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NET ZERO

How universities are overhauling operations in an effort to reduce their greenhouse gas emissions

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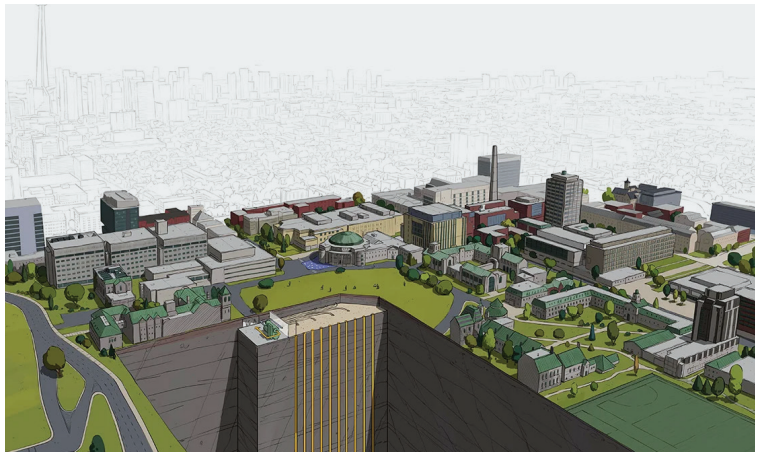
The centrepiece of the University of Toronto's downtown St. George campus was a hot mess last spring.

What was once a lush lawn sprawling out before Oxbridge-inspired University College – U of T's founding campus building, erected in the late 1850s – had been torn up and transformed into a massive, muddy construction site littered with trailers, shipping containers, heavy machinery, skids of building materials, temporary fencing, mounds of dirt, hard-hatted workers and lots of concrete.

But this was no case of paving paradise to put up a parking lot. In fact, cars have been banished from King's College Circle, the road that rings the grounds, while the university completes an ambitious $23-million plan to sink more than 370 pipes 250 metres underground, forming what's being touted as Canada's largest known urban ground-source heat pump system. The "geoexchange" is expected to be operational this fall, at which point it will draw heat from campus buildings – many more than a century old – during the warmer months, store it and release it back into the buildings throughout the winter. A subterranean classroom is being integrated as part of a "living lab" and the grounds will feature granite-paved walkways and green space. Parking will be cut by a third of its previous capacity and moved from surface level to an underground lot directly above the network of vertical pipes.

Part of a much bigger plan to cut the campus's current 93,000 tonnes of greenhouse gas emissions (GHGs) down by an estimated 46,000 tonnes by 2030, the project is "a really great example of what we are trying to do at a much larger scale through our 30-year climate-positive strategy," says Ron Saporta, U of T's chief operating officer for property services and sustainability, operations and real estate partnerships.

That strategy is a bid to make the campus – one of Toronto's largest public emitters – go beyond "net zero" emissions by 2050. The plan, estimated most recently at $1.7 billion, is to cut the downtown campus's emissions by 80 per cent (while its physical footprint almost doubles due to anticipated enrolment and facility expansion) and more than balance out the remainder through its development of renewable energy projects off-site, such as a solar panel installation.



A rendering of the new geoexchange the University of Toronto is constructing 250 metres below King's College Circle at its St. George campus in downtown Toronto.

While perhaps the costliest and most labour-intensive of sustainability plans proposed by a Canadian university, U of T's is among many pledges, plans and workboots-on-the-ground actions that Canadian universities have announced over the last five years and beyond to respond to the increasingly urgent call to hold global warming to below 2 degrees Celsius above pre-industrial levels, as Canada agreed to in the 2015 Paris Agreement.

Some projects are splashy: geothermal loops and geoexchanges, zero-carbon buildings, integrated solar panels and solar parks, electrified vehicle fleets and microgrids. Others are under-the-radar workhorses that aren't likely to be launched with a cheery press release: deep retrofits of aging heating and cooling systems, updated windows and new building-monitoring equipment.

The magnitude of the challenge can be daunting, but humanity has

ILLUSTRATION: NICOLAS DEMERS

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the technology, scientific know-how and money to meet it if we act swiftly and purposefully to cut our emissions by half within the next decade, says Elisabeth Gilmore, an associate professor of environmental engineering at Carleton University and a lead author of a 2022 report by the Intergovernmental Panel on Climate Change. There are more than 95 universities across Canada and while many of their researchers are contributing in ways both theoretical and applied to the global mission to mitigate climate change, these institutions also have an important role to carry out on an operational level.

"Many of them can be the size of a small city," Dr. Gilmore says. "If you look across at all the properties they own, the land that they have, they start to look like a big player."

According to recent data from Universities Canada (publisher of *University Affairs*), 75 per cent of its member institutions "have dedicated sustainability strategies." Big or small, universities are also seen as exemplars to the wider world by trying out new approaches to mitigate the effects of climate change that can be scaled to other communities – U of T says its geoexchange shows that a technology previously thought best suited to newer builds (and one already used in smaller-scale new builds on all three of its campuses) is possible in an urban heritage district. They share the results of those experiments all while educating students in a paradigm that's shifting to be more planet-friendly and contributing meaningfully to this worldwide mission.

Being "in the heart of wildfire country," in Kamloops, British Columbia – an area also prone to floods – puts a fine point on Thompson Rivers University's work towards becoming fossil fuel-free by 2030, says Matt Milovick, the university's vice-president of administration and finance. Central to that is its development of a low-carbon district energy system. The project will switch most of TRU's buildings from individual natural gas boilers to a centralized heating system run on air-source heat pumps and B.C.'s electricity grid, which comes with a lower rate of emissions. That's expected to cut about 95 per cent of TRU's direct campus emissions which, as a small campus, were already relatively low at 3,771.70 tonnes in 2020.

The skinny on scope

Greenhouse gas emissions are categorized by "scope" to differentiate them by their source and who or what controls them. A university's emissions typically cover all three scopes. The Greenhouse Gas Protocol is a common global standards organization that provides guidance on emissions accounting.

Scope one: These are emissions under a university's direct control. Typically, the main source of scope one emissions on campus is fuel for heating, such as natural gas or oil, and gas to power campus vehicles.

Scope two: "Indirect" emissions that are produced by an energy supplier, such as electricity from a natural gas plant.

Scope three: These are all other indirect emissions created by goods, services and transportation related to university activities. They can include commuting to and from campus, conference travel, investments and the production and distribution of food sold on campus.

Carbon neutral? Net zero?

There is much debate about terms and limited standards when it comes to defining what it means to be carbon neutral or a "net zero" campus.

Net zero: The United Nations defines net zero as "cutting greenhouse gas emissions to as close to zero as possible, with any remaining emissions re-absorbed from the atmosphere, by oceans and forests, for instance." In practice, "net zero" campuses can still be GHG emitters but balance their accounting through other carbon-absorbing activities, either as "carbon sinks" or as offsets. How much those activities actually make up for emissions and how much they should be used is up for debate.

Carbon neutral: Today, most prefer the term "net zero" to "carbon neutral", a term that has been critiqued for leaving out GHG sources besides those that are carbon-based, among other reasons.

Emissions math

Greenhouse gases such as carbon dioxide, methane and nitrous oxide are measured in terms of their CO2 equivalent (calculated according to their global-warming potential) and by the tonne. A car has been estimated to typically emit about 4.6 tonnes of CO2 emissions in one year.

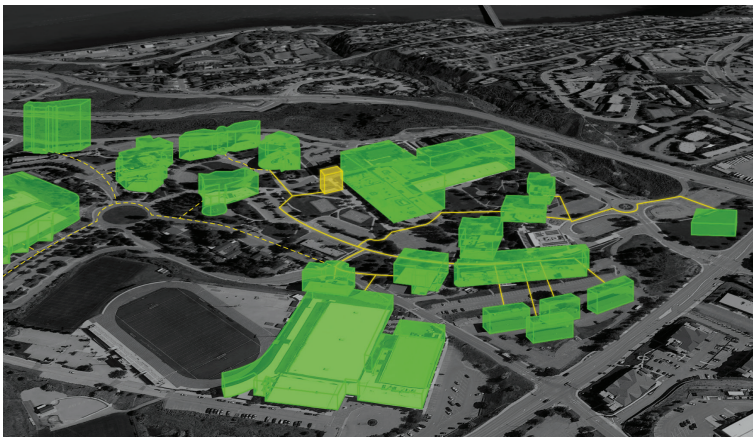
A snapshot of sustainable energy projects underway at campuses across Canada:

Simon Fraser University opened a wood waste-fed biomass plant in 2021 to heat and provide hot water to most of its campus in Burnaby, B.C., and half of its residences, slashing emissions by 85 per cent.

The **University of Winnipeg** draws 20 per cent of its annual electricity from a solar array on the roof of its Axworthy Health and RecPlex and has cut its greenhouse gas emissions by 17 per cent thanks to "Manitoba's first urban biomass silo," run on wood pellets.

Wilfrid Laurier University in Waterloo, Ont., completed a microgrid in 2022 with a six-megawatt battery storage system, part of a $48-million energy efficiency program.

The **University of Regina** is building a microgrid as a testing ground and potential source of self-generated renewable energy.



Thompson Rivers University is building a low district energy system that features a closed-loop, centralized piping system which will redistribute thermal energies to buildings across its campus in Kamloops, B.C.

TRU will invest $7.5 million to construct the building housing the equipment. But the private sector partner it brought onboard, Creative Energy, will install and operate the equipment and the centralized piping system that will redistribute thermal energies to buildings across campus. Creative Energy will recoup its costs over time by charging TRU for the heating. Electrification means the university's costs will shoot up anywhere from 35 to 50 per cent depending on usage, says Mr. Milovick, adding that TRU's gradual upgrading of its air monitoring and control systems will help ensure heating and cooling are only happening where and when they're needed. Creative Energy will also provide operational data to students for research purposes.

"When you have a campus that understands the need for change, that we're in the middle of a probably worsening climate crisis, it makes the ask for these types of investments a lot easier," he says. "People understand what the priorities are."

Burning fossil fuels for heating is the leading source of most campuses' "scope one" direct greenhouse gas emissions, followed by campus vehicles. District energy systems have been a popular way to address such emissions because of how they can achieve economies of scale, increasing efficiency and lowering costs. However, it's the boring-but-important retrofits to existing buildings that are considered the starting place for the most substantial and economical emissions cuts. U of T's Project LEAP, which involves significant retrofits, is estimated to realize more than a 50 per cent emissions cut.

"I think the estimates are that you can reduce your energy consumption by 60 per cent just through conservation," says Jonathan Rausseo, senior specialist with the office of campus sustainability at the University of Ottawa. "Once we bring those numbers down, we can talk about things like renewable [energy technologies] and switching energy sources."

A series of retrofits between 2012 and 2013 at U of O's Morisset Library recaptured surplus heat generated by the building's computers and human occupants and redistributed it. The reengineered heating and cooling system, including heat pumps and heat-recovering thermal wheels, amounted to a 33 per cent cut in energy consumption but even better, a 106 per cent cut in heat needs, making it a net heat producer. A similar approach has been used with 10 other existing buildings on campus, leading some people at U of O to wonder if the facilities team views them as mere human batteries: "If you're running around too much, we will take the heat off of you and be like, 'Thank you, that's going back into the [heating] loop,'" Mr. Rausseo jokes.

Government policy, public and private investments, and provincial realities impact universities' options. Even if the costs can be absorbed, a switch to electrification through the provincial grid only improves the GHG picture if that power comes from sources that generally have lower emissions rates, as is often the case in B.C., Manitoba, Ontario, Quebec and Newfoundland and Labrador – provinces that run largely on hydroelectricity or, in Ontario's case, nuclear power. Financially speaking, the federal government's carbon price, which increases annually, incentives like feed-in tariff schemes that pay a premium to renewable energy generators

PHOTOS (LEFT TO RIGHT): SIMON FRASER UNIVERSITY; WILFRID LAURIER UNIVERSITY. ILLUSTRATION: CREATIVENERGY

A geothermal loop at **Bishop's University** in Sherbrooke, Que., has eliminated the use of heating oil and reduced the institution's natural gas consumption.

Saint Mary's University in Halifax has been replacing the south wall of its 22-storey Loyola Residence with an integrated solar panel, making it "the tallest integrated solar building in North America."

Cape Breton University launched the Gardiner Mines Wind Farm in 2016 in partnership with private company Natural Forces. CBU says the wind farm produces more electricity for the Nova Scotia power grid than the campus consumes.

Newfoundland's **Memorial University** has been working on converting its buildings from oil-heated to predominantly electric through a government-supported project. It is expected to cut emissions by nearly 30,000 tonnes.

looped into the province's energy grid, and investment programs like the Low Carbon Economy Fund and Canada Infrastructure Bank all encourage universities to make a change. Some universities have even developed "green revolving funds" that reinvest energy savings from one project back into the fund to pay upfront costs for the next.

While some universities have yet to announce clear targets and timelines for reductions, others are already copping awards for their efforts. The *Times Higher Education* Impact Rankings recently named the University of Victoria, the University of British Columbia and Simon Fraser University among its top five universities globally for climate action. Université Laval and Université de Sherbrooke have received high marks in the "air and climate" category along with the highest possible "platinum" rating (also earned by TRU) from the Sustainability Tracking, Assessment and Rating System, a benchmarking program run by the U.S.-based Association for the Advancement of Sustainability in Higher Education. Both U Laval and U de Sherbrooke are among a handful of Quebec universities that have also declared themselves "climate neutral" – Bishop's University did so this year preceded by École de technologie supérieure in 2021. Like the term "net zero" though, this does not mean they are emissions-free.

And anyway, Dr. Gilmore notes that "climate neutral" isn't "a well-constrained term." U Laval, reportedly the first Canadian university to publicly claim this term in 2015, emitted more than 20,000 tonnes in scope one and two emissions in 2020-21. But it balanced those emissions through nearly 12,000 tonnes offset via the 397-square-kilometre Montmorency Forest – which it manages on behalf of the Quebec government as a research site – and other offsets purchased from non-profit organizations.

François Gélineau, U Laval's vice-rector, international affairs and sustainable development, knows that claiming carbon neutrality using such offsets can be controversial with some critics – including some members of the university community – suggesting they let institutions off the hook without having to make real changes to business as usual. He also knows that the university hasn't stopped there.

"We've done a lot, we want to do more, and our aim is to reduce the offset to zero," says Dr. Gélineau, adding that "we need people to challenge us to keep going further – that's a good thing."

Even "net zero" plans come under fire for limiting themselves to scope one emissions – which some universities defend as being those they can best control – and sometimes scope two.

"It's become a little too easy for an organization to claim that it's net zero," says Patrick Cigana, senior adviser at Polytechnique Montréal's sustainability office. He is also the informal coordinator of a greenhouse gas emissions subcommittee of the Réseau universitaire québécois en développement durable, with a common interest in sustainability.

Seldom part of "net zero" plans, scope three emissions are produced indirectly through third-party products and services that support university activities and are harder to assess. A 2020 survey by the Canadian Association of University Business Officers revealed that most universities were measuring their scope one and two emissions but only 42 per cent were tracking scope three. And most of those institutions were encountering difficulties, such as inadequate access to good data, a lack of understanding of the process and inconsistencies around methodologies.

Facing a similar challenge, Mr. Cigana's subcommittee is trying to develop a common understanding among all Quebec universities for how to calculate and measure scope three emissions as well as which ones should be included in a "net zero" commitment.

"We all agree that our commitment has to include scope three because scope one and two are usually just a very small portion of our emissions, especially here in Quebec where nearly all our electricity is hydroelectric," he says. "Scope three can be anywhere from 30 to 80 per cent of GHG emissions in a university, so we can't just ignore it."

Offsets through controlled or purchased assets or activities that are supposed to contribute towards emissions removal are a common way for universities to balance out their remaining scope one and two emissions and neutralize scope three impacts like business travel. But as U Laval and other universities have encountered, they're controversial. Too often, offsets are "a license to continue business as usual," says Kate Ervine, who researches them as part of her work on the political economy of climate change mitigation at Halifax's Saint Mary's University.

PHOTOS (LEFT TO RIGHT): BISHOP'S UNIVERSITY; SAINT MARY'S UNIVERSITY

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True carbon offsets must represent a carbon reduction that would not have occurred otherwise, she says, a concept known as "additionality" because they would be in addition to what's already happening. The common practice of buying and selling offsets for forests that are not threatened is not that, she points out. And there can be "false equivalencies" between the carbon absorption capacity of a forest and an institution's scope one emissions. "We tend to get sold a narrative that our forests can soak it all up – it's not true," says Dr. Ervine. "Net zero is not zero. What I want is honest language."

In 2019, UBC calculated that air travel accounts for 17,694 tonnes of its scope three emissions compared to nearly 39,000 tonnes emitted from campus buildings and energy use. It has set a target of cutting these 2019 emissions levels by half by 2030, along with an overall plan to eliminate operational emissions by 2035. In response, a group of concerned UBC librarians developed an air travel decision tree. Ostensibly a tool to guide people's choices around work-related flying, in practice it's helping the librarians – whose career advancements are also influenced by the conferences they attend and present at – spark potentially culture-changing conversations with supervisors and others about how academic activities and standards can be restructured to align with climate action goals.

"We consider the document to be a safe space to consider these questions," says Elizabeth Stevenson, circulation supervisor at UBC's Woodward Library and current co-chair of the UBC Library Climate Action Team. Ms. Stevenson developed the tool with colleague Mathew Vis-Dunbar, data and digital scholarship librarian at UBC Okanagan. "We made it as neutral as possible and as accessible as possible because they can be really difficult, uncomfortable questions to ask."

Such examples speak to the value of dialogue and exchange – fundamental to university life – among all parties impacted by this great emissions transition, and to questioning the structures that underpin institutions and cultures and whether they are the right ones for our times. This, believes Dr. Gilmore, is where real change starts.

"Through the process of learning how to produce these structures, we learn more about how to produce these transformations," says Dr. Gilmore. "Where I start to get really excited is when the universities themselves, because of the nature of what we're being asked to do, start to change as well." UA

Moira MacDonald is an award-winning journalist and writer based in Toronto.

Net zero at work: glossary

Heat pump: These come in a variety of formats and sources and work like a refrigerator. The basic idea is that heat is extracted from a source – the air (even in winter!), the ground, water – and transferred to where it's needed via fluid circulating through a closed-loop system (open-loop systems are possible in some conditions). In winter, the heat is extracted and pumped indoors. In summer, it works in reverse – heat is extracted from inside and pumped out.

Geoexchange: This is a storage-based heat pump system. Heat is extracted from indoors and stored deep below the surface where the temperature remains around a constant 10 to 12 degrees Celsius. In winter, it works in reverse.

Geothermal loops: A series of pipes making up part of a geothermic heat pump system where thermal energy is extracted from deep below-ground, brought up to a usable temperature using electricity and circulated to where it's needed through a series of loops.

Zero-carbon building: Not a standardized term, though the Canada Green Building Council defines it as a building that is "highly energy-efficient and minimizes greenhouse gas emissions from building materials and operations." It allows carbon offsets as a counterbalance to any remaining emissions.