to maximize the use of the geo-exchange during the summer months. Previously, only the secondary loop which consists of a few air handling units which serve some office and lab spaces used the geo-exchange. After the optimization, when capacity is available, the geo-exchange will also serve the north loads which serve various locations in the Science Wing including offices, atriums, labs and corridors. Improvements to the Building Automation System (BAS) included integrating pressure and temperature sensors to regulate the heat pump based on real-time data and adding alarms to minimize downtime, allowing operating engineers to act proactively. Energy storage optimizations were made to ensure that excess thermal energy is stored in the geo-exchange bed during periods of low demand and to prevent saturation of the geo-exchange field. Finally, added flexibility was integrated by installing a fluid cooler to take advantage of free cooling and utilizing a heat recovery system to serve various air-handling units under appropriate circumstances.

Appendix C: Emission Factors

Scope 1 GHG Emissions

The University of Toronto uses the ECCC's "Canada Greenhouse Quantification Requirements 2017" guideline for Scope 1 GHG Emissions.

U of T Tri-Campus Fossil Fuel Emission Factors			
Scope	**Utility**	**Unit**	**Emissions Factor (eCO_2 kg)**
Scope 1	Natural Gas	kg/m^3	1.975
Scope 1	Light Fuel Oil	kg/L	2.762
Scope 1	Diesel	kg/L	2.686
References Natural Gas eCO_2 kg EF includes the sum of: 1. CO_2 Equation 2-11 of ECCC's - CANADA'S GREENHOUSE GAS QUANTIFICATION REQUIREMENTS Dec 2017 (GHGQR) 2. CH_4 Equation 2-13 of GHGQR 2017 Table 2-4 CH4 EF 0.00098 kg/GJ, GWP 25 3. N_2O Equation 2-13 of GHGQR 2017 Table 2-4 N2O EF 0.00087 kg/GJ, GWP 298			

Scope 2 GHG Emissions

Electrical Emissions Factors are based on the Ontario Electricity Grid intensity. U of T calculates emission factors for electricity based on the IESO 2021 Annual Planning Outlook Data Tables, Figure 42: Electricity Sector Greenhouse Gas Emissions, Historical and Forecast and Figure 24: Energy Production Outlook, with Continued Availability of Existing Resources. The data tables are used to calculate historical emission factors, beginning from 2005, and projected future emissions from a forecasted electricity supply mix and Ontario production output.

https://www.ieso.ca/Sector-Participants/Planning-and-Forecasting/Annual-Planning-Outlook

Appendix D: Description of CDM Measures 2024-2029

CDM 1: ESCB Energy Audit & Commissioning (2023 – 2024)

The energy audit at the Environmental Science and Chemistry Building (ESCB) involves a systematic examination of energy usage to identify inefficiencies and recommend energy conservation methods. A cross-functional team worked closely with the manager of technical services in the lab to produce a memo about various ongoing energy projects in the building to increase awareness to the occupants. This also involves educating building occupants on energy-saving practices and considering a fume hood SASH closing campaign.

Another significant activity in the ESCB is the optimization of the geo-exchange system. Firstly, a system review was conducted, which involves thoroughly inspecting and verifying the building's loads and its integration with the existing geo-exchange system. Further evaluation was conducted on the heating and cooling loops, followed by reviewing the design specifications. Secondly, functional tests were performed to ensure that all systems operate as intended, including verifying the responsiveness of control systems and tuning the proportional-integral-derivative (PID) loops. Thirdly, a BTU meter was installed to analyze the heat produced by the heat recovery process and to verify the flow and temperatures of the supply and return lines. The final step involved the fine-tuning of the geo-exchange system based on recommendations from the commissioning study to maximize efficiency and performance, with the overall building HVAC systems, and implementing any necessary improvements.
Other corrective measures identified and implemented as part of this project include HVAC scheduling, chilled water optimization, hot water loop tuning, air-handling unit (AHU) setpoint adjustments and optimization of the earth tubes.

CDM 2: Science Wing Green Building Migration, Existing Building Commissioning & Kitchen Demand Control Ventilation (2023 – 2024)

Upgrading the Siemens Building Automation System (BAS) software from Insight to Desigo (older to newer version) signifies a strategic move towards enhancing the overall efficiency, functionality, and security of our building management infrastructure. This update represents a commitment to staying current with technological advancements and leveraging the latest features and improvements offered by Siemens.

Through this upgrade this complex building will be viewed from a holistic approach such that inefficiencies will be eliminated so that the building can be optimized. Due to the current state of the BAS, analysis of the systems is limited.

A key energy saving component to this project is introducing demand control kitchen ventilation to the food court, the Marketplace, in the Humanities Wing. The project involves integrating the fan motors with variable frequency drives (VFDs), installing dampers within the ductwork and adding optical and temperature sensors to monitor smoke and heat generated while cooking. The sensors will allow the system to control the fume hood's air exhaust rate proportionally to the quantity of smoke or heat detected which ultimately reduces the fan-power required to exhaust air when the kitchen does not require it. Electricity savings are anticipated from ramping down or turning the fan during periods of low or no demand. Natural gas savings are anticipated from reducing the amount of air exhausted, which will no longer need to be replaced and re-heated with make-up air to satisfy the building's ventilation requirements.

CDM 3: LED Lighting Conversion (2024 – 2029)

The ongoing LED lighting conversion project at the campus marks a significant step towards sustainable energy practices. Certain areas on campus have already undergone successful LED retrofitting, replacing fluorescent lighting systems with energy-efficient LED fixtures – via retrofits or full replacement. This initial phase has demonstrated tangible benefits, including reduced energy consumption and lower operational costs.

As part of the broader initiative, the campus aims to continue this work across various facilities, ensuring comprehensive coverage and maximizing energy savings. LED technology not only enhances illumination but also offers a longer lifespan and lower maintenance requirements, contributing to further cost-effectiveness in the long run and less material sent to the landfills. Through the systematic conversion of lighting infrastructure, the UTSC campus anticipates significant reductions in energy consumption, a decrease in associated costs, and a positive environmental impact, reinforcing its dedication to sustainable practices.

CDM 4: ESCB Fume hood DCV (2024)

Implementing demand control ventilation for fume hoods is a strategy aimed at optimizing energy efficiency and operational costs in laboratory settings. The ESCB is an energy intensive building which uses 100% outside air which needs to be heated or cooled before it enters the lab space. The primary objective is to selectively turn off exhaust fans associated with fume hoods during unoccupied hours, a practice that aligns with sustainable and cost-effective building management principles.

A scheduled base demand control ventilation approach will be used to determine the actual need for ventilation in the lab space. By shutting down exhaust fans during periods of inactivity significant energy savings can be achieved. This approach not only reduces electricity consumption but also extends the lifespan of equipment.

CDM 5: Science Wing Mechanical Penthouse Heat Reclaim (2024)

If the following AHUs (AC17A, AC17B, or Alfonse Air Handling Unit) call for heating the unit can take advantage of the heat reclaim, the chiller plant setpoint increases. This adjustment is intended to optimize free cooling or heat recovery opportunities and subsequently unload the chiller, promoting energy efficiency and operational cost savings.

CDM 6: Central Plant Heat Recovery Chiller (2024)

This project involves adding heat recovery chillers in our central cooling plant which are designed to recover and repurpose excess heat generated during the cooling process, converting it into a valuable resource for heating applications within our facility.

The heat recovery chillers will allow for the heat that is typically expelled as waste during the cooling cycle to be recovered. This recovered heat is then redirected for use in our low temperature hot water heating distribution systems. Furthermore, during periods when cooling demands are lower, the recovered heat can be utilized to meet heating needs, thus reducing the reliance on additional heating equipment.

CDM 7: Science Wing 1st Floor Fume hood DCV (2024)

The primary objective is to selectively ramp down or turn off fume hood exhaust fans during unoccupied hours in the Science Wing. We will use a scheduled-base demand control ventilation approach to determine the actual need for ventilation in the lab space. By turning down exhaust fans during periods of inactivity, significant energy savings can be achieved.

This approach not only reduces electricity consumption but also extends the lifespan of equipment and minimizes wear and tear on the fume hood systems. Consequently, it contributes to a more sustainable and environmentally conscious laboratory operation.

CDM 8: Humanities Wing Envelope and Mechanical ECMs (2024 – 2025)

A Carbon and Energy Performance study was conducted in the Humanities Wing. From this study, various building envelope and mechanical system energy conservation measures (ECMs) have been proposed to achieve net-zero GHG emissions. This endeavor will involve implementing a tighter building envelope coupled with strategic mechanical upgrades.

The envelope upgrade involves the installation of modern insulation materials, energy-efficient windows, and addressing key areas of envelope air leakage. This comprehensive approach ensures that the building's exterior is optimized for thermal performance, minimizing heat loss and improving overall building air tightness. The result is a more comfortable interior environment while significantly reducing the need for excessive heating and cooling.

In tandem with the envelope improvements, various mechanical energy conservation measures will be implemented. This includes the integration of high-efficiency HVAC systems, lighting upgrades, and advanced energy management controls. The goal is to systematically reduce energy consumption associated with heating, ventilation, air conditioning, and other mechanical systems, contributing to substantial operational cost savings. The project's holistic nature addresses both passive and active strategies, creating a synergy that maximizes energy efficiency.

CDM 9: Humanities Wing & Kina Wiiya Enadong (KW) Building Heat Pump Phase 2 (2025-2026)

Heat Pump Phase 2 utilizes a geo-exchange field coupled with a heat pump system to meet the heating and cooling demands of the Humanities Wing & KW building. During the winter, the heat pump extracts heat from the geo-exchange bed to provide heating for the spaces, while in the summer, the process is reversed to cool the building.

The use of a heat pump enhances energy efficiency by transferring heat between the geo-exchange field and the building with minimal energy input. This results in reduced operational costs and a decreased environmental impact compared to conventional heating and cooling systems.

CDM 10: Science Wing AHU 8, 14, 15 Replacement (2024 – 2026)

The proposed upgrade of AHUs 8, 14, and 15 in the Science Wing represents a strategic initiative to enhance energy efficiency. The upgrade involves transitioning from a steam system to a more advanced hot water system, bringing several benefits to the overall HVAC infrastructure.

The shift from steam to hot water technology is expected to improve the precision and control of heating within the air-handling units. Additionally, the conversion to hot water systems often results in increased reliability and ease of maintenance. In the future, these air-handling units can be coupled with a heat pump or direct expansion (DX) coil for further energy savings.

CDM 11: Humanities Wing AHU Replacement (2025)

The proposed upgrade of AHUs in the Humanities Wing involves transitioning from steam to hot water systems, optimizing energy efficiency and enhancing HVAC performance. The move to hot water aligns with modern energy conservation practices, underscoring a commitment to sustainability in the Humanities Wing's heating and ventilation operations. This project will be accompanied by the proposed Heat Pump Phase 2 to be used as a source of heating and cooling.

CDM 12: ARC, Bladen, Highland Hall Heat Pump Phase 3 (2026-2029)

Heat Pump Phase 3 on the South Campus includes the Academic Resource Centre (ARC), Bladen Wing and Highland Hall. The heating and cooling loads of each building will be assessed to verify the infrastructure is available to meet the demands. Following this assessment, a decision will be made to convert the current heating and cooling loops to use ground source, air source or an alternative technology to condition the space.

CDM 13: Science Wing & SRB Heat Pump Phase 4 (2026-2029)

The Science Wing field currently hosts the existing geo-exchange which serves the Science Wing mechanical penthouse units. The Science Research Building (SRB) is a connected addition to the Science Wing and can benefit from the expansion of the current system. A load assessment will be completed to assess how many boreholes will be added to increase the current infrastructure's capacity. Through this capacity increase, more spaces in the Science Wing and the Science Research Building can take advantage of this technology and limit our reliance on traditional heating and cooling methods.