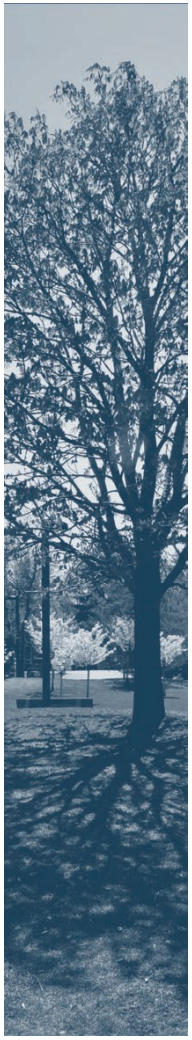
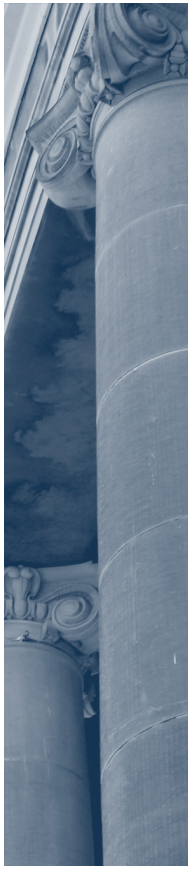
Low-Carbon Action Plan

2019-2024


UNIVERSITY OF TORONTO

Low-Carbon Action Plan (2019-2024)
Released 2019
Available online: uoft.me/LowCarbon19

UNIVERSITY OF TORONTO

A Message from the President

The University of Toronto's Low-Carbon Action Plan, 2019-2024 is the result of diligent work from staff in operations across all three campuses and outlines the University of Toronto's ambitious plan to meet our climate change commitments. Last year, U of T joined the University Climate Change Coalition (UC3), a group of leading North American research institutions dedicated to accelerating the reduction of greenhouse gas (GHG) emissions. As part of the coalition, and under a 2015 agreement with the Province of Ontario, U of T has set an impressive goal: to reduce GHG emissions by 37 per cent from 1990 levels by the year 2030. We are also developing programming to engage the Toronto area community to galvanize local, regional, and national action on climate change.

Operating in an urban setting with cold winters and hot, humid summers presents unique operational challenges. Balancing the needs of a large research intensive institution while designing and fostering spaces that promote sustainability is no small feat. As indicated in this report, to meet our goal we will implement strategies that make our existing spaces more efficient, build to ambitious energy performance standards, and seek out innovative solutions to remove carbon from our three campuses.

In fact, efforts are already well underway. In 2018, we designed and developed a series of projects to reduce GHG levels; using the capture of exhaust heat from our main stack; smart building controls; high efficiency boilers; ground source heat pumps; and solar energy. These actions are expected to reduce 8,600 tonnes of eCO_2 emissions.

U of T's dedication to reducing GHG emissions significantly draws from our recognition that universities have a crucial role in meeting the urgent challenge of climate change. We have an outstanding record when it comes to both research in the field and carbon reduction efforts on our campuses, and we look forward to building on that foundation to maximize our positive impact.

On behalf of the University of Toronto, I extend congratulations on the development of the Low-Carbon Action Plan, and I thank the dedicated team at University Operations for their leadership, hard work and creativity in responding to the pressing challenge of climate change.

Sincerely,

Meric S. Gertler
President

Traditional Land Acknowledgment

We wish to acknowledge this land on which the University of Toronto operates. For thousands of years it has been the traditional land of the Huron-Wendat, the Seneca, and most recently, the Mississaugas of the Credit River. Today, this meeting place is still the home to many Indigenous people from across Turtle Island and we are grateful to have the opportunity to work on this land.

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A Message from Chief Operating Officer, Property Services & Sustainability

The University of Toronto is taking action to meet the challenge of climate change. We have set a 2030 goal to reduce greenhouse gas emissions across our three campuses by 37 per cent from 1990 levels.

We have been working hard to balance the needs of a growing, research-intensive institution, to design spaces that promote well-being, and to reduce our energy consumption. With an increase in student population and building area, the University has lowered its carbon and energy intensity over the last two decades.

Achieving our 2030 goal requires a diverse mix of strategies and solutions that we will implement across our campuses. We will improve power and thermal production, distribute energy more efficiently, and reduce energy consumption. We will also collaborate with our brilliant faculty and students to foster innovative solutions in-house.

Sustainability and continuous improvement are embedded in the fabric of University of Toronto operations. We create smart, resilient, and welcoming spaces for our students, faculty and staff. Climate change is one of our society's most important challenges, and we believe we have the plan, the people, the expertise, and the drive to achieve our low-carbon goal and improve the well-being of our community.

Ron Saporta
Chief Operating Officer
Property Services & Sustainability

Acknowledgements

Our Tri-Campus Sustainability Board works to effectively embed sustainability into the fabric of University of Toronto's operations. Thank you to the members of the Tri-Campus Sustainability Board and associates for making our Low-Carbon Action Plan (2019-2024) possible. The team will play a crucial role in executing and advancing initiatives described in this document to achieve our low-carbon commitment.

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Key Definitions

Carbon Carbon is referred to throughout this plan as the carbon dioxide equivalent, unless otherwise stated.

Carbon capture (and storage) A method for trapping carbon dioxide (CO_2) emissions thereby preventing the CO_2 from entering the atmosphere.

Carbon dioxide equivalent (eCO_2) A standard unit for measuring and comparing carbon footprints. Each greenhouse gas has a different global warming potential (GWP) and persists for a different length of time in the atmosphere. eCO_2 expresses the impact of different GHGs in terms of the amount of CO_2 that would have the equivalent GWP.

GHG intensity (or carbon intensity) The rate of GHGs or carbon emitted relative to a specific unit or activity. For example: eCO_2 emitted per square meter of building floor space.

Energy intensity The rate of energy used relative to a specific unit or activity. For example: energy used for heating, cooling, or lighting per square meter of building floor space.

Greenhouse Gas (GHG) Gases that trap heat in the atmosphere, for example, carbon dioxide (CO_2). These gases differ on how long they stay in the atmosphere and how strongly they impact the atmosphere.

Gross Square Metres (GSM) The sum of all floor areas within the outside faces of exterior walls.

Scope 1, 2, 3 emissions An organization's greenhouse gas emissions can be classified into three categories: Scope 1 emissions are direct emissions from sources that are owned or controlled by the organization, like the burning of natural gas to generate steam for heating and cooling. Scope 2 emissions are indirect emissions from the generation of purchased energy, like purchasing and consuming electricity from a utility provider. Scope 3 emissions are indirect emissions (not included in scope 2) that occur in the value chain of the organization, such as emissions associated with travel. Scope 3 is not covered in this document.

Who We Are: One School, Three Campuses

2018 Facts & Figures

1827
Year Established

266
Buildings

1,790,704
Gross square meters (floor space)

Staff

7,198

Faculty

14,434

Building on a History of Excellence

The University of Toronto holds a strong record of operational sustainability, including some of the following achievements:

Awarded Canada's Greenest Employer 6 times. Canada's Greenest Employer is an editorial competition organized by the Canada's Top 100 Employers project. This special designation recognizes the employers that lead the nation in creating a culture of environmental awareness in their organizations.

$8.5M green revolving fund — one of the largest in North America, providing funding for significant energy reduction projects and building retrofits.

100+ years of district energy. We currently produce more than 80 per cent of our heating and 20 per cent of our electricity needs for our downtown Toronto campus.

In 2017, **we created the Committee on the Environment, Climate Change and Sustainability.** Its mandate is to identify ways to advance the University's contribution to sustainability and meeting the challenge of climate change, with a particular focus on research and innovation, teaching, and University operations.

1st post-secondary institution in Canada to have an on-site embedded Energy Manager.

Dedicated St. George campus projects from 2009/10 to 2018/19 have:

Achieved a reduction of more than 55 thousand tonnes of equivalent carbon dioxide (eCO_2) emissions.

Saved over 1.25 billion litres of water (equivalent to 500 Olympic-size pools).

Avoided over $30 million in utilities costs.

Our Commitment

Scott Mabury
Vice-President, Operations and
Real Estate Partnerships

"The University of Toronto has set a goal to advance towards a 37% reduction in greenhouse gas emissions by 2030, from a 1990 level baseline." -Scott Mabury

Our university has a long-standing commitment to operational sustainability and environmental stewardship that continues to grow in momentum. In 2018, the University of Toronto joined the University Climate Change Coalition (UC3); a group of leading research universities in North America committed to reducing greenhouse gas (GHG) emissions on their own campuses and in their communities. In line with this commitment, the University of Toronto set a goal to reduce GHG emissions 37 per cent by 2030, below a 1990 baseline level.

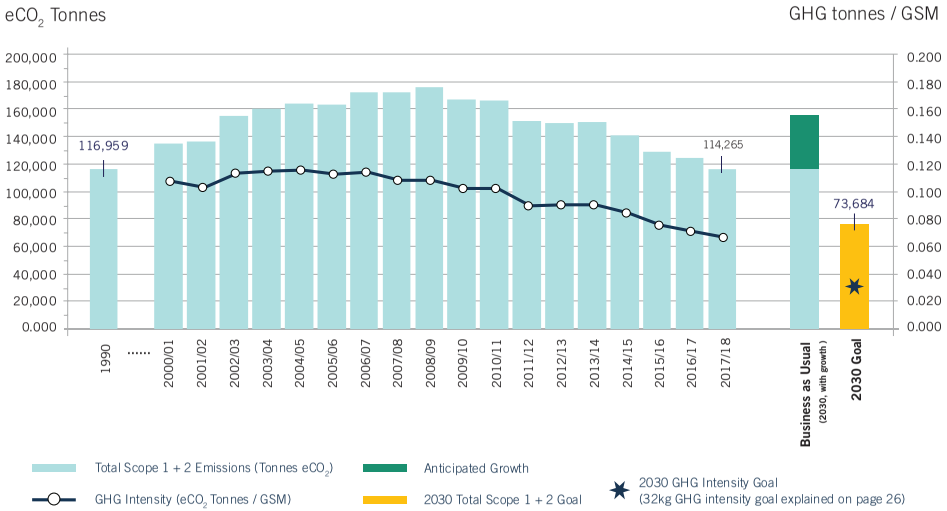
UTM bridge pond
Credit: Randy Landicho

Our Plan

Where we are in 2019

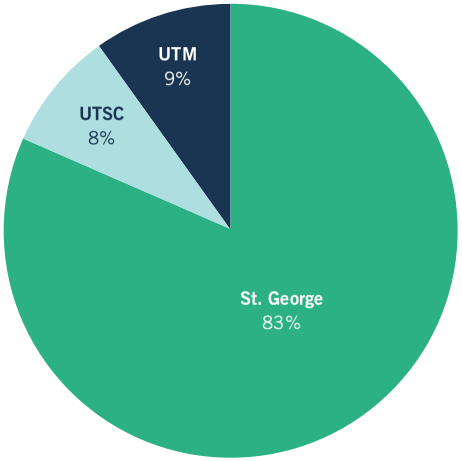
In the last two decades, all three University of Toronto campuses have undergone immense growth—both in student enrollment and building space. Even with this growth, we have reduced our GHG emissions and energy consumption (per capita and per gross square meter*).

University of Toronto:
Tri-Campus Total Scope 1 + 2 eCO_2 Emissions**



The chart above shows how we have been reducing total scope 1 and 2 GHG emissions and where we need to be to meet our 2030 reduction goal. The gap from where we are now to where we need to be in 2030 is being addressed by our reduction plans and projects, many of which are described in the following pages.

*Gross square meter (GSM)
**This data represents all purchased utility sources including Toronto Hydro, Hydro One, Enbridge Gas, Enwave and other natural gas suppliers. Purchased utilities and GSM data include all 3 campuses, federated colleges, and external entities for scope 1 & 2 emissions.



Breakdown of GHG Emissions by Campus

Operating one of the world's top research-intensive universities is an immense task. In 2017-2018, U of T emitted 114,265 tonnes of eCO_2 (carbon dioxide equivalents) for all operated or owned assets. The downtown University of Toronto St. George campus (St. George) is the largest campus in size and student population and represented 83 per cent of those emissions. University of Toronto Mississauga (UTM) accounted for 9 per cent and University of Toronto Scarborough (UTSC) 8 per cent.

We use a lot of energy at U of T for lighting, comfort, teaching, research, and equipment. What factors influence our energy use?

Size—We are big. U of T has three campuses with 266 buildings—1,790,704 gross square metres of building floor space.

Age—We've been around for a while. Many of the buildings at U of T's downtown St. George campus are over 80 years old, and use more heating and cooling than newer buildings. Existing building stock is a large contributor to our GHG emissions.

Climate—We live in a climate of extremes. Toronto has hot, humid summers and cold, windy winters, which means we need more heating and cooling for comfort.

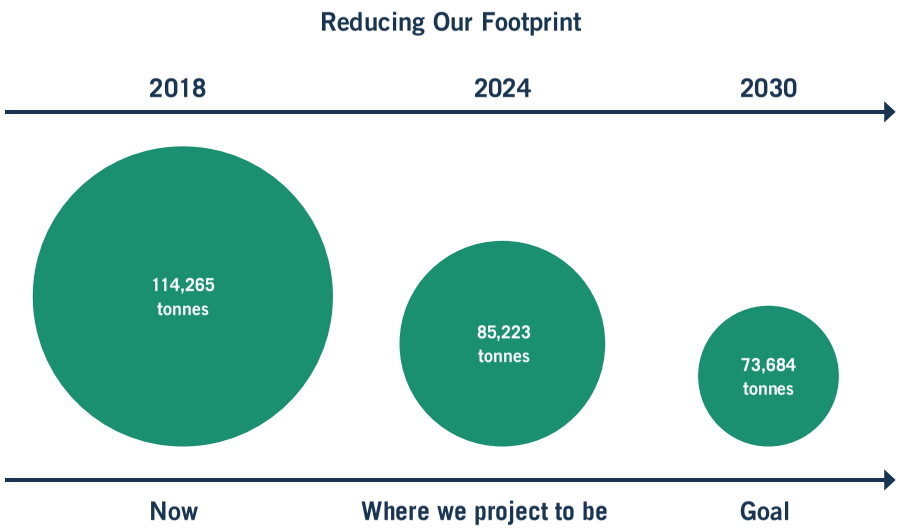
Activities—We do research. A lot of it. U of T is a research-intensive university with many laboratories, which require more energy than offices or classrooms.

Distribution—We purchase, convert, and distribute energy (steam, hot water, chilled water, and electricity) to buildings on our campuses and in some cases, off-campus sites as well.

Our Plan

Where we need to be in 2030

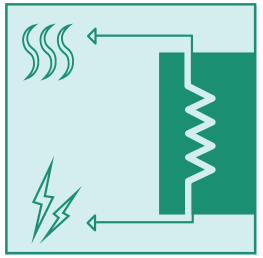
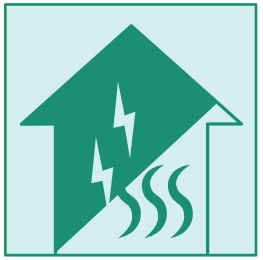
In 1990, U of T emitted 116,959 tonnes of eCO_2. To reach our 2030 reduction goal of 37 per cent from our 1990 baseline, we will need to reduce our annual emissions to below 73,684 tonnes eCO_2. The "Reducing Our Footprint" diagram below illustrates our 2018 year-end starting point, where we plan to be after this 5 year plan, and our 2030 goal. Where we project to be includes our 2019-2024 target GHG reductions (yellow boxes outlined in this plan), and accounts for smart growth across our campuses.



We will optimize how we produce, distribute, and consume electricity and natural gas on our campuses.

How we plan to achieve our goal

We have developed a five-year plan (2019-2024) to implement carbon reduction strategies across our campuses. To meet our 2030 GHG target, we will focus on optimizing how we produce, distribute, and consume electricity and natural gas. These efforts will result in substantial energy and GHG reductions while improving comfort. This document details some of the strategies and projects we are pursuing over the next five years. All target GHG reductions in this plan represent future projects and savings. Total target GHG reductions in the yellow boxes represent the sum of the projects described in each section.

PRODUCE	DISTRIBUTE	CONSUME
		
Clean Energy & Carbon Capture	Efficient Distribution	Reduced Consumption

2019 Greenhouse Gas Campus Retrofits Program (GGRP)

In 2018-19, the University of Toronto completed major projects aimed at reducing current and future greenhouse gas emissions across its three campuses. We combined support leveraged from the provincial government with our own investments to complete projects ranging from rooftop solar systems to ground source heat pumps. These projects represent over $50 million in investment and more than 8,600 tonnes in annual GHG emission reductions. Meeting these tight project schedules confirms our capacity and ability to develop and implement high performing energy and carbon reduction projects with timely efficiency.

Total Target GHG Reduction =

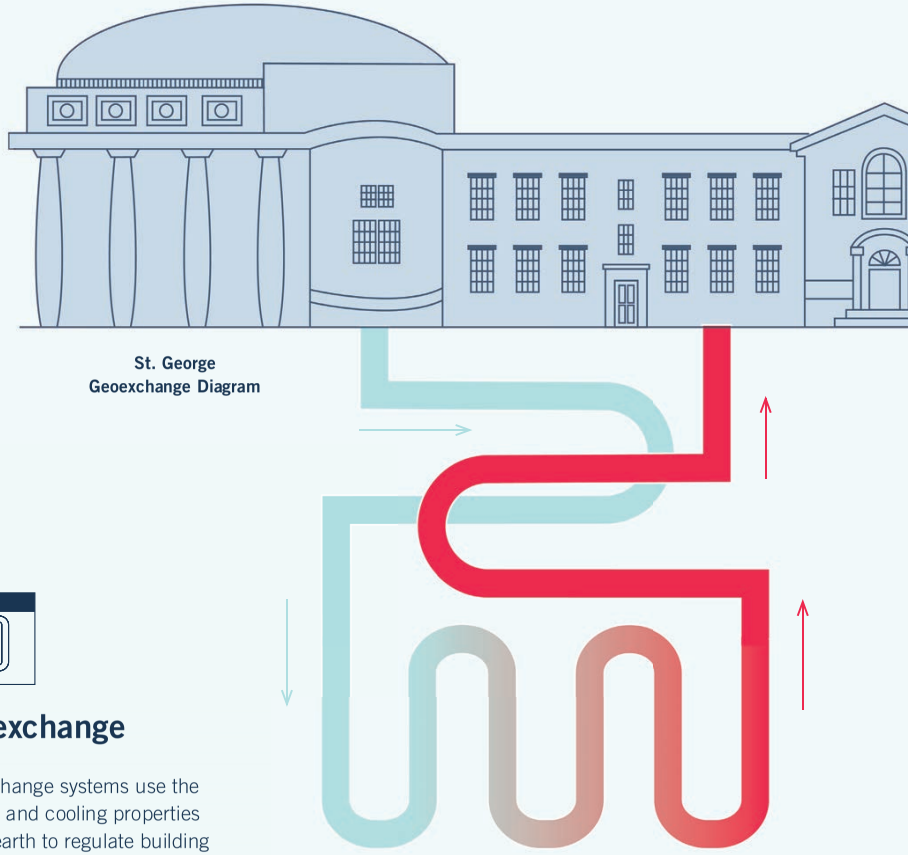
8,600

Tonnes eCO_2/ year

Produce: Clean Energy & Carbon Capture

St. George Geoexchange
Credit: Muhanad Sidek

To meet our GHG reduction target, we will reduce the use of natural gas and use cleaner energy along with strategies to capture carbon. In the next five years, we plan to increase the energy we generate on campuses from renewable sources such as solar and geoexchange technologies. Combined with energy recovery, high performance building designs, and optimization of existing facilities, these low-carbon solutions will guide us to meeting our target. Further to this, our operations staff are collaborating with U of T's world-class researchers to develop new methods of capturing carbon to convert CO_2 into useable feedstock.



St. George
Geoexchange Diagram

Geoexchange

Geoexchange systems use the heating and cooling properties of the earth to regulate building temperature. During the winter, the ground is warmer than the outside air temperature. This ground heat is transferred by fluid circulating in the deep vertical pipes of the geoexchange system and distributed to buildings for heating. In the summer this process is reversed—heat from the buildings is transferred to the ground (and used the following winter). All of this is powered using low-carbon electricity.

We will increase our use of low-carbon energy sources for heating and cooling.

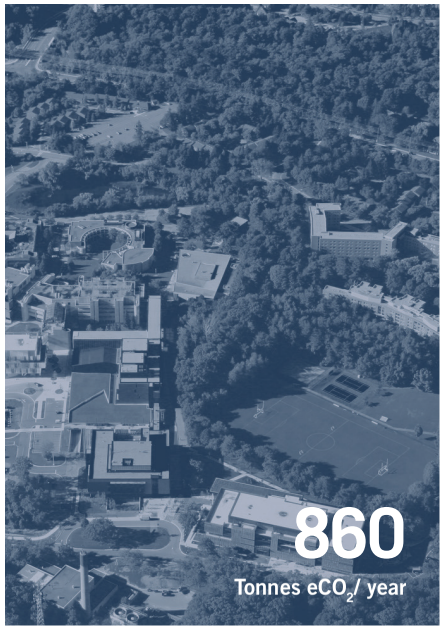
Produce: Clean Energy & Carbon Capture

St. George: Geoexchange on Front Campus

For the proposed St. George geoexchange project, over 350 deep boreholes will be drilled under Front Campus, creating Canada's largest known ground source heat pump in an urban setting. The low-carbon, electric heat pumps will be used to produce heating for buildings around King's College Circle. These buildings are currently heated by natural gas, a high-carbon fuel, and will be renovated to fully attain the benefits of the geoexchange energy.

UTM: New Science Building Geoexchange

The UTM Science Building will be one of the most energy-efficient biological and chemical research laboratory buildings in the world—modelled to use 65 per cent less energy than a conventional building. The geoexchange system will provide 60 per cent of the heating and cooling for the building.



UTSC: Geoexchange Phase 2 on South Campus

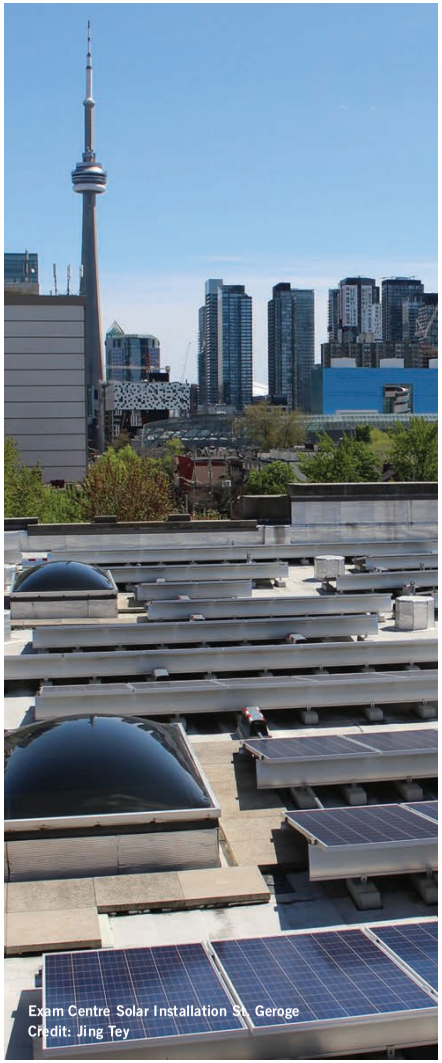
This proposed geoexchange system will build on the existing system serving the UTSC Science Building on the South Campus that currently provides an installed rated capacity of 1,115 kW for heating and supplanting natural gas-based heating. Plans are also underway at UTSC for a North Campus distributed energy system. Target GHG reductions for these new projects are 315 and 290 tonnes eCO_2 respectively.

Total Target GHG Reduction from Geoexchange =

16,465

Tonnes eCO_2/ year

Produce: Clean Energy & Carbon Capture


Exam Centre Solar Installation St. Geroge
Credit: Jing Tey

Solar Energy

Harnessing solar power will enable the university to reduce the use of electricity from the grid, and gas-heated hot water. In addition to the solar capacity already at U of T, new solar panels will be installed across our three campuses to reduce the amount of GHGs that would have been produced from purchased electricity or natural gas.

Total Target GHG Reduction from Solar =

200

Tonnes eCO_2/ year

Doubling Our Renewable Solar Energy

- We will double the solar capacity on our downtown campus
- We will increase the use of solar energy to heat water for pools and showers

Carbon Capture, Sequestration and Use: Collaborating with Our Innovative Researchers

In addition to reducing GHG emissions, the university is testing and implementing innovative methods for carbon capture, sequestration, and use. Examples of U of T academic teams working with U of T operations to capture and use carbon, and apply research to real world conditions are described below.

Professor David Sinton, Professor Ted Sargent, and the Carbon Electrocatalytic Recycling Toronto (CERT) team are developing and scaling a system that uses solar-powered electricity to process water and CO_2 into ethylene feedstocks—the raw material most used to create petrochemicals. The CERT team is collaborating with U of T to scale up technologies that capture and re-purpose CO_2 into valuable ethylene and ethanol feedstocks used around the world.

Professor Geoffrey Ozin and the Solar Fuels team are working to turn CO_2 into biofuels using renewable solar energy to split the hydrogen out of water. Using their combination of photocatalytic technologies and expertise, they are working toward a way to take carbon out of the boiler exhaust and convert it into valuable biodiesels that would normally come from petroleum feedstocks.

These and other game-changing solutions are being developed here with the assistance of our operations staff. The objective is to help us reduce our emissions and to get these technologies from the labs to a commercial setting.


U of T Carbon Electrocatalytic Recycling Toronto (CERT) team, working under the supervision of Professor David Sinton and Professor Ted Sargent

Distribute: Efficient Distribution

UTSC hot water distribution
Credit: Deepal Patel

We will improve the efficiency of our energy distribution systems, reduce losses, maximize heat recovery, and distribute more low-carbon heating and cooling energy on our campuses.

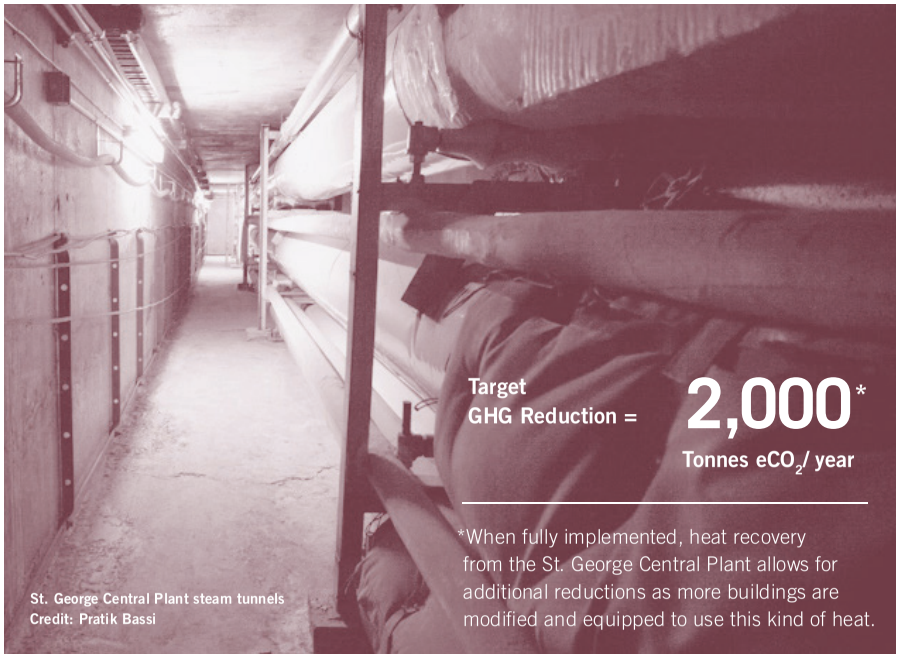
District Energy System Efficiencies

The University of Toronto has over a century of innovation with district energy systems. For example, the district energy system on the St. George campus was established in 1912! At St. George, the Central Plant distributes electricity and steam to buildings on-campus and off-campus sites such as the Royal Ontario Museum and Gardiner Museum. The Central Plant uses natural gas to make steam and electricity, which is a more efficient way to distribute energy than placing boilers in every building or connecting directly to the electricity grid. We plan to reduce the use of natural gas through conservation, optimization, and switching from steam to low-temperature water through the use of geoexchange and energy recovery.

Distribute: Efficient Distribution

St. George: Waste Heat Recovery and Use

The exhaust system collects heat in the stack at the Central Plant and converts it to hot water for heating buildings. This captured waste heat is considered zero incremental carbon, as additional natural gas is not used to heat the water. We are increasing our heat recovery by expanding the system to capture even more heat that would have otherwise been wasted. We will retrofit the heating systems that are currently steam-heated in order to increase the use of recovered heat.



St. George Central Plant steam tunnels
Credit: Pratik Bassi

Target GHG Reduction = 2,000* Tonnes eCO_2/ year

*When fully implemented, heat recovery from the St. George Central Plant allows for additional reductions as more buildings are modified and equipped to use this kind of heat.

UTSC: South Campus Steam to Hot Water Conversion Phase 2

The University of Toronto Scarborough is continuing to convert campus building heating systems from steam to hot water. Building on renovations on the original Science Wing building, UTSC will continue to convert heating systems in the Humanities Wing, including the installation of high-efficiency boilers and ground source heat pumps. Combined with improved delivery and controls, the new system will result in better comfort and substantially lower GHG emissions.

UTSC Science Wing, Credit: Ken Jones

Total Target GHG Reduction from Distribution Improvements = 2,260 Tonnes eCO_2/ year

Consume: Reduced Consumption

UTSC Environmental Science and Chemistry Building
(Awarded the 2018 Institutional Award by the Canada Green Building Council)
Credit: Ken Jones

We will reduce energy consumption in our existing and new buildings through retrofits, building systems optimization, and by designing to standards with superior performance in energy and carbon intensity.

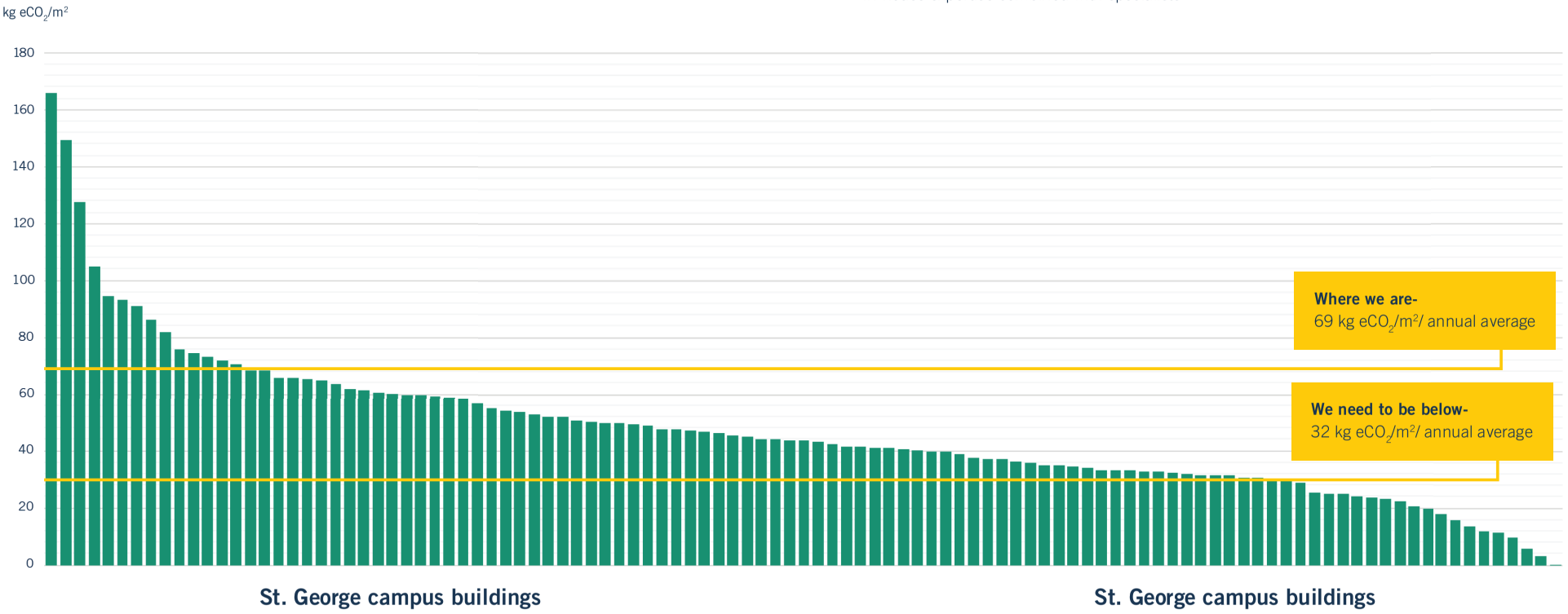
U of T is large and growing. We have an extensive portfolio of existing buildings, many of which are aged and require significant retrofits to reduce energy use and GHG footprints. We also have many new buildings planned for all three campuses over the next ten years. We will need to reduce our energy consumption in existing buildings and apply our design standard to all new buildings to ensure we meet our low-carbon goal. Through engagement programs, we will continue to interact with occupants to monitor and analyze operations and to safeguard conduct is in alignment with U of T's building performance standards and carbon reduction goals. We will also further learning opportunities from our reduced consumption efforts.

Consume: Reduced Consumption

Existing Building Optimization: Investing in Energy Reduction

U of T's existing buildings account for the bulk of our current GHG emissions. We have a large range in building GHG intensities at St. George (as illustrated in the chart below), with a current average of about 69 kg eCO_2/m^2. We need to reduce this intensity to below 32 kg eCO_2/m^2/ year to meet our 2030 goal. We have developed an $8.5 million Utilities Reduction Revolving Fund (URRF) to invest in deep retrofit energy conservation measures. By taking advantage of in-house expertise combined with specialists in significant energy conservation solutions, we will define and implement projects that result in large energy reductions across our campuses. For example, we regularly evaluate strategies for improving how we control the buildings, distribute air, optimize equipment, enhance insulation, upgrade windows, and reduce air leakage. Investing in existing building energy performance will significantly reduce our carbon footprint and improve comfort.

Current Building GHG Intensity Distribution – St. George



Consume: Reduced Consumption

Existing Buildings at St. George: Exploring Energy Recovery

A U of T team based on an Energy Services Company (U-ESCo) model is being established at St. George. Consisting of internal energy managers, engineers, and other building science experts, the team will collaboratively develop deep-dive energy conservation projects. One such opportunity for exploration is the capture and reuse of heat. For example, a large data centre on campus generates excess thermal energy. We can capture this energy waste and use it to heat and cool the building year round—treating these systems like computational boilers. This example renovation will offset over 700 tonnes of GHGs and reduce the need for conventional heating supplies by 73 per cent. We will evaluate energy recovery options in other buildings to reduce our energy consumption and GHG emissions.

Target GHG Reduction From Reducing Energy Consumption in Existing Buildings at St. George =

6,000

Tonnes eCO_2/ year

UTSC: Science Wing Dedicated Outdoor Air System Phase 2

UTSC's Science Wing is a laboratory intensive building that places elevated demand on utilities in order to operate. Compared to office spaces, laboratories require high air exchange rates in order to provide adequate ventilation for the handling of volatile substances used for research purposes. The air handling units that service this building are the largest on the UTSC campus and represent a major portion of the heating and cooling demand. The original building air handling units required replacement as they approached end of life. The air handling units had original steam heating coils replaced with higher efficiency hot water coils. The new air handling units have also been configured to take advantage of unique existing dual duct infrastructure to provide an innovative control system that supplies dedicated outdoor air to spaces served according to varying occupancy and fresh air requirements.

Target GHG Reduction =

300

Tonnes eCO_2/ year

UTM: HVAC Upgrades & Optimization

The University of Toronto Mississauga is upgrading the heating, ventilation, and air conditioning (HVAC) systems of several buildings. Projects include boiler and rooftop unit replacements, chiller replacement and optimization, installation of variable frequency drives, and conversion of domestic hot water systems to on-demand. Upgrades will save both electricity and natural gas, and result in more comfortable conditions for building occupants. Upgrades and retrofits will take place in the Central Utilities Plant, Student Centre, Erindale Hall, Oscar Peterson Hall, and Davis Building.

More buildings with old control technologies will also be updated in the next five years. Advanced controls allow our operators to monitor and adjust heating, cooling, and ventilation to better suit actual conditions and time of day. They will also be able to watch the performance of the buildings from a control centre, and react to wayward conditions before they affect energy performance and the comfort of building occupants.

Target GHG Reduction =

320

Tonnes eCO_2/ year

UTM Davis Building
Credit: Scott Northworthy

Total Target GHG Reduction from Building Optimization =

6,620

Tonnes eCO_2/ year

Consume: Reduced Consumption

Managing Our Growth: Enhancing Design Standards for New Building Construction and Renovation

All new buildings and major renovations will be designed to high standards that define superior performance for energy intensity, carbon intensity, and comfort. All new buildings and major renovations will have energy and carbon use indices +40 per cent more efficient than the industry-respected American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) standard 90.1. Our standards will be updated to reflect superior performance potential as new technologies and practices improve. We expect these advanced building design performance standards to account for close to 8,325 tonnes of avoided eCO_2/ year by 2024.

Target GHG Avoidance from Designing to New Building Performance Standards =

8,325

Tonnes eCO_2/ year

St. George Academic Wood Tower

The University of Toronto is planning to build a 14-storey academic tower made of timber on its downtown Toronto campus—expected to be the tallest mass timber and concrete hybrid building in North America. The Academic Wood Tower is an example of low-carbon and high performance design, incorporating new design standards. Designed to achieve a GHG intensity performance of 14-15 kg eCO_2/m^2, our Academic Wood Tower will perform well below our 32 kg eCO_2/m^2 target for 2030.

Academic Wood Tower
Credit: MacLennan Jaunkains Miller
Architects: Patkau Architects

Thomas Fisher Rare Book Library
Credit: Jing Tey

Lighting

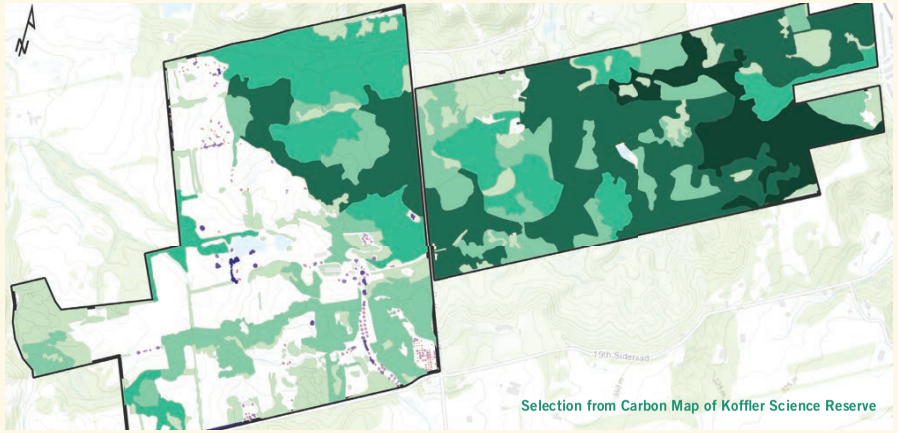
Quality lighting is an important influence on high performance work and learning. We will be replacing a significant number of interior and exterior lights with far more efficient LEDs. These new lights, combined with state of the art controls, will save about 40 per cent of the electricity costs and last longer than traditional bulbs. Savings will be used to invest in projects with higher GHG reductions. We are planning to replace over 3,000 lights over the next 5 years across our campuses.

Target GHG Reduction from Lighting Retrofits =

1,000

Tonnes eCO_2/ year

U of T Trees: Carbon Stock & Sequestration



Selection from Carbon Map of Koffler Science Reserve

Trees are natural carbon sinks due to their ability to uptake CO_2 from the atmosphere and store carbon in their wood. As such, they are one of the most important long-term and nature-based solutions to climate change. U of T properties, including, St. George, UTM, UTSC, Hart House Farm, Koffler Scientific Reserve at Jokers Hill, and Gull Lake, have a significant number of forests and trees that have been capturing and storing carbon for decades. Working with the Faculty of Forestry, we calculated that about 44,288 tonnes of elemental carbon (equivalent to 162,540 tonnes CO_2) has been captured and held by our trees.

Each year, our trees continue to capture an additional 5,260 tonnes of CO_2 (equivalent to 1,433 tonnes of elemental carbon). Our forests, trees and green space provide many other co-benefits and contribute to achieving a low-carbon future in other ways. They are critical for ameliorating local climate, mitigating urban heat island and water runoff, trapping pollutants, providing wildlife habitat, and enhancing human well-being. We will continue to work with forestry experts to pursue strategic forest conservation, planning, management, and restoration strategies. This integrated approach will promote maintaining stored carbon, and maximize carbon sequestration, while protecting and enhancing forest biodiversity, ensuring its sustainability and resilience.

CO_2 Captured by Trees on U of T Urban Properties (St. George, UTM, UTSC, U of T Institute for Aerospace Studies (UTIAS)) =

1,097

Tonnes eCO_2/ year

Fostering Innovative Solutions

Campus as a Living Lab & Experiential Learning

Students and faculty apply skills in teaching and research to real-world operational settings through course work, collaborations with research teams, Work Study, and programs like Campus as a Living Lab (CLL). The mandate of the CLL approach is to bring faculty members, students, staff, and, where appropriate, external partners together to collaborate on developing sustainability projects that combine operational and academic activities. Such projects will contribute to the operational sustainability goals of the University, and also provide an opportunity for research and experiential learning. In 2018, the Committee for Environment, Climate Change, and Sustainability (CECCS) CLL subcommittee identified and approved six projects to act as living labs—one new project and one retrofit project per campus.

U of T's size and location uniquely position its operations at a dynamic urban intersection that provides opportunities for collaboration with the wider community. One such opportunity is the Net-Zero Laneway pilot project in the Huron-Sussex neighbourhood, which served as a Campus as a Living Lab course project in Fall 2018. These opportunities facilitate the development of hand-on-skills, crucial for the creation of the next generation of leaders and problem solvers tackling climate change. We will continue to encourage and facilitate the integration of students and faculty within operations in piloting and developing tomorrow's solutions.

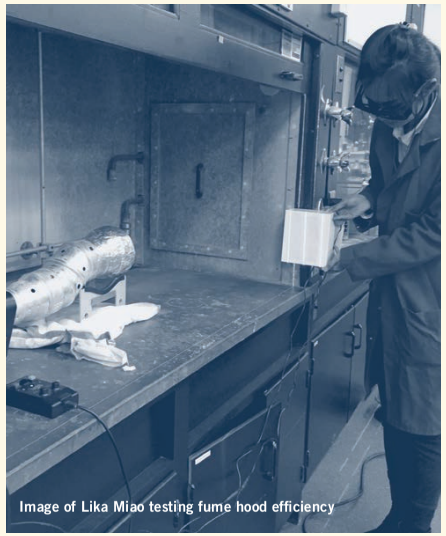


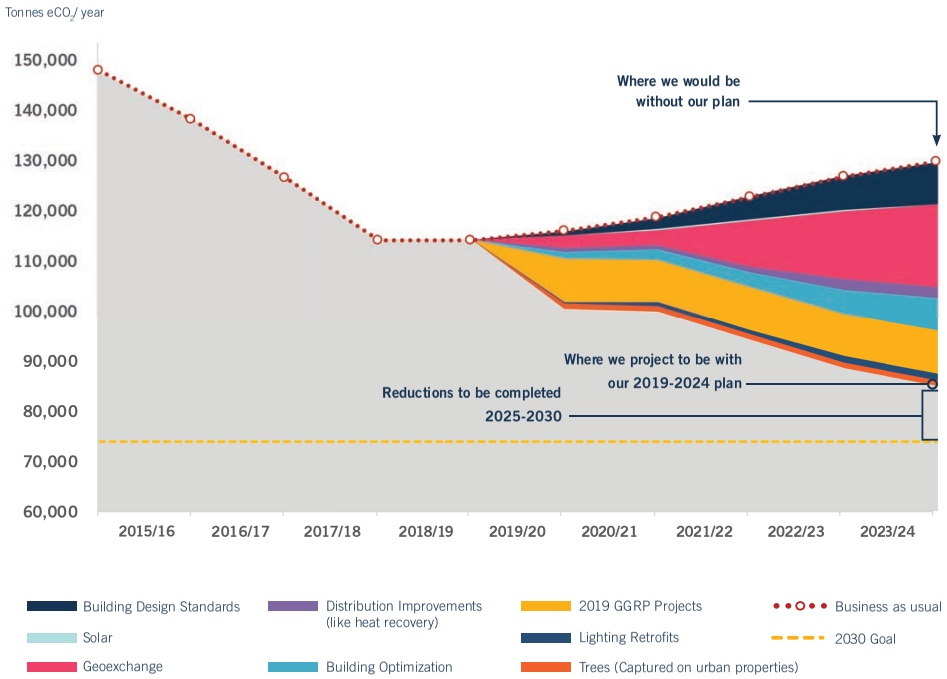
Image of Lika Miao testing fume hood efficiency

Example Project: Fume Hood Performance Optimization

Research-intensive universities have many laboratory fume hoods that exhaust large amounts of energy. With more than 1,200 fume hoods in labs across our campuses, U of T is no exception. We have the opportunity to optimize fume hood use to save energy, improve safety, and reduce GHGs. Student researchers, the Sustainability Office, and the Environmental Health & Safety department have collaborated to create a unique way to improve fume hood efficiency. This project has resulted in energy savings and GHG reductions, while maintaining optimum safety.

Pathway to 2030

University of Toronto: Tri-Campus Planned GHG Reductions (2019-2024)



To put us on a path to achieve our 2030 low-carbon goal, we will improve energy and thermal production, enhance energy distribution efficiency, and reduce our energy consumption. The chart above illustrates the types of projects we will implement over the next five years to reduce GHG emissions across all three University of Toronto campuses. With this 2019-2024 low-carbon action plan in place, we will be 80 per cent closer to achieving our goal. Beyond our five-year plan, we will continue to find ways to use the best low-carbon, high performance solutions to maintain long-term savings. Our staff, industry experts, faculty, and students are laying the important groundwork for achieving our 2030 goal.

Summary of Target GHG Reductions:

2019 Greenhouse Gas Campus Retrofits Program (GGRP) = **8,600** Tonnes eCO_2/ year	Building Optimization = **6,620** Tonnes eCO_2/ year
Geoexchange = **16,465** Tonnes eCO_2/ year	GHG Avoidance from Designing to New Building Standards = **8,325** Tonnes eCO_2/ year
Solar = **200** Tonnes eCO_2/ year	Lighting Retrofits = **1,000** Tonnes eCO_2/ year
Distribution Improvements = **2,260** Tonnes eCO_2/ year	GHGs Captured from Trees on Urban U of T Properties = **1,097** Tonnes eCO_2/ year

Total Planned Reductions by 2024

44,567

Tonnes eCO_2/ year