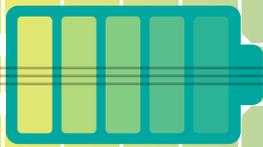


THE ROAD TO LOW- CARBON UNIVERSITY CAMPUSES



kWh



2017 GOING GREENER
REPORT ON ENVIRONMENTAL
SUSTAINABILITY



ONTARIO'S
UNIVERSITIES
Partnering for a better future

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INTRODUCTION

We know Ontarians are worried about the effects of climate change on our environment.

That's why Ontario universities are partnering to build a better, greener future.

We are acting now to support our students, our communities and the province.

Universities are adding new courses and programs for students—from engineering net-zero buildings to building net-zero companies—to develop the talent pipeline for the green economy. Students are passionate about making their campuses more sustainable and are driving change to make it happen.

Universities are bringing together community members and organizations to have frank conversations about how local governments and homeowners can prepare for and adapt to a changing climate.

Universities are helping the province reduce greenhouse gas emissions and save energy by rethinking campus operations. They are leading research on clean technology and electric cars, alternative fuels, and the next generation of batteries that will position Ontario as a global leader in these fields. By renovating and retrofitting old buildings, they are reducing energy use and lowering carbon emissions. New low-carbon buildings will minimize our footprint for generations to come.

This report, covering activities in 2016-17, features university commitments and targets, case studies of impressive retrofit projects, and highlights how universities are deeply engaged in building a cleaner future.



ROAD MAPS TO LOW-CARBON CAMPUSES

Ontario universities have long been committed to action on climate change.

In 2009, the heads of Ontario's universities pledged to "assist in finding solutions to the challenges of environmental sustainability; to share knowledge about sustainability and climate change; and to incorporate, wherever possible, principles of sustainability into our own operations."

Universities report annually on their progress and efforts on environmental sustainability, from academic programs to reducing greenhouse gas (GHG) emissions to sourcing local food. Much work has been undertaken over the past

decade to reduce reliance on fossil fuels in university operations.

But as climate change becomes an increasing threat in Ontario and globally, universities are stepping up to the challenge – and stepping up their commitment.

Over the next two years, every Ontario university will develop a road map to a low-carbon campus.

These campus plans will reinforce university leadership in and commitment to a sustainable future, including reducing energy use and emissions, and helping Ontario meet climate change targets. In addition to institutional responsibility across operations, road maps will address universities' continued commitment to research and innovation, curriculum and education.

In May 2018, York University will host a conference for the Ontario Chapter of the Association of Higher Education Facilities Officers with the theme of Creating a Road Map to Carbon-Free Campuses.

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Over the next two years, every Ontario university will develop a road map to a low-carbon campus.



CONFIRMING THEIR COMMITMENT TO ACTION

Ontario universities are actively engaged in creating a low-carbon future – both on campus and beyond. Some 89 per cent of universities surveyed this year have an official sustainability strategy, or one under-way. And 94 per cent of campuses regularly set and review targets for reducing CO₂ and other GHG emissions, or are in the planning stages.

One clear example is **Queen's University**, which has set a target to become carbon neutral by 2040.

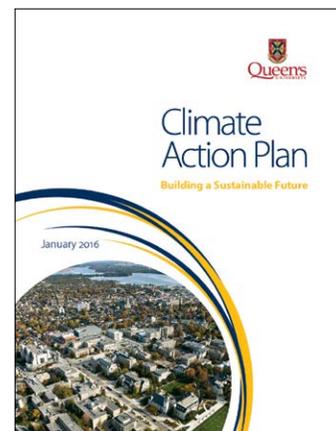
This goal was established in the university's Climate Action Plan, which was published in early 2016.

The plan's development involved students, staff, faculty and community members who participated on an Advisory Committee and its working groups. The process included extensive research and data collection, as well as consultation with the Queen's community through a forum and a Climate Action Plan survey.

In addition to the carbon neutrality goal, the plan has set low-carbon solutions to reduce the carbon footprint by 35 per cent by 2020 and 70 per cent by 2030, set against a baseline year of 2008. The plan further highlights reduction successes to date, the university's engagement on climate-related research and curriculum, and identifies further reduction opportunities to achieve the targets.

As of 2016, Queen's has achieved an overall reduction in GHG pollution of 24 per cent from 2008 levels.

Additionally, there are several projects under development that align with the Climate Action Plan goals, targeting an additional reduction of 6,000 tonnes of CO₂e (carbon dioxide equivalent), or a further 13-per-cent reduction.



Professor John Robinson is U of T's first presidential adviser on the environment, climate change and sustainability (ECCS). The appointment stems from the university's comprehensive action plan.

RETROFITTING TO REDUCE EMISSIONS

The [Pembina Institute](#) reports that two-thirds of GHG reductions from buildings will come from retrofits to existing building stock. Deep energy retrofits that take a holistic approach to renovations, targeting “energy hog” buildings, and using proven methods and technologies, will quickly help to achieve emissions-reductions targets and ensure that current buildings are as energy efficient as possible.

As one of Canada’s most research-intensive institutions, **McMaster University’s** labs have high energy consumption (and costs) due to strict ventilation and air quality controls.

In 2016, the university completed work to retro-commission the ventilation in several energy-intensive labs using Demand Control Ventilation (DCV), which is recognized by the U.S. Department of Energy as a best practice. Retro-commissioning is a type of deep energy retrofit that improves the systems and equipment within a building.

With DCV, ventilation is automatically adjusted based on the number of occupants or the demands they create. For example, when the lab air quality is acceptable, the system reduces the lab air flow to maintain comfort levels;

when demands are greater, the system enhances lab safety by delivering higher fresh air flows. Because the system delivers air where required, as opposed to throughout the facility, significant energy savings are achieved.

Thanks to these upgrades, the Michael DeGroot Centre for Learning and Discovery and the John Hodgins engineering building will now avoid 760 tonnes of CO₂e annually.

McMaster is also implementing DCV in its Chemistry Wing, for an annual GHG avoidance of 510 tonnes of CO₂e.

Energy cost savings for these three buildings is more than \$400,000 annually.



A uOttawa deep energy retrofit at its Roger Guindon Hall is saving \$1 million and more than 1,000 tonnes annually – representing six per cent of the entire campus emissions.





← UTM's new low-flow fume hoods.

District energy systems centralize heating and cooling for distribution to multiple buildings. Co-generation is the simultaneous production of electricity and heat – also known as “combined heat and power.”

Brock was able to retrofit an already efficient plant with next-generation equipment resulting in large efficiency gains while reducing GHG emissions and decreasing Brock's carbon footprint.

Built in 1994, the co-generation plant supplies almost 80 per cent of the campus heating, cooling and electrical needs. With project completion scheduled for spring 2018, Brock will replace four vintage engine/generators with two higher efficiency, higher output models. The new units will be 16 per cent more efficient per kilowatt hour, increasing the facility's overall efficiency by 14 per cent.

This will reduce Brock's carbon emissions by 3,209 tonnes of GHGs per year – the equivalent of taking 687 cars off the road for one year.

This year, the **University of Toronto-Scarborough's** (UTSC) sustainability efforts have been focused on utilizing the Strategic Investment Fund to modernize 20 of its research facilities.

Four large air handling systems have been upgraded using a combination of energy reduction strategies, including dedicated outdoor control, Demand Control Ventilation, and heat recovery measures.

Similarly, the **University of Toronto – Mississauga** (UTM) undertook a project to drastically reduce the amount of energy used in laboratory spaces through an air quality monitoring project. Under normal conditions, lab spaces undergo eight or more air changes per hour, where air is exhausted from the lab and replaced with fresh air from outdoors.

UTM has installed systems that monitor the air quality in labs and are able to automatically adjust for the optimal level of airflow. This has cut in half the number of air changes when the space is unoccupied – down to four or fewer air changes per hour. This results in significant savings, particularly during evenings and weekends when research is not taking place.

Implementation of this type of system typically results in energy savings

of 40 to 60 per cent, with commensurate reductions in GHG emissions. The project was to be completed in December 2017.

In Budget 2016, the federal government announced the Post-Secondary Institutions Strategic Investment Fund (SIF) to modernize and improve the environmental sustainability of research and commercialization facilities in Canada.

Brock University received SIF funding to improve the operating efficiency of its district energy co-generation facility.



→ Brock's district energy co-generation facility.



← UTSC's SIF renovation is part of the historic Lab Innovation for Toronto (LIFT) project, which will renew 47 per cent of U of T's research space.

All 20,000 square feet of renovated space has been brought to life with high efficiency LED lighting. UTSC is making building envelope improvements, including concrete remediation and the installation of new high performance windows, which decrease heating and cooling loads. The building envelope is what separates the interior and the exterior of a building, including the roof, walls and windows.

In total, these renovations will yield approximately \$200,000 per year in utilities savings, and reduce GHG emissions by approximately 200 tonnes of CO₂e – the equivalent of 15 average Canadian households, or permanently taking 35 cars off the road.

As it transitions to a low-carbon campus, **Carleton University** is reducing its footprint while boosting research on green technology and smart environments.

Carleton received \$26.4 million in infrastructure funding from the federal and provincial governments, with an additional \$23.5 million investment from Carleton toward a major retrofit and modernization program. The program includes the creation of Carleton's Sustainability Energy Research Facility and a new Cogeneration Research Observation Centre. Six Carleton buildings are being upgraded and there will be conversion to LED lighting

across the campus grounds and tunnel infrastructure.

The net positive impact in carbon reduction is the equivalent of taking 772 cars off the road for a year or eliminating the emissions from 383 homes for one year. The projects will reduce energy use on campus by eight per cent.

In addition, the renovation program will support the creation of the Institute for Advanced Research and Innovation in Smart Environments (ARISE) focusing on applied research in clean technology, health technology, and information and communication technology. The collaborative research and training at ARISE, supported by industry, will facilitate startups and contribute to economic growth.



Carleton's net positive impact in carbon reduction is the equivalent of taking 772 cars off the road or eliminating emissions from 383 homes for one year

At the St. George campus of the **University of Toronto**, the Exam Centre is one of the most sustainable buildings on campus. With its most recent green feature addition, the installation of solar panels that were connected to the grid in early 2017, it is even greener.

The system should provide about 75,000 kilowatt hours annually. In comparison, a regular house uses about 10,000 kilowatt hours a year, so this will produce 7.5 times more energy than an average Toronto home uses each year.

Retrofitted from a warehouse in 2008, the building was the university's first LEED Gold project. The 67-kilowatt solar array is another addition to its already extensive sustainability features. Other green features include a living wall in the lobby where more than 60,000 students visit to write their exams, two large cisterns that collect rainwater used to flush toilets, and a sustainable roof. Overall, the building uses roughly 60 per cent less water and 30 per cent less electricity than a typical building.

The project was awarded First Prize in the Open Category of CAUBO's 2017 Quality & Productivity Awards to recognize its "triple bottom line" approach to

sustainability, which incorporates environmental, social and economic factors.

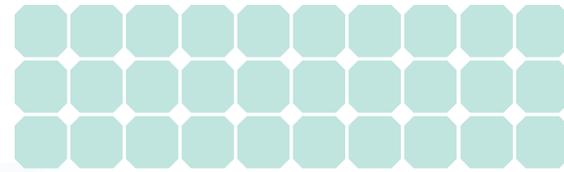
Wilfrid Laurier University has undertaken a comprehensive, multi-phase initiative to transform its building portfolio into a leading example of sustainable management, as part of its Laurier Energy Efficiency Program (LEEP).

In Phase 1, standard and deep energy retrofits were completed in three buildings as part of an "energy performance contract," which guarantees energy savings. Solar thermal walls were installed to harness renewable energy, as well as DCV and scheduling and occupancy controls. An additional audit expanded the energy conservation and GHG reduction initiative to an additional 35 buildings in Phase 2.

Phase 3 includes installing approximately 500kW of solar PV, 2MW of battery storage, with a detailed engineering study under way to implement a fully functioning microgrid. Micro-(power) grids can operate independently of the main electrical grid.

Laurier is completing the upgrades through an Energy Service Company (ESCO) agreement with Johnson Controls Inc. and has partnered with Waterloo North Hydro, Brantford Power, Union Gas, and the Region of Waterloo to secure financial incentives tied to energy savings performance.

Already this project is seeing a GHG reduction of 23.5 tonnes of CO2 in the first quarter of 2017, with further annual reductions of 332 tonnes expected when Phase 2 wraps up at the end of 2018. As a result of the LEEP Phase 1 and 2 initiatives, the university will realize more than \$1 million in annual energy cost savings.



↓ Ron Swail (COO, Property Services & Sustainability – far left) and colleagues from the solar panel project on UofT's Exam Centre roof.

PHOTO CREDIT: JONATHAN SABENIANO



EDUCATING FOR A GREENER FUTURE

Each year, universities add new programs and courses on environmental sustainability. Below are just a few examples of how they are helping educate the next generation to be critical thinkers and leaders on issues of sustainability and climate change.

BROCK UNIVERSITY

Brock's Environmental Sustainability Research Centre (ESRC) has developed new open-content material focused on environmental sustainability in practice, as part of an eCampus Ontario initiative. These free modules are associated with the ESRC's new online undergraduate course, **Environmental Sustainability in Practice**.

CARLETON UNIVERSITY

Carleton has launched **Societal Transformation and Climate Change: Training the Next Generation of Scholars in sub-Saharan Africa and Canada**. The \$1.8-million program is designed to train tomorrow's climate change research leaders in partnership with three African universities in Tanzania, Malawi and Ghana. It's taking place from 2017 to the end of 2020.

LAURETIAN UNIVERSITY

Laurentian's School of the Environment has introduced a new course on **climate change vulnerability, impacts, and adaptation**. The third-year course is taught in collaboration with the Ontario Centre for Climate Impacts and Adaptation Resources' research unit located on campus.

MCMASTER UNIVERSITY

McMaster offers two new courses: Introduction to Sustainability and a final year course in **Leadership in Sustainability** where students gain leadership skills and apply them by working in interdisciplinary teams to develop and implement a sustainability-focused project within the community.

UNIVERSITY OF OTTAWA

Ottawa's Leadership, Strategy and Sustainability course explores corporate social responsibility to build a solid business case for more sustainable enterprises. This hands-on course focuses on the leadership skills required to create successful business strategies for the future, including social entrepreneurship, carbon-negative enterprises, industrial ecology and the circular economy.



QUEEN'S UNIVERSITY

A new graduate level course has been created at Queen's within the Mechanical and Materials Engineering program: **Net-Zero Energy Buildings and Communities**. The course provides an introduction to what is meant by net-zero energy buildings and communities and considers how the net-zero energy state can be achieved, and what considerations need to be taken into account in planning.

RYERSON UNIVERSITY

Ryerson's new **Professional Master's Diploma in Energy and Innovation** exposes participants to the relevant knowledge and skills required to excel as leaders in the fast-growing and rapidly changing Canadian energy sector.

UNIVERSITY OF TORONTO

Toronto's new course, **U of T as a Living Lab of Sustainability**, demonstrates commitment at the executive level to integrating academic and operational sustainability in the context of treating its campus as a living laboratory of sustainable practice, research and teaching. The course involves an applied research project on aspects of campus sustainability, working in close partnership with operational staff at the university.

UNIVERSITY OF TORONTO

The University of Toronto-Mississauga is offering several new courses, including **Managing our Waste; Managing Urban Ecosystems; Comparative Environmental Policy; Politics and Policy of Wildlife Conservation; Climatology of Canadian Landscapes; Geographies of Indigenous Identity and Well-being; and Environmental Justice**.

WESTERN UNIVERSITY

Western's new course, **Indigenous Peoples, Globalization and the Environment**, is an examination of natural resource development emphasizing the interplay between Indigenous peoples, the state and international developers. Its **Environmental Science and Sustainability** course provides an overview of the science underlying key issues (e.g. climate change, loss of biodiversity and ecosystem function, air and water pollution, and resource use) and how each issue impacts environmental sustainability from the local to global scale.

YORK UNIVERSITY AND SENECA COLLEGE

York and Seneca College jointly offer an **Urban Sustainability** program. Students learn about the need for reform of market mechanisms to achieve environmental goals; how to achieve a balance between social and economic considerations; water resource planning and management; transportation planning; and soil and material testing. Completion of the joint program prepares students for work in the planning, design and construction of major infrastructure and services including roads, tunnels, bridges, water supplies, buildings and new communities.





← York's LEED Gold Bergeron Centre for Engineering Excellence.

While universities focus on retrofitting aging buildings to reduce emissions, they are also planning for the future with new buildings that meet increasingly strict green standards.

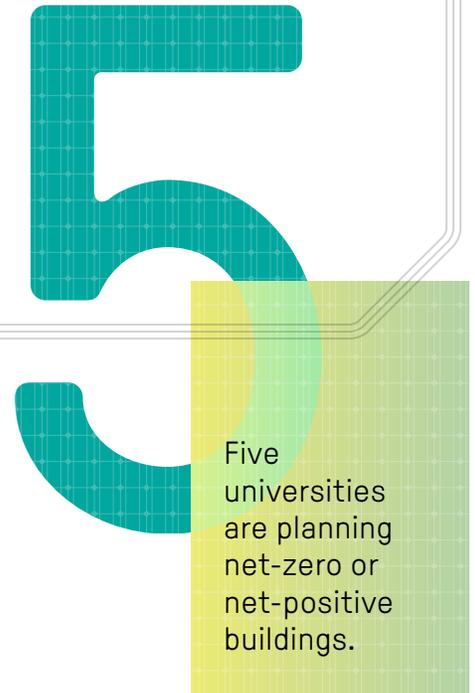
Even before LEED certification was introduced in Canada, **York University** was ahead of the curve. More than 20 years ago, York directed that all capital projects demonstrate commitment to sustainable development. The university's green building efforts focused on building envelope efficiency, use of passive light, energy conservation/performance, reduction in emissions, sustainably sourced materials and green construction practices.

The Computer Science and Engineering Building (2001) was York's inaugural foray into green buildings and was one of the first built in Ontario, receiving the World Architecture International Green Building Award in 2002.

The creation of the York Research Tower (2009) formalized York's pursuit of LEED, leading to the first LEED Silver building on campus.

By 2015, York achieved its first LEED Gold with the Bergeron Centre for Engineering Excellence, named one of Toronto's most beautiful buildings, and York's highest achievement in green building to date.

Plans are underway for two additional LEED Gold buildings, as York contemplates net zero standards.



100%
of universities surveyed have buildings built to recognized sustainable or green building standards, including LEED and Green Globes.

CREATING RESILIENT COMMUNITIES

As the threats of climate change outpace human efforts to reverse its impacts, many communities and jurisdictions are focusing on resilience and adaptation as a parallel strategy to cope with the effects.

Lakehead University is one university that is actively engaged in these discussions.

The effects of climate destabilization are evident on Lake Superior, where large iceberg-like formations developed in 2015. It is speculated that warming in high latitudes ultimately sent Arctic air to central Canada. While Lake Superior saw heavy ice, humans have reduced Arctic sea ice dramatically, changing one of the major geographic features on the planet.

What do these types of changes mean for local communities?

In 2016-17, **EarthCare Thunder Bay** – a partnership between the City of Thunder Bay and the community – and Lakehead collaborated using a participatory research method called “photovoice” to record, share, and reflect on climate change in the community of Thunder Bay.

The exercise documented and identified ideas about building resilience, used photography to raise community awareness about climate change, and built momentum for future projects and action. A community photo exhibit was developed and showcased in multiple locations. Follow the story at: www.climatechangetbay.com.

Kelsey Jones-Casey is a Fulbright fellow who visited Lakehead University in the winter of 2017. Her project, **Boreal Heartbeat**, posed the question: What does climate change mean for people who live close to the land in Northwestern Ontario? Kelsey’s interviews are intended to capture the stories of these people and track the climate-related changes and impacts – both on the land and on the people.

↓ “Icebergs” on Lake Superior – a sign of climate destabilization.

PHOTO CREDIT: PAUL BERGER



Waterloo Region’s first ever **Decarbonization Forum** was held in 2016, hosted by Professor Heather Douglas, Waterloo Chair in Science and Society, and facilitated by the **Waterloo Institute for Sustainable Energy**. The forum convened more than 50 local experts from academia, local utilities, government, civil society, and business sectors over a two-day workshop to discuss the ambitious goal of the making the region’s energy systems fossil-fuel free by 2050.

RESEARCH & TECHNOLOGY

Producing clean energy is important. But where and how do we store it for future use? Research into clean, renewable energy production and storage are a vital part of the solutions to address climate change. Universities are also addressing food production and water shortages, which are critical global issues.

Ryerson University is proud to lead the Natural Sciences and Engineering Research Council of Canada (NSERC) Energy Storage Technology Network (NESTNet). With \$5 million in funding, this five-year undertaking is a pan-Canadian network consisting of 15 universities and 26 industry and government partners, all focused on the future of energy storage – an essential technology in Canada’s transition to clean energy.

NESTNet collaboratively explores many different types of energy storage, including flywheels, lithium-ion batteries and compressed air, while determining how best to integrate these technologies into electricity grids. By partnering

with the private sector, NESTNet enables directed progress – without duplication of efforts – towards a strong domestic Canadian energy storage industry that is also competitive in the global marketplace.

NESTNet is also committed to training the next generation that will power the future of Canadian energy storage. Through the second year of the network, 90 highly qualified personnel have worked with NESTNet’s theme leaders.



← Ryerson’s NESTNet research team.

→ Western's Andy Sun is researching the next generation of batteries in partnership with the China Automotive Battery Research Institute.

Western University engineering professor Andy Sun is giving his research – and the world – quite a charge with his latest partnership with a Beijing battery research company.

Sun, a Canada Research Chair in Nanomaterials for Energy Conversion and Storage, is partnering with the China Automotive Battery Research Institute Co. Ltd. in hopes of solving critical and long-standing problems with battery life and safety by working towards solid-state batteries – all in an effort to fight climate change and reduce greenhouse gas emissions.

He hopes these next-generation batteries will have significant impact on everything from cars to phones and laptops, moving from the current liquid to a solid-state electrolyte. Traditional liquid batteries pose safety issues because of their flammability, and they often do not hold their charge.

While electric cars may now have a range of 200 kilometres per charge, Sun believes that can double to 400 with a solid-state battery. Instead of charging your cellphone every day, that could be just once a week.

The Institute will invest \$3.35 million in Western to create the Solid State Battery Research Joint Laboratory, located in Sun's Western Engineering labs. The five-year agreement begins January 1, 2018.

Water – specifically accessibility to freshwater resources – is widely proclaimed to be one the 21st century's greatest challenges. As the global agricultural sector consumes about 70 per cent of



all accessible freshwater, both a challenge and opportunity exists.

The **University of Ontario Institute of Technology (UOIT)** is tackling this issue through research on “ecofarming.”

The ECOSAFEFARMING concept aims to create a new technology that allows urban wastewater to be processed innovatively to produce clean, inherently nutrient-rich irrigation water and hydrogen. In this way, the project addresses issues related to safe food production and clean, sustainable energy production.

UOIT's Ibrahim Dincer, who oversees operation of the university's Clean Energy Research Laboratory, is part of an international research team developing and testing this new irrigation system.

“The ‘treated’ water can be reused to irrigate crops, while the hydrogen (gas) captured by the system can be reused as an on-site energy source to power greenhouses with hydroponic crops and irrigation systems for land crops,” says Dincer.

The innovative ecofarming system, and its potential to save substantial volumes of freshwater around the world, has attracted grant funding from NSERC.



The **ECOSAFEFARMING** concept aims to create a new technology that allows urban wastewater to be processed innovatively to produce clean, inherently nutrient-rich irrigation water

DRIVING CLEAN

Transportation remains one of the largest contributors to greenhouse gas emissions. Research and development of electric vehicles and technology is being undertaken at universities across the province. Universities are also setting the example by making changes to their campus operations. They are adopting electric campus vehicles, promoting bike and car shares, and 11 universities now have electric vehicle charging stations.

In 2016, the **University of Waterloo** launched the Green and Intelligent Automotive (GAIA) research facility to develop the next generation of low-carbon and intelligent vehicles. This state-of-the-art space consists of three integrated research cells focusing on powertrain efficiency, long-lasting car batteries, and testing vehicles on a full-chassis rolling dynamometer – a device that measures power, force or speed.

As part of the Waterloo Centre for Automotive Research (WatCAR), GAIA allows researchers to develop and test new clean energy technologies for hybrid, electric, and combustion vehicles to

improve fuel efficiency and reduce carbon emissions. It will also facilitate research on connected vehicles that will allow car batteries to feed into Canada's electricity grid during periods of high demand.

With all three cells integrated into a single facility, GAIA speeds up the research and development timeline for new technologies, allowing industry partners to mobilize findings rapidly into real-world products and services.

WatCAR supports more than 130 researchers across all six faculties at the University of Waterloo.



→ uWaterloo's Green and Intelligent Automotive (GAIA) research facility is testing the next generation of clean vehicles.





The **University of Ottawa** is looking to decarbonize its campus transportation fleet. The majority of this plan relies on the transition from internal combustion engine vehicles to electric vehicles. But it is also finding better ways to move staff around campus.

Cycling and active transportation is safer, healthier, faster, and more cost effective in many cases. And with the introduction of the uOttawa car-free campus core, encouraging cycling aligns with the vision outlined in the uOttawa Campus Master Plan 2016.

In the spring of 2017, the Facilities department purchased six service bicycles to transition to a lower carbon fleet. These bicycles are available to all

Facilities staff. They are equipped with small carrier boxes to hold tools and documents. Staff have also been provided with training materials and safety equipment.

Data will be tracked to determine the efficacy of the program in reducing emissions, and staff feedback is positive so far. Future plans include the purchase of other kinds of bikes, such as service tricycles.

↑ uOttawa's green transportation fleet.



CONCLUSION

Big challenges lie ahead and Ontario universities and their campus communities are taking action. Year over year they have demonstrated progress in reducing greenhouse gas emissions on campus. They have reaffirmed their commitment to bold, broad strategies to tackle climate change and educate the next generation of green leaders. They have stepped up research into adaptation, climate science and clean technology that will have positive global impacts.

In this report, we have highlighted the role universities are playing in partnering for a greener Ontario. A low-carbon future will mean a more vibrant economy, a higher quality of life and a better future for all Ontarians.



Do you want to learn more about any of the projects and initiatives featured in this report? Contact the Council of Ontario Universities (cou.on.ca/about/contact-us) to be put in touch with the right contact at each campus.



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