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CANADA'S INNOVATION LEADERS 2023



Solving Global Challenges Through Research Partnerships and Collaborations

Canadian researchers work across disciplines, sectors and borders to tackle everything from climate change and green energy to food security and environmental sustainability

By Debbie Lawes

The challenges facing humanity today are increasingly global, complex and interconnected. They are also beyond the capacity of any one scientist, institution or even country to solve.

That became abundantly clear during the COVID-19 pandemic when an unprecedented mobilization of thousands of scientists from around the world worked at breakneck speeds to develop a safe and effective vaccine. It took just two months from sequencing the DNA of the SARS-CoV-2 virus to clinical trials – the fastest in the history of vaccine development.

The concerted response to COVID-19 offers renewed hope that collaborating across disciplines, organizations and borders can develop solutions to other global challenges, from climate change and energy transition to food security and environmental sustainability. Canadian scientists and innovators from government, academia, the public sector and industry are key players in all these initiatives.

UNIVERSITY OF ALBERTA Preparing for the next pandemic

Canada was unprepared when the COVID-19 pandemic struck in March 2020. A dearth of vaccine manufacturing capacity, the exit of major pharma companies, and a lack of highly skilled workers all hindered the country's ability to respond quickly to the largest global health crisis in a century.

Not again. The federal government is investing \$570 million to strengthen Canada's pandemic preparedness with the creation of five new research hubs, including one led by the University of Alberta.

The PRAIRIE Hub brings together

experts, research facilities and training programs from the University of Alberta, in partnership with universities, government, and industry across Western Canada – all in a coordinated effort to accelerate the development and commercialization of vaccines, antivirals and diagnostics.

"To help Canada prepare for the next pandemic we needed a broad and robust approach, one that identifies our specific regional strengths and coordinates them into a cohesive national response. The hubs play a key role in this response," said Dr. Aminah Robinson Fayek, Vice-President (Research and Innovation) at U of A.

The U of A also houses the Striving for Pandemic Preparedness Research Consortium, which received \$55 million from the provincial government to create a made-in-Alberta vaccine and drug development pipeline. These initiatives bring together world-renowned experts in virology, diagnostics and antivirals, including Drs. Lorne Tyrrell, Michael Houghton, David Evans, Matthias Götze, Joanne Lemieux, and Chris Le, as well as researchers in public health and the social impacts of pandemics. Dr. Timothy Caulfield, for example, is a leader in dispelling COVID-19 misinformation and an important contributor to scientific literacy.

"On the infrastructure side, we also host Canada's largest biosafety Level 3 facilities for cell culture and pre-clinical animal studies, and the Canadian Critical Drug Initiative, a new biomanufacturing facility that will produce critically needed drugs and create hundreds of jobs in the next four years," said Fayek.

Preparing for the next pandemic requires a new perspective – one that acknowledges the human-animal-environment connection in infectious diseases, she added.

"The PRAIRIE Hub has a unique strength in this "One Health" approach, recognizing the importance of these relationships and the need to act collaboratively, at local, national, and global levels, in providing protection from future pandemics."

“Thanks to the BMC, we launched the first clinical trial of made-in-Canada CAR-T therapy in 2019. That trial has saved more than a dozen lives so far, and we are now expanding it across the country.”

DR. DUNCAN STEWART
Executive Vice-President of Research, The Ottawa Hospital

OTTAWA'S BIOTHERAPEUTICS MANUFACTURING CENTRE

Bringing life-saving therapies to patients faster

Translating scientific discovery into life-saving therapies can be notoriously slow, often taking 10 to 20 years. The Ottawa Hospital is cutting that time in half with a translational accelerator program that includes a world-class facility that turns biological materials such as genes, cells and viruses into new therapies.

"Over the last five years, there has been an unprecedented surge in demand for biomanufacturing to produce innovative treatments for cancer, cardiovascular disease, neurological disease and other conditions," said Dr. Duncan Stewart, a senior scientist in regenerative medicine and Executive Vice-President of Research at The Ottawa Hospital.

The Biotherapeutics Manufacturing Centre (BMC) was launched 16 years ago to help meet that demand. Since then, it has manufactured more than 20 different biotherapies and vaccines for human clinical trials in Canada, the

U.S., Europe and Asia. It also produced a promising cellular therapy for COVID-19 within a few months at the height of the pandemic.

"BMC is unique because our biomanufacturing facility is embedded within a research hospital, and because we're the only such facility with a track record of both virus and cell manufacturing," explained Stewart.

For example, the BMC is the only Canadian facility capable of manufacturing clinical-grade viruses that can reprogram a patient's immune cells to recognize and kill their cancer.

"Thanks to BMC, we launched the first clinical trial of made-in-Canada CAR-T therapy in 2019. That trial has saved more than a dozen lives so far, and we are now expanding it across the country," said Stewart.

Collaborations have been key to the BMC's success. Over the past five years, it has partnered with cell manufacturing

Research Chair in Decolonial Futures at Lakehead University. Dr. Lana Ray and her team, including Dr. Anna Koné, Associate Professor in Lakehead's Department of Health Sciences, have partnered with traditional knowledge holders and Waasgeiizhig Nanaandawe'iyewigamig Health Access Centre (WNHAC), an Indigenous health clinic in Kenora, Ont.

The project explores cancer as a symptom of colonialism, and how traditional healing, on its own and/or integrated with Western medicine, can reduce cancer risks.

"The health problems that resulted from colonialism are far reaching, whether from intergenerational trauma, poverty or a western diet. This project is looking at how to reverse some of those risk factors by exploring how traditional healing can protect against the impacts of colonialism for Indigenous people in Kenora," said Dr. Andrew P. Dean, Vice-President, Research and Innovation at Lakehead University.

The project supports one of the Truth and Reconciliation Commissions calls to action: to recognize the value of Indigenous healing practices and use them in the treatment of Indigenous patients in collaboration with Indigenous healers and Elders.

"I don't know of another project like this," said Dean. "It's a new area of study, and an under-researched one."

As a northern university, Lakehead has strong links with local Indigenous communities. For example, last year's launch of the Anishinaabe Kendaasiwin Institute (AKI) (loosely translated to "Anishnaabe knowledge systems") seeks to privilege Anishinaabe ways of knowing and being in research, to advance research excellence defined by Anishinaabe peoples and principles, to expand and support Indigenous governed and driven research, and to support community building and mobilization between Indigenous peoples.

Ray is also the Director of AKI. "AKI was founded on the premise that if research is done right, it can play an important role in advancing the visions and needs of Indigenous peoples and lands," she said in a release announcing the new institute. "We at AKI are committed to engaging in research that is relevant to Indigenous peoples and meets Indigenous defined ethical standards."

facilities in Alberta and British Columbia, BioCanRx and the National Research Council. More recently, it played a key role in creating the Canadian Pandemic Preparedness Hub (CP2H), which brings together industry, academia, healthcare, and government to move discoveries into clinical practice – quickly and cost-effectively.

"Our hub is particularly strong in biomanufacturing, which is the biggest gap in this process," said Stewart. "We have an incredible opportunity right now to expand BMC as part of The Ottawa Hospital's new campus and solidify Ottawa's role as a leading destination for health innovation and early-phase clinical trials."

LAKEHEAD UNIVERSITY Decolonizing cancer care

Cancer is among the leading causes of death for First Nations people in Canada.

Traditional healing could help to reverse this worrying trend.

That's the idea driving a five-year, \$1.2-million project led by the Indigenous

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UNIVERSITY OF CALGARY
Start something.

At UCalgary, we're **pushing the boundaries of discovery** to tackle global challenges and maximize impact through collaborative transdisciplinary approaches.

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UNIVERSITY OF
WATERLOO



UNLOCKING SOLUTIONS FOR A SUSTAINABLE FUTURE.

ON IT.

The Sustainable Futures initiative at the University of Waterloo is accelerating new collaborations to propel research in climate, clean energy and water. As a keeper of a substantial portion of the earth's natural resources, Canada has a leading role to play and Waterloo is working hard to drive solutions to protect and preserve our planet. From electric vehicle design and affordable energy storage to sustainable city planning, we're on it.

YOU+WATERLOO

Where there's a challenge, Waterloo is on it.

uwaterloo.ca/research/sustainable-futures



Canada's TOP 50 RESEARCH UNIVERSITIES 2023

Rank		University	Sponsored Research Income			Research Intensity		Tier*	Prov
2022	2021		FY2022 \$000	FY2021 \$000	% Change 2021-2022	\$ per Faculty \$000	\$ per Grad Student \$000		
1	1	University of Toronto ⁺	\$1,341,082	\$1,461,571	-8.2	\$483.1	\$62.7	M	ON
2	2	University of British Columbia	\$737,129	\$726,838	1.4	\$287.8	\$58.7	M	BC
3	3	McGill University	\$699,204	\$687,413	1.7	\$382.5	\$69.8	M	QC
4	4	Université de Montréal	\$660,041	\$682,369	-3.3	\$314.3	\$35.8	M	QC
5	5	University of Alberta	\$597,428	\$554,133	7.8	\$293.0	\$71.3	M	AB
6	7	University of Calgary	\$506,139	\$504,480	0.3	\$334.7	\$67.6	M	AB
7	6	Université Laval	\$469,362	\$515,077	-8.9	\$295.0	\$36.9	M	QC
8	8	University of Ottawa	\$432,275	\$432,676	-0.1	\$329.0	\$52.9	M	ON
9	9	McMaster University	\$369,861	\$374,609	-1.3	\$407.3	\$68.5	M	ON
10	15	Université de Sherbrooke	\$248,613	\$207,332	19.9	\$192.4	\$22.8	M	QC
11	10	University of Saskatchewan	\$239,652	\$285,434	-16.0	\$233.8	\$66.5	M	SK
12	11	Western University	\$232,620	\$264,426	-12.0	\$150.9	\$31.7	M	ON
13	12	University of Manitoba	\$210,975	\$231,904	-9.0	\$173.2	\$52.4	M	MB
14	14	University of Waterloo	\$196,267	\$221,029	-11.2	\$160.6	\$30.4	C	ON
15	16	Dalhousie University	\$190,796	\$183,746	3.8	\$154.4	\$46.2	M	NS
16	13	Queen's University	\$182,607	\$227,337	-19.7	\$213.1	\$27.1	M	ON
17	18	Memorial University of Newfoundland	\$175,792	\$176,069	-0.2	\$182.9	\$42.9	M	NL
18	17	University of Guelph	\$163,541	\$182,768	-10.5	\$194.2	\$52.1	C	ON
19	20	University of Victoria	\$146,650	\$123,708	18.5	\$188.3	\$48.1	C	BC
20	19	Simon Fraser University	\$141,177	\$171,611	-17.7	\$154.6	\$29.5	C	BC
21	21	York University	\$111,459	\$105,541	5.6	\$79.3	\$17.3	C	ON
22	24	Université du Québec à Montréal	\$92,436	\$88,212	4.8	\$83.3	\$10.6	C	QC
23	23	Carleton University	\$90,238	\$97,431	-7.4	\$101.2	\$20.4	C	ON
24	25	Concordia University	\$87,452	\$75,782	15.4	\$100.4	\$12.4	C	QC
25	22	Toronto Metropolitan University	\$85,491	\$102,357	-16.5	\$92.2	\$28.1	C	ON
26	26	Institut national de la recherche scientifique	\$80,361	\$69,829	15.1	\$505.4	\$105.2	S	QC
27	27	University of New Brunswick	\$54,420	\$55,666	-2.2	\$117.3	\$27.6	C	NB
28	28	Université du Québec à Trois-Rivières	\$47,480	\$44,077	7.7	\$102.1	\$14.0	U	QC
29	29	École de technologie supérieure	\$42,385	\$37,733	12.3	\$196.2	\$16.6	S	QC
30	34	Laurentian University	\$39,784	\$25,238	57.6	\$167.2	\$40.0	U	ON
31	31	Université du Québec à Rimouski	\$36,144	\$35,930	0.6	\$168.9	\$28.0	U	QC
32	30	University of Windsor	\$34,831	\$37,069	-6.0	\$69.2	\$7.1	C	ON
33	33	Université du Québec à Chicoutimi	\$34,158	\$29,054	17.6	\$126.0	\$15.3	U	QC
34	32	University of Regina	\$31,649	\$31,259	1.2	\$73.1	\$14.7	U	SK
35	35	Lakehead University	\$23,887	\$24,395	-2.1	\$65.6	\$16.6	U	ON
36	37	Ontario Tech University	\$22,858	\$21,170	8.0	\$95.2	\$24.1	U	ON
37	36	Université du Québec en Abitibi-Témiscamingue	\$19,959	\$22,837	-12.6	\$134.0	\$23.9	U	QC
38	38	Wilfrid Laurier University	\$18,777	\$20,813	-9.8	\$34.5	\$7.8	U	ON
39	39	University of Lethbridge	\$17,821	\$18,184	-2.0	\$53.5	\$25.3	U	AB
40	42	University of Northern British Columbia	\$17,718	\$15,153	16.9	\$86.9	\$26.0	U	BC
41	41	University of Winnipeg	\$16,612	\$15,419	7.7	\$55.0	\$61.8	U	MB
42	40	Brock University	\$16,292	\$16,561	-1.6	\$28.1	\$9.2	U	ON
43		Royal Military College of Canada ⁺⁺	\$14,843	\$13,050	13.7	\$73.8	\$22.9	U	ON
44	43	Trent University	\$13,051	\$13,838	-5.7	\$45.6	\$16.2	U	ON
45	45	Saint Mary's University	\$12,123	\$12,340	-1.8	\$43.8	\$16.3	U	NS
46	47	Université du Québec en Outaouais	\$12,028	\$11,434	5.2	\$48.5	\$8.5	U	QC
47	46	Université de Moncton	\$10,610	\$11,659	-9.0	\$31.5	\$17.3	U	NB
48	44	University of Prince Edward Island	\$10,586	\$12,875	-17.8	\$37.7	\$20.9	U	PE
49		Thompson Rivers University	\$8,538	\$6,571	29.9	\$50.5	\$9.8	U	BC
50	50	Université TÉLUQ	\$8,406	\$6,757	24.4	\$65.2	\$6.9	U	QC

Notes:

- Sponsored research income includes all funds to support research received in the form of a grant, contract or contribution from all sources external to the institution.
 - Financial data were obtained from Statistics Canada, except where noted.
 - Fiscal 2021 figures may have been adjusted as more accurate information became available.
 - Faculty headcounts for academic year 2021-2022 were used to calculate Research Intensity-\$ per Faculty. Includes full/part-time: full, associate and assistant ranks as provided/available. Data were obtained from Research Infosource's Canadian University R&D Database.
 - Graduate student enrollment headcounts for academic year 2021-2022 were used to calculate Research Intensity-\$ per Graduate Student. Includes full and part-time students enrolled in graduate level (master's and doctorate) programs and courses leading to degrees, certificates or diplomas. Excludes students enrolled in health-related internships/residencies and first professional programs. Data were obtained from Maritime Provinces Higher Education Commission, Ministère de l'Éducation et de l'Enseignement supérieur, Ontario Ministry of Advanced Education and Skills Development, Manitoba Advanced Learning Division, Alberta Advanced Education, BC HEADSet and some individual universities.
 - All data are provided for the main university including its affiliated institutions, where applicable.
 - All main institutions are members of the Canadian Association of University Business Officers (CAUBO).
- *Tier: M - Medical, C - Comprehensive, U - Undergraduate, S - Specialized (not full-service)
⁺Sponsored research income administered by affiliated hospitals was reported one fiscal year in arrears
⁺⁺Sponsored research income figures were obtained directly from the university
- Research Infosource Inc. is Canada's source of R&D intelligence. For further information, please visit researchinfosource.com

Research Universities of the Year 2023

Three universities gain Research Infosource's designation of *Research University of the Year* in their category for their performance on a balanced set of input and output measures. These full-service universities demonstrated superior performance on key measures of research success.

Rank	Medical	Score*	Rank	Comprehensive	Score*	Rank	Undergraduate	Score*
1	University of Toronto	96.9	1	University of Waterloo	94.5	1	Ontario Tech University	81.4
2	McGill University	88.1	2	University of Guelph	86.4	2	University of Regina	80.5
3	University of British Columbia	78.1	3	University of Victoria	80.9	3	Lakehead University	73.3

*The score in each category is out of a possible 100 points based on the following measures and weighting: total sponsored research income (20%), research intensity per faculty (20%), research intensity per graduate student (10%), total number of publications in leading journals (20%), publication intensity (20%) and publication impact (10%). For each measure in each category, the top ranking institution was assigned a score of 100 and the other institutions' scores were allocated points and calculated based on their ranking positions. See www.researchinfosource.com for details.

CANADA'S TOP 50

Research Universities

Research Income Plummetts

Research income at *Canada's Top 50 Research Universities* declined by -2.6%, between Fiscal 2021 and Fiscal 2022 to a combined \$9.05 billion. This is only the second time in more than 20 years that the Top 50 universities reported a decline in overall research income. (The previous time was in Fiscal 2014, when research income fell by -1.6%.) Research income expanded at 24 universities and declined at 26 others. In FY2022, average faculty research intensity – research income per faculty member – was \$219,100, a decrease of -3.8% over FY2021. Graduate student research intensity – research income per graduate student – was \$39,600, a decline of -7.6%.

The FY2022 result was mainly due to a significant drop in Total Federal Government funding (down -9.3% to \$4.33 billion). Research funding received from SSHRC (down -23.6% to \$352.5 million), NSERC (down -11.8% to \$925.8 million) and CIHR (down -0.1% to \$1.17 billion) all shrank. However, funds received from CFI increased over the period (up 7.9%). Total Provincial Government research funding also was up this year by 5.6% to \$1.28 billion mainly due to increased funding from the British Columbia and Quebec Governments (up 17.3% and 14.2% respectively). In contrast, funding from the Ontario Provincial Government was down significantly (-12.5%). Research funding from Municipal and Foreign Governments both reversed themselves in FY2022, returning to positive growth of 45.3% and 23.0% respectively. Corporate research funding continued to disappoint, falling by -3.2% to \$1.06 billion year-on-year. Not-for-Profit funding, however, was a bright spot, increasing by 8.3% to \$1.76 billion.

\$100 Million Club

Research Infosource salutes the 21 universities that gained membership in the prestigious *\$100 Million Club* – institutions that attracted \$100 million or more of research income in FY2022. However, the disappointing Top 50 overall situation was mirrored in Club members' results; their combined research income dropped by -4.4% during the period, more than the national average. Research income fell at 13 of the Club institutions. Additionally, with one university dropping off, the remaining members' share of Top 50 research income dropped to 89% of the total in FY2022 from 91% in FY2021.

University Tiers

The combined research income at the 16 Medical universities fell by -3.0% to \$7.29 billion in FY2022, as did the research income at the 11 Comprehensive universities (down -4.5% to \$1.20 billion). Research income at 21 Undergraduate institutions on the other hand, posted an overall increase of 6.0% to \$433.3 million and accounted for 5% of the total, up from 4% in FY2021.

The top universities in each tier as measured by research income were: University of Toronto (Medical tier, \$1.34 billion, 1st place overall), University of

Waterloo (Comprehensive tier, \$196.3 million, 14th overall) and Université du Québec à Trois-Rivières (Undergraduate tier, \$47.5 million, 28th overall).

Research Income Growth

Overall, in FY2022, 24 universities recorded gains in research income versus 26 where research income dropped. This compares with FY2021 when 45 universities posted research income growth versus only five where research income fell.

The Medical tier leader standout on research income growth was Université de Sherbrooke (19.9%). University of Victoria led the Comprehensive tier (18.5%) and Laurentian University was the Undergraduate tier and overall research income growth leader (57.6%).

Faculty Research Intensity

In FY2022, faculty research intensity – research income per faculty position – was \$219,100, down -3.8% from FY2021. The leading full-service university winners included: University of Toronto (Medical), which topped the ranking for faculty research intensity (\$483,100 of research income per faculty) and was joined by other tier leaders University of Guelph (Comprehensive, \$194,200) and Université du Québec à Rimouski (Undergraduate, \$168,900).

Graduate Student Research Intensity

Graduate student research intensity – research income per graduate student – was also down -7.6% in FY2022. On average, Top 50 graduate student research intensity was \$39,600, compared to \$42,800 in FY2021. Winners by category were: University of Alberta (Medical tier \$71,300 research income per graduate student), University of Guelph (Comprehensive tier, \$52,100) and University of Winnipeg (Undergraduate tier, \$61,800).

Provincial Performance

In FY2022, 18 Ontario universities attracted 37% (\$3.39 billion) of the national research income total, down from 39% in FY2021. Quebec's 14 institutions garnered 28% (\$2.54 billion) of the Top 50 total, up from 27% the year prior. Three Alberta universities had 12% of research income (\$1.12 billion), the same proportion of the total as in FY2021. British Columbia's five institutions also attracted 12% of all research income (\$1.05 billion), up from 11% in FY2021.

Disappointingly, 14 out of the 18 universities in Ontario saw their overall Ontario research income decline in FY2022, posting a combined -6.9% decrease over FY2021. Although only three out of the 14 institutions in Quebec reported negative research income growth, their combined growth was up just 1.0% over the year prior. Alberta's institutions posted a combined 4.1% growth over FY2021. In British Columbia the combined research income growth was virtually flat over the year prior (0.7%), as was the combined research income for the six universities located in Atlantic Canada (0.4%).

Top Universities by Tier FY2022					
Research Income			Research Income Growth (% Change FY2021-FY2022)		
Rank	Medical	\$000	Rank	Medical	%
1	University of Toronto	\$1,341,082	1	Université de Sherbrooke	19.9
2	University of British Columbia	\$737,129	2	University of Alberta	7.8
3	McGill University	\$699,204	3	Dalhousie University	3.8
Rank	Comprehensive	\$000	Rank	Comprehensive	%
1	University of Waterloo	\$196,267	1	University of Victoria	18.5
2	University of Guelph	\$163,541	2	Concordia University	15.4
3	University of Victoria	\$146,650	3	York University	5.6
Rank	Undergraduate	\$000	Rank	Undergraduate	%
1	Université du Québec à Trois-Rivières	\$47,480	1	Laurentian University	57.6
2	Laurentian University	\$39,784	2	Thompson Rivers University	29.9
3	Université du Québec à Rimouski	\$36,144	3	Université TÉLUQ	24.4
Faculty Research Intensity (\$ per Faculty)			Graduate Student Research Intensity (\$ per Graduate Student)		
Rank	Medical	\$000	Rank	Medical	\$000
1	University of Toronto	\$483.1	1	University of Alberta	\$71.3
2	McMaster University	\$407.3	2	McGill University	\$69.8
3	McGill University	\$382.5	3	McMaster University	\$68.5
Rank	Comprehensive	\$000	Rank	Comprehensive	\$000
1	University of Guelph	\$194.2	1	University of Guelph	\$52.1
2	University of Victoria	\$188.3	2	University of Victoria	\$48.1
3	University of Waterloo	\$160.6	3	University of Waterloo	\$30.4
Rank	Undergraduate	\$000	Rank	Undergraduate	\$000
1	Université du Québec à Rimouski	\$168.9	1	University of Winnipeg	\$61.8
2	Laurentian University	\$167.2	2	Laurentian University	\$40.0
3	Université du Québec en Abitibi-Témiscamingue	\$134.0	3	Université du Québec à Rimouski	\$28.0

Note: Based on full-service universities on the 2023 Top 50 Research Universities list.

Research Universities of the Year

Research Infosource has designated 3 institutions as *Research Universities of the Year 2023* in their respective categories: University of Toronto (Medical), University of Waterloo (Comprehensive) and Ontario Tech University (Undergraduate). These institutions demonstrated superior performance on key measures of research success.

This Year and Next

There is no way to sugar-coat the FY2022 result; university research funding had a very bad year, only the second time in recent memory where funding declined. Some of this can perhaps be attributed to a tapering of emergency research funding in response to COVID-19. Regardless, combined with rising inflation across the economy, that can only mean a sharp drop in purchasing power for the available resources.

Funds received from the Federal Government fell sharply. Federal granting agency funding was down by -6.6% in total and by -8.7% considering only the three core funding agencies (i.e., excluding the Canada Foundation for Innovation). CFI funding was up by 7.9%. Funding through the Canada Research Chairs program was down by -11.2%. Social Sciences and Humanities Research Council outlays – which include a substantial element of Tri-Council money – fell a hefty -23.6%.

Funding of university research by Corporations was down by -3.2%, on the heels of a drop of -4.1% the prior year. This can only bode poorly for the country's long-term economic prospects.

Provincial research funding results – an overall rise of 5.6% – masked a deep divide. Whereas research

Top 50 – Leading Provinces

Province	% of Total
Ontario (18)	37
Quebec (14)	28
Alberta (3)	12
British Columbia (5)	12

funding available to its universities through the Province of British Columbia jumped by 17.3% and Quebec Government funding was up 14.2%, Ontario Government funding declined a precipitous -12.5%. Alberta Government funding rose by a modest 3.5%.

The only "winners" in FY2022 were the Undergraduate universities, where research income rose by a combined 6.0% in total, versus declines of -3.0% at the Medical universities and -4.5% at the Comprehensive institutions.

In short, little went right on the research funding scene last year and much of that is down to the Federal Government. So, recent cries for more funds from many university presidents are strongly grounded. At this stage new funding is needed simply to address the funding deficit. However, these calls come against the backdrop of pressure to reduce federal spending, not increase it.

Needless to say, governments are facing many competing funding demands from different parts of society. It will be interesting to see whether next year's budget will prioritize university research funding or whether universities are in for a new era of belt tightening.

Leading the way to health equity



At Toronto Metropolitan University, we are applying a critical lens to break down barriers within our health and social systems. And we are partnering with communities in various ways to create a holistic, equitable health-care system for all.

Toronto Metropolitan University

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PARTNER PERSPECTIVE



Dr. Steven N. Liss
Vice-President
Research and Innovation
Toronto Metropolitan University

As we navigate the complexities of an ever-evolving global landscape, the role of science diplomacy has become increasingly crucial in fostering collaborative research initiatives that transcend borders. A paradigm shift toward community-engaged and inclusive research practices has taken root, emphasizing the importance of involving diverse perspectives for comprehensive problem-solving.

Toronto Metropolitan University's (TMU) researchers actively engage in cross-cultural collaborations, recognizing that complex challenges require diverse perspectives and collective action. Through these partnerships, TMU is not only contributing to the global knowledge pool but also fostering diplomatic relations that extend beyond the realm of politics, emphasizing shared humanity in the pursuit of scientific understanding.

Led by **Dr. Anna Triandafyllidou**, TMU's Canada First Research Excellence Fund program, Migrant Integration in the Mid-21st Century: Bridging Divides, leverages national collaboration with partners Concordia University in Montréal, the University of Alberta and the University of British Columbia. This \$98.6 million program brings together 25 research leaders and more than 200 organizations seeking scalable solutions to build a new understanding of

Creating an inclusive future through global partnerships

the challenges and opportunities that migrant integration poses for Canada and the world.

Another collaboration showcasing TMU's dedication to wielding science as a tool for positive global impact is the work of **Dr. Carolyn Johns**, who is co-leading a U.S. – Canada research team to establish the Global Center for Understanding Climate Change Impacts on Transboundary Waters. This joint research project with the University of Michigan and McMaster University was awarded more than \$10 million to research climate change impacts, in particular on vulnerable communities.

TMU's inclusive research practices extend beyond traditional academic boundaries, fostering partnerships with community organizations, businesses and policymakers. This holistic approach ensures research outcomes have practical applications and contribute to the well-being of the communities involved. **Dr. Mandana Vahabi**, Co-Director of the Centre for Global Health and Health Equity, recently received the Canadian Cancer Research Alliance's Distinguished Service to Cancer Research award for her pioneering, innovative and impactful research in often underfunded areas and for highlighting the importance of integrating research into practice, particularly for underserved communities in Canada and India.

Research is strengthened by a willingness to cross disciplinary boundaries, break down barriers, build alliances and take risks to advance inquiry, discovery and knowledge. This need is especially evident in rapidly developing fields, like quantum computing,

which are changing the way we live and work. TMU is developing training to equip a workforce capable of harnessing the potential of quantum technologies through a collaboration with Xanadu, which allows TMU students and researchers to access world-class quantum computing hardware and software to explore and develop novel software applications.

Quantum technologies will play a significant role in how our future cities are planned and operated. TMU is poised to make significant strides in leveraging technology to manage networked transportation systems, smart infrastructure and energy grids. The Centre for Urban Energy (CUE), led by **Dr. Bala Venkatesh**, takes an academic-industry partnership approach to deliver novel, tangible, sustainable and affordable solutions to the pressing energy problems of today – and tomorrow. CUE has partnerships that span the globe from South America, Europe and Asia, and they work collaboratively and inclusively with an international group of experts to develop real-world, deployable clean energy solutions.

In an era where the challenges facing humanity are inherently global, collaborative research can contribute to science diplomacy to build bridges between nations and foster an environment where researchers from diverse backgrounds can unite to address shared challenges. By fostering partnerships between researchers and communities, we can enhance the relevance and applicability of research outcomes, ensuring they address real-world challenges and contribute positively to societal well-being.

Uvic

CLEAN ENERGY FOR COMMUNITIES

Accelerating Community Energy Transformation (ACET) is moving Canada closer to a net-zero future by supporting local, place-based clean energy transitions, one community at a time. uvic.ca/ACET



This research was undertaken thanks in part to funding from the Canada First Research Excellence Fund.

Think and live green

Groundbreaking innovations

At the Multiscale Research Complex in Hydrology, Hydraulics, and Environment—the first in North America—we go with the flow. We are **developing innovative solutions to meet planetary challenges ranging from better flood prediction** to improving water quality here in Canada and in the rest of the world.

The world's first star in sustainable development

With outstanding research practices and an impressive amount of action to inspire and propel our societies to greener heights, it's no wonder that **UdeS is breaking records and topping the prestigious international STARS ranking.**



See the vitality of our research for yourself

UDS Université de Sherbrooke

LEADERS' CORNER



At the University of Waterloo, we have prioritized our research into areas where we can play a critical role for maximum impact with an eye to the future. Our strategic Futures Framework focuses on economic futures, health futures, societal futures, sustainable futures and technological futures.

Charmaine B. Dean
Vice-President, Research and International
University of Waterloo



Moving our research out of our labs and into the hands of those who can put it to its best use is core to our mission. Our entrepreneurial culture is driving commercialization and has positioned our start-ups for success – creating jobs, diversifying the economy and helping to keep Canada competitive.

Andy Knights
Vice-President, Research (Acting)
McMaster University



Carleton University's research-intensive approach to critical issues includes taking a leadership role in climate change adaptation, sustainability and energy efficiency. They are some of our greatest strengths. Our award-winning faculty and researchers are contributing innovative solutions to assure a better future for Canada and the world.

Rafik Goubran
Vice-President (Research and International) and Chancellor's Professor
Carleton University



More than ever, universities have a critical role to play as sites for discovery and as beacons of truth in our society. McGill's researchers are advancing and mobilizing their knowledge to address some of the world's most pressing challenges, from improving treatments and outcomes for rare diseases and cancer, to building more sustainable technologies and communities. Together, these efforts are contributing to a healthier, more innovative future for all.

Deep Saini
Principal and Vice-Chancellor
McGill University



Toronto Metropolitan University researchers are accelerating research to meet pressing challenges. By building on our expertise and strategic strengths, we bring focus to fundamental questions and adapt rapidly to a changing world in an era of disruptive technologies and intractable global problems.

With our partners, we are advancing innovation in critical areas, including health and biomedical technologies, immigration, energy transitions and cybersecurity. We are developing solutions with a focus on technological and social dimensions to promote an inclusive future for communities and all Canadians.

Dr. Steven N. Liss
Vice-President, Research and Innovation
Toronto Metropolitan University



The University of Ottawa is a leader in the Canadian research and innovation ecosystem. The world-first collaborative Brain-Heart Interconnectome program, together with our future Advanced Medical Research Centre and stellar research projects conducted with all our affiliated hospital research institutes, will transform the health of Canadians and generate new lifesaving treatments. With industry-university partnership in AI and cybersecurity, we are also instrumental in strengthening the competitiveness and success of our country.

Sylvain Charbonneau
Vice-President, Research and Innovation
University of Ottawa



Lakehead University is proud to rank in the top three Research Universities of the Year and as #1 in not-for-profit research income spotlight in the undergraduate category. Through partnerships and community connections, our researchers make an impact locally and globally to tackle the pressing issues of today, including healthcare inequities, food insecurity, housing access, and climate change.

Dr. Andrew P. Dean
Vice-President, Research and Innovation
Lakehead University



At Queen's, we are focused on creating the right conditions for research to thrive. From support for major science facilities to opportunities for early-career researchers and HQP, investing in research is investing in people. And it's these people who, through partnership and collaboration, will position Canada to tackle the world's most pressing challenges.

Dr. Nancy Ross
Vice-Principal Research
Queen's University



Ontario Tech University is delighted to be named Research University of the Year among Canada's undergraduate universities for 2023. This achievement is a reflection of the tremendous strides our university has made in research intensity and industry partnerships. The strengths of our faculty members along with unique labs and facilities offer great opportunities for partners to invest in research and development that will grow Canada's economy.

Les Jacobs, PhD, FRSC, ICD
Vice-President, Research and Innovation
Ontario Tech University



Through purposeful collaboration, Generator at Sheridan drives innovation and meaningful impact for an ever-changing world. Our researchers engage with passion and creativity, and Sheridan continues to receive recognition as a national leader in partnering with industry and community.

Andrea England
Vice Provost, Research
Sheridan College



The Centre for Biodiversity Genomics (CBG) is transforming biodiversity science by integrating DNA sequencing, digital imaging, and informatics. Before 2050, the CBG and its global research network will fully inventory multicellular species and launch a global biomonitoring system to support humanity in addressing the biodiversity crisis.

Dr. Paul Hebert, OC, FRSC
CEO & Canadian Research Chair in Molecular Biodiversity
Centre for Biodiversity Genomics,
University of Guelph



At the University of Alberta our eyes are on the future. From advancing solutions in energy and environment, artificial intelligence, health and well-being to forging new paths in Indigenous research, agriculture and food, and social transformations our expertise is being brought to bear on today's most pressing global issues. United with partners in industry, academia and government, we are ready to move Forward with Purpose.

Aminah Robinson Fayek
Vice-President, Research and Innovation
University of Alberta



One of the largest and most diverse universities in Canada, York University is a driving force for positive change. Through a new Strategic Research Plan 2023-2028 focused on purposeful research and socially responsible innovation, York is committed to collaborative and interdisciplinary research excellence with global reach and positive community impact.

Amir Asif
Vice-President
Research & Innovation
York University



Academic partnerships are crucial in tackling green economy priorities. Lambton is leading these efforts, notably through the Canadian Bio-Cleantech Applied Research Network and the Canadian Material Circular Economy Syndicate. These initiatives drive innovation, commercialization, and job creation in Canada's growing cleantech sector, aligning with national environmental goals.

Dr. Mehdi Sheikzadeh
Senior Vice-President, Research & Innovation
Lambton College



eCampusOntario is thrilled to support collaborative innovation partnerships between Ontario businesses and the province's colleges, universities and Indigenous Institutes. The Ontario Collaborative Innovation Platform (OCIP) helps businesses remain at the forefront of their sector while giving students valuable work experiences, ensuring Ontario's innovation capacity is stronger for tomorrow.

Dr. Robert Luke
Chief Executive Officer
eCampusOntario

Decoding the Cosmos

Building on our Nobel Prize-winning research in neutrino science, we're seeking to unlock the mysteries of the universe – from dark matter to anti-matter.

With experiments connecting experts across the globe, researchers at the **Arthur B. McDonald Canadian Astroparticle Physics Research Institute** are working at SNOLAB, one of the world's most unique scientific facilities, to investigate the biggest questions in astroparticle physics, cosmology, and astronomy.

Canada is leading galactic-sized science with global impact.



queensu.ca/solving-tomorrow-today



SNOLAB. CFI Major Science Initiatives funding announcement.
Photo: Gerry Kingsley

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UNIVERSITY *of* GUELPH



Leading change through
education and innovation

Discover how our research
is building a sustainable future

Get Future Ready



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From idea to impact



We partner for innovation

The University of Ottawa plays a pivotal role in the Canadian innovation ecosystem.

Whether it's by launching the Advanced Medical Research Centre, fostering collaboration between academia, industry and government to quickly generate new lifesaving treatments, or bringing advances in AI and cybersecurity to Kanata North, we are instrumental in strengthening the competitiveness and success of our country.



Découvrez nos activités d'innovation



Learn more about innovation at uOttawa



Our reputation *speaks* for itself.

Providing solutions to the issues of today through trusted research grounded in evidence and action—Lakehead University is uniquely positioned to push the boundaries of research and effectively enact change regionally, nationally, and globally.

By fostering collaborations with industry, community, academic, government, and Indigenous partners, Lakehead researchers drive discoveries and innovations that contribute to more sustainable, prosperous, and healthy communities.



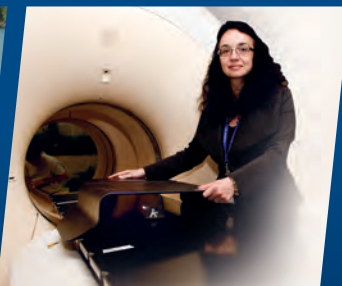
OUR RESEARCH PRIORITIES



CULTURES, SOCIETIES, AND SOCIAL JUSTICE



FIRST NATIONS, MÉTIS, AND INUIT RESEARCH



HEALTH AND WELL-BEING



INFORMATICS, NEW MATERIALS, AND TECHNOLOGIES



SUSTAINABILITY, RESOURCES, AND THE ENVIRONMENT

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Lakehead UNIVERSITY

PARTNER PERSPECTIVE

UP TO THE CHALLENGE: Shaping a brighter future through research, innovation and collaboration



Dr. Shayan Sharif
Interim Associate Vice-President
(Research)
University of Guelph

As Canada's Food University, the University of Guelph recognizes the crucial role our local and global food systems play in addressing many of the world's greatest challenges: improving food security; reducing antimicrobial resistance; and controlling the emergence of new animal diseases, many of which can spill over to humans, causing epidemics or even pandemics.

Through our holistic approach to agri-food research and innovation, we lead the way in delivering evidence-informed solutions that span the entire food system – from field to fork. This holistic, evidence-informed approach is core to our institutional commitment to *Improve Life*.

Our world-class programs, including veterinary and agricultural sciences, extend U of G's long history of pioneering innovation by examining problems through a wide-angle lens: seeing the world as a multidimensional ecosystem and recognizing the relationships among humans, non-human animals and the environment. Today,

this comprehensive framework is known as the One Health approach. One Health brings together experts and perspectives from multiple disciplines – including social sciences and humanities – to collaborate and deliver comprehensive solutions for these critical issues.

U of G established the One Health Institute in 2019 to propel inter- and trans-disciplinary research while creating programs for training the next generation of One Health thought leaders. These future leaders learn how to integrate both the scientific and the socio-cultural aspects of health at the interface of animals, humans and the environment.

Our students have the unique opportunity to learn directly from leading experts who actively collaborate at the highest international levels to address our planet's most complex challenges. For example, Dr. Scott Weese, professor at the Ontario Veterinary College and director of U of G's Centre for Public Health and Zoonoses, serves on the Global Leaders Group on Antimicrobial Resistance. Recently, Dr. Evan Fraser, professor in the College of Social and Applied Human Sciences and director of the Arrell Food Institute, was appointed to a United Nations steering committee on world food security. Engaged learning for our students and global impact for our researchers reflect U of G's ability to work not only across academic disciplines but also with government and industry partners.

As one of U of G's most longstanding and significant research partnerships, the Ontario Agri-Food Innovation Alliance is a leading example

of what government and academia can accomplish by working together. The Alliance brings together the Government of Ontario, the Agricultural Research Institute of Ontario and U of G to deliver Ontario agri-food solutions with global impact. This partnership leverages U of G's global leadership in agricultural, food and veterinary sciences to deliver world-class training, laboratory services, research and veterinary programs. These initiatives fuel effective solutions to agri-food challenges and support farmers, processors, business and communities in Ontario, in Canada and around the world.

Through our dedication to academic and research excellence and our commitment to meaningful collaboration, U of G delivers agri-food innovations that truly make a difference. From new disease-resistant varieties of soybeans to naturally healthier dairy cattle that require fewer antibiotics, we help ensure a more resilient food system that bolsters domestic food production while reducing the risk of antimicrobial resistance.

At the University of Guelph, we are committed to meeting these grand challenges by remaining laser-focused on advancing research, education and partnerships that produce the next generation of innovators and innovations.

Dr. Shayan Sharif is an immunologist in the Ontario Veterinary College and interim associate vice-president research (agri-food partnership). He is internationally recognized for his work on avian influenza and animal-pathogen interactions.

PARTNER PERSPECTIVE



Martha Crago
Vice-Principal
Research and Innovation
McGill University

To accelerate research, the world needs international collaborations

Amid geopolitical complexity, Canada must continue to recognize the enormous benefits of conducting collaborative research that transcends disciplines and national boundaries. International research collaborations were essential in catalyzing the rapid response to COVID-19, and they remain critical to improving global health.

The Canada First Research Excellence Fund (CFREF), established by the Government of Canada in 2014, contributes enormously to a culture of mutually-funded partnered research in Canada. The CFREF has helped solidify Canada's knowledge leadership and is accelerating international scientific collaboration.

For example, the Helmholtz International BigBrain Analytics and Learning Laboratory (HIBALL), unites McGill with the Helmholtz Forschungszentrum Jülich as one of nine prestigious Helmholtz International Labs. Funded jointly by the Helmholtz Association and by Healthy Brains, Healthy Lives (HBHL) – a McGill-led CFREF initiative – HIBALL explores big data applications, notably AI, in neuroscience. HIBALL is combining brain data to build an ultra-high-resolution atlas of the brain's anatomy – its 'wiring' – and its functional organization.

Just as we need the whole machinery of data science to understand connectivity in the brain, we need diverse teams to tackle psychiatric disorders,

which are the leading cause of disability worldwide. The McGill-Douglas Max Planck Institute of Psychiatry International Collaborative Initiative in Adversity and Mental Health unites German and Canadian scientists to address this global health issue. Based on the strong, existing collaborations between these institutions, this first-of-its-kind international effort is researching the biological and environmental determinants of psychiatric disorders.

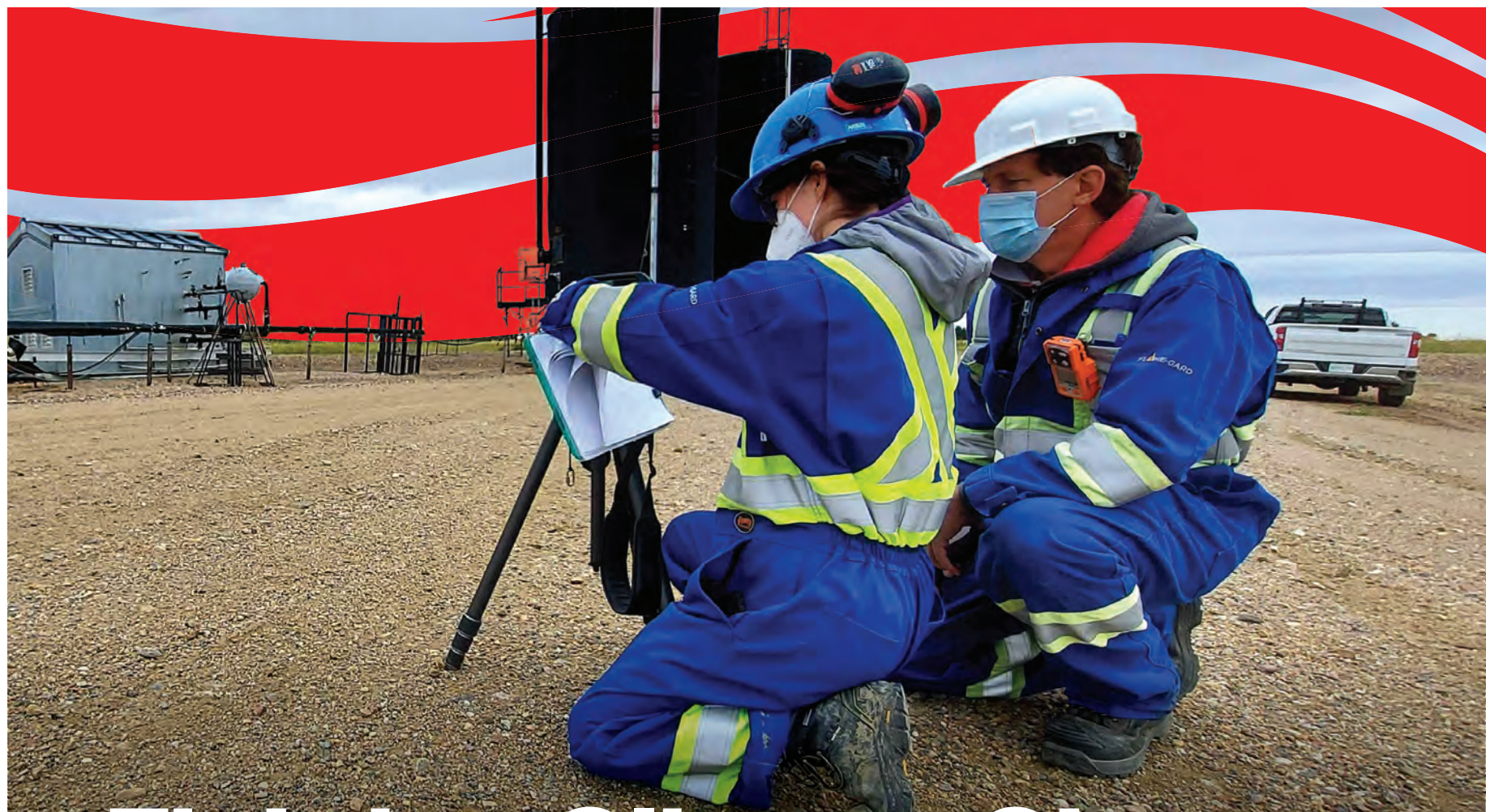
For the development of novel RNA therapeutics, collaboration is clearly essential, both to the progress of research and for the betterment of society. This is the ethos of the McGill-led CFREF initiative, DNA to RNA (D2R): An Inclusive Canadian Approach to Genomic-based RNA Therapeutics, awarded \$165M from the CFREF in 2023, and bolstered by \$188M from industry, academic, government, community, and non-profit partners on four continents. D2R promises to revolutionize medicine through novel RNA therapeutics for rare and infectious diseases, and cancer. D2R will produce research that is inclusive and relevant to the health needs of medically underserved groups, including Indigenous communities and the elderly.

These CFREF initiatives offer incredible training opportunities. We must not underestimate the role that students play in building international partnerships that span generations and link Canada to other nations. Having experience in multiple research environments is not only important for career development, but it can

also prepare emerging researchers to connect disciplines and nations.

It is in this spirit that McGill will lead the Symposium on Genomic Medicine, RNA Therapeutics and Health this spring in Tokyo, organised in partnership with the RIKEN Center of Integrated Medical Sciences, McGill's Victor Phillip Dahdaleh Institute of Genomic Medicine, the newly founded Pasteur Institute-Japan, and the UK Biobank. The Symposium will bring together academic and industry representatives from Japan, South-East Asia, Europe, and North America to discuss the future of biomedicine, and to promote international collaboration and partnership. Students from McGill's joint PhD in Genomic Medicine with Kyoto University, which is supported by the Japanese Ministry of Education, Culture, Sport, Science and Technology's Top Global University Program and the Fonds de Recherche du Québec, will also participate – further enhancing their training in international collaboration.

The adage 'two heads are better than one' has been overused, but the benefits to science and society of uniting the best and brightest minds are plain to see. While there may be testing times ahead for international research collaborations, Canada must continue to set bold research aspirations, embrace every opportunity to share our expertise with like-minded partners, and train our students to be global ambassadors. The health of all Canadians, and people around the world, will be better for it.



Fighting Climate Change Tracking Canada's Methane Emissions

In alignment with its Global Methane Pledge, Canada aims to urgently slash methane emissions.

To achieve this, Carleton University's Energy and Emissions Research Lab led by Prof. Matthew Johnson is leading a pioneering, national-scale effort employing innovative technologies to measure and track methane emissions at thousands of oil and gas sites from Manitoba to British Columbia.

Their mission: to create Canada's first accurate methane inventory, providing transparent data to guide mitigation, climate policy and regulation.

With approximately 30% of global temperature rise attributed to methane, Johnson's research is pivotal in the fight against climate change.

carleton.ca

Carleton
University





FOCUS ON Climate Change Research in Action



Across Canada, academic researchers are working on practical solutions to reduce global warming, and build resilient communities

By Debbie Lawes

Canada has committed to reduce greenhouse gas emissions by 40–45% below 2005 levels by 2030 and achieve net zero by 2050.

Getting there won't be easy, but there is hope. Rapid action to reduce emissions of carbon and methane can still limit human-induced global warming.

Academic researchers from multiple scientific fields are working hand-in-hand with industry partners, government, civil organizations, Indigenous groups and local communities to co-develop and implement solutions that can reduce our carbon footprint. A warming world also means working with stakeholders nationally, regionally and locally on adaptation strategies that can protect people, nature, our prosperity and way of life.

Research Infosource interviewed several academic leaders from across Canada to learn more about their efforts to translate climate change research into action.

UNIVERSITY OF VICTORIA

Converting to clean energy – one community at a time

The University of Victoria is leading a new climate-fighting initiative that will help Canada achieve its target of net-zero emissions by 2050 – one community at a time.

Accelerating Community Energy Transformation (ACET) is a seven-year, \$83.6-million initiative aimed at helping the 79% of Canadians living outside major cities, including rural, remote and Indigenous communities, reduce their reliance on fossil fuels and transform regional economies.

“We’re taking a bottom-up approach to reach net zero by working with individual communities, building on work we’ve been doing in this area for over a decade. The first step is to understand the specific challenges that are slowing their transition, be it technology, adoption, implementation, regulatory barriers or business models,” said Dr. Curran Crawford, Executive Director of ACET, which received support from the Canada First Research Excellence Fund.

“We’re taking a bottom up approach to reach net zero by working with individual communities, building on work we’ve been doing in this area for over a decade.”

DR. CURRAN CRAWFORD

Executive Director of Accelerating Community Energy Transformation (ACET), University of Victoria

ACET brings together more than 100 researchers and students from nine interdisciplinary areas of expertise, working in collaboration with over 40 partners, including five First Nations and three municipalities. Other academic partners include Royal Roads University, Université du Québec à Trois-Rivières, the University of British Columbia and Yukon University.

Solutions will be designed in partnership with Indigenous and remote communities that rely on diesel, as well as grid-connected towns and municipalities. Many projects are already underway.

For example, prototype testing with the UVic-led Blind Channel off-grid tidal power project, near West Thurlow Island, is successfully demonstrating the potential for harnessing tidal currents to power off-grid communities. In Haida Gwaii, researchers are helping local residents explore their options for harnessing ocean waves and tidal flows to reduce their diesel usage.

In larger communities like Victoria, a collaboration with the city is studying how EV fast charging

infrastructure can support the transition to climate-friendly transportation. For other communities, solutions may come in the form of green hydrogen or decentralized energy systems (microgrids) that combine renewable power and energy storage.

Crawford said each community will define their own energy, economic and social visions for the future.

“Lessons learned from these demonstrations will serve as case studies for communities around the world in how to harness their own natural resources to transition to greener and more resilient energy systems.”

YORK UNIVERSITY

Supporting Indigenous climate leadership

Indigenous peoples make up 6.2% of the world's population and steward 22% of the world's surface – yet they are responsible for maintaining 80% of the biodiversity on earth. They are also on the frontlines of the climate crisis.

Despite being proven stewards of the environment for millennia, Indigenous peoples are not at the table when it comes to making important provincial, national or international decisions related to climate change and biodiversity.

A York University research team, comprised primarily of Indigenous and feminist scholars, is on a mission to help change that.

“Indigenous peoples in Canada demonstrate climate leadership through land-based practices, restoring Indigenous economies, and decolonial movements like #LandBack, but we’re not fully consulted on important climate change issues. Our sovereignty is not respected, and our treaties are not fully implemented. As a result, Indigenous nations are not parties to international treaties like the Paris Agreement on climate change,” said Dr. Angele Alook, Assistant Professor at York's School of Gender, Sexuality and Women's Studies, and member of the Bigstone Cree Nation in Alberta.

Alook and York law professor Dr. Deborah McGregor, from Whitefish River First Nation in Ontario, are leading a three-year project showcasing how Indigenous communities are using traditional knowledge and governance to address climate change. Their collaborators include Dr. Brock Pitawa-

nakat, also of Whitefish River First Nation, Dr. Alan Corbiere of M'Chigeeng First Nation in Ontario, and Dr. Graeme Reed, Anishinaabe from the Great Lakes (Wiikwemkoong Unceded Territory).

The project employs Indigenous research methods that put Indigenous communities first, with a particular focus on amplifying the voices of women, gender diverse people, youth, Elders, and traditional knowledge keepers.

“Since we have Indigenous laws that require respect and reciprocity with the land, we are already climate leaders. This project aims to capture those stories and to let other researchers and policymakers know that Indigenous peoples are already doing this work,” added Alook.

The research team is interviewing Indigenous leaders from Canada and at international forums like the United Nations Climate Change Conference. To maximize their impact and reach, findings will be shared through publications, as well as art-based approaches such as documentaries, photography and graphic novels.

“We don't want to just tell that sad story about climate change,” said Alook. “We want to tell the story of how Indigenous knowledge, such as Indigenous laws of caring and decolonial feminist climate policy solutions, can provide a just transition to a more sustainable future.”

CARLETON UNIVERSITY

Pinpointing methane leaks at oil and gas sites

Canada's commitment to cut 75% of all methane emissions from the oil and gas industry by 2030 depends on knowing exactly where – and how much – methane is being released.

A lab at Carleton University now has the answers.

The Energy and Emissions Research Lab (EERL), led by engineering professor Dr. Matthew Johnson, recently completed a baseline census, or inventory, of methane leaking from thousands of oil and gas sites across Western Canada. This first for Canada, and the world, provides a practical tool that governments and industry can use to reduce global warming by a quarter degree Celsius by 2050, and a full half degree by the end of the century.

“This first for Canada, and the world, provides a practical tool that governments and industry can use to reduce global warming.”

DR. MATTHEW JOHNSON

Scientific Director at Energy and Emissions Research Lab (EERL), Carleton University

“Now that we have these actual measurements and data, Canada has a real chance to quickly do something that matters with methane. We can bend the trajectory of warming and become a template for the world,” said Johnson, who as Scientific Director at the EERL oversees a team of about 10 graduate students, postdoctoral fellows and research associates.

Methane is about 80 times more potent than carbon dioxide as a climate pollutant, and the energy sector is Canada's biggest source of national methane emissions. Using onsite optical gas imaging surveys and airborne LiDAR (a type of laser radar) at oil and gas sites across Western Canada, the EERL team found far higher methane emissions than previously reported.

“All the official data for how much methane is being produced are estimates, bad estimates it turns out,” said Johnson.

The EERL has been able to replace those estimates with verifiable data, using high-resolution imagery that can pinpoint methane leaks in a single compressor, storage tank or other equipment.

Companies looking to export liquid natural gas (LNG), in particular, have an incentive to accurately measure their methane emissions.

“By meeting these targets, Canada's emerging LNG sector would be poised to deliver the cleanest product in the world while we're transitioning to zero-carbon energy sources,” said Johnson, who describes himself as a pragmatic environmentalist.

Interest in the lab's data and methodologies is garnering interest from outside of Canada, including from Colombia and the United States.

Added Johnson: “If we're going to be successful in reducing methane emissions, we need to do this everywhere.”

QUEEN'S UNIVERSITY

Turning CO2 into renewable fuels

Researchers at Queen's University have found a way to take carbon dioxide from the atmosphere and turn it into chemicals and renewable fuels.

The discovery, led by Dr. Cao Thang Dinh, makes this process more efficient by integrating the capture of CO2 and its conversion into a single step.

“Carbon capture is currently used in the oil industry to recover more oil, but that's not the kind of application that we want. We want to open up new economic opportunities for CO2 utilization that reduces our overall carbon footprint,” said Dinh, who spoke to Research Infosource from Germany where he was receiving the Scientific Breakthrough of the Year award from the Falling Walls Foundation.

CO2 is a molecule that can be converted into several different molecules, including chemicals used to make polymers (plastics) such as polyethylene and polypropylene, as well as fuels like methane, methanol and ethanol.

But one of the biggest challenges has been the significant amount of energy, often sourced from fossil fuels, needed to convert CO2 into compounds.

Dinh developed an electrochemical process that reduces the amount of energy needed for CO2 capture and conversion. At the heart of this process is thin layers of catalyst – the material that converts the CO2.

As Dinh explained, the potential applications are game-changing.

“It would allow intermittent renewable energy like wind and solar to be converted into liquid fuel that could be easily stored as you would any other fuel,” said Dinh, Assistant Professor in the Department of Chemical Engineering at Smith Engineering at Queen's.

Dinh's lab is also working with an industrial partner to convert oxygen in the air into hydrogen peroxide for wastewater treatment. Another project is looking at converting CO2 and nitrogen from the air to produce urea – a widely used fertilizer. This same chemical process can be used to convert water into useful applications.

Dinh's team has demonstrated the process works in a lab environment and estimates it will take another five-to-ten years to scale-up products using this technology. “As long as you have air, water and renewable energy,” he said, “you could implement this technology anywhere in the world.”

ONTARIO TECH UNIVERSITY

Fueling a resurgence in net-zero nuclear energy

Nuclear power is experiencing a resurgence as the world looks for powerful low-carbon energy sources to accelerate the world's transition to net zero.

One of the global scientific leaders in this space is Ontario Tech University, located 25 km from the Pickering and Darlington nuclear power plants, just east of Toronto, and 150 km from the Bruce Nuclear Generating Station on the eastern shore of Lake Huron.

In 2021, Ontario Power Generation renewed its longstanding research collaboration with Ontario Tech with a new \$5-million investment.

“OPG is a big partner for us,” said Dr. Les Jacobs, Vice-President, Research and Innovation at Ontario Tech. “We also have very close ties with Bruce Power, Atomic Energy of Canada and Canadian Nuclear Laboratories in Chalk River, as well as the whole nuclear supply chain.”

Ontario Tech is the only Canadian university with an accredited undergraduate degree in nuclear engineering, and its students fill a critical need for skilled workers in the sector.

On the research side, the university has several top experts in hydrogen and small modular reactors (SMRs), including four research chairs. Ontario Tech is also home to Canada's first scientific centre for SMRs, as well as the Clean Energy Research Lab, which Jacobs describes as “Canada's top hydrogen research lab”.

“We are also developing what we call a subcritical nuclear assembly, essentially a no-power small micro modular reactor that can be used for teaching and research.”

In June, Ontario Tech was awarded more than \$935,000 from the Natural Sciences and Engineering Research Council of Canada and the Canadian Nuclear Safety Commission to study SMRs. Like traditional nuclear reactors, SMRs use fission to create heat, but their smaller size offers a promising pathway to support Canada's low-carbon energy transition.

Those strengths were key in the International Atomic Energy Agency decision in 2021 to designate Ontario Tech as the IAEA Collaborating Centre for Canada on advanced nuclear power technology. It is studying how nuclear power, particularly SMRs, can be integrated into existing energy systems, including renewables.

“Our slogan at Ontario Tech is ‘Tech with a Conscience’ and nuclear fits with that,” said Jacobs. “If you care about climate change, then nuclear is definitely a key part of the solution for Canada.”

RESEARCHERS' CORNER



Dr. Mandana Vahabi
Professor
Daphne Cockwell School of Nursing
Toronto Metropolitan University

Focusing on issues such as public health, health equity and the social determinants of health, Dr. Mandana Vahabi's national award-winning cancer research addresses challenges like promoting screening amongst underserved populations.

One example is her leadership of an international team using arts-based approaches to health promotion to increase human papillomavirus (HPV) self-sampling in India. Through this and other Canada-based projects, Dr. Vahabi's research is improving the lives of marginalized and equity-seeking communities by increasing access to critical health information and screening.



Miroslava Kavcic
Associate Professor, Department of Civil Engineering
Faculty of Engineering, University of Ottawa

Code requirements for the building thermal envelopes are becoming more stringent in Canada. However, conventional insulation materials, such as polystyrene and polyurethane, are not carbon neutral. Supported by the Canada Foundation for Innovation's John R. Evans Leaders Fund (JELF), Professor Miroslava Kavcic's project will use organic waste materials from agriculture and forestry industries to create sustainable construction products. By using hemp, flax and wood shavings, her team aims to develop materials with excellent insulating properties to build resilient, zero-carbon and energy efficient buildings.



Catherine M. Burns is Professor in Systems Design Engineering at the University of Waterloo where she directs her research lab, the Advanced Interface Design Lab and holds a Tier 1 Canada Research Chair in Human Factors and Healthcare Systems. Catherine's work focuses on Cognitive Work Analysis, Ecological Interface Design and the development of decision support systems.

Catherine Burns
Associate Vice President,
Health Initiatives and Canada Research Chair
University of Waterloo



Immediate action to reduce methane emissions is one of the most impactful things we can do to fight climate change. My team at Carleton University is producing Canada's first-ever oil and gas sector methane census, combining aerial- and ground-based measurements at thousands of upstream sites. Our work is helping define a path to meet Canada's 2030 reduction targets, but success will require ongoing effort to measure, track, and verify progress toward this critical goal.

Matthew Johnson
Professor, Mechanical and Aerospace Engineering and Scientific
Director the Energy and Emissions Lab
Carleton University



Dr. Curran Crawford
Executive Director, Accelerating Community Energy Transformation Initiative,
University of Victoria; Professor, Faculty of Engineering & Computer Science

Curran is an expert in sustainable energy systems design and operation. His research develops and applies computational tools to optimize renewable energy system designs and operations. Application areas include offshore wind and tidal energy, electrified transportation, e-fuel production and carbon capture and sequestration, in partnership with communities, government and industry. Dr. Crawford's decades of experience in renewable electricity generation and integration into both on- and off-grid communities is the foundation for his leadership of UVic's Accelerating Community Energy Transformation initiative.



Niagara College (NC) research teams are recognized for responding to industry needs at the speed of business. For example, Ana Cristina Vega Lugo, PhD, brings a wealth of scientific knowledge to her work in beverage innovation with NC's Food & Beverage Innovation Centre. Vega Lugo recently led a research team in partnership with industry to introduce a new quinoa-based beer to the market. Miski Brewing has already launched this organic product, thanks to this vital applied research work.

Ana Cristina Vega Lugo, PhD
Scientific Manager
Food & Beverage Innovation Centre
Niagara College



Dr. Manjusri Misra
Tier 1 Canada Research Chair in Sustainable Biocomposites
School of Engineering & Department of Plant Agriculture
University of Guelph

As an international leader in sustainable materials, Dr. Manjusri Misra designs new materials using renewable resources like agricultural fibres, biocarbon and biopolymers that reduce waste and have lower global environmental impact. Her success with bio(nano) composites has resulted in commercial applications including compostable packaging and automotive parts, and has led to award-winning products.



Elected as a Fellow of the Royal Society of Canada in 2021, Dr. Lori Chambers has transformed understandings of the history of Canadian law, particularly with regards to women and gender. Her original and ground-breaking research includes discussions of property law, unwed parenthood, adoption, violence against women, and settler-Indigenous relations in the North. Highly esteemed by historians and law professionals, her work has revealed how the past continues to shape our legal present.

Dr. Lori Chambers
Professor, Departments of Gender and Women's Studies and Health Sciences
Lakehead University



Dr. Abdul Raouf, PhD
Research Chair – Geospatial Technologies
Saskatchewan Polytechnic

Dr. Abdul Raouf has over three decades of applied research, teaching and training experience. His research interests focus on the application of remote sensing, geographic information system (GIS) and global navigation satellite system (GNSS) technologies for resource mapping and management, environmental impact assessment, vegetation mapping and disaster mitigation. Abdul's recent projects have focused on working in partnership with Indigenous communities to apply geospatial technologies to land and resource management questions.



Dr. Marjan Eggermont, PhD
Professor (Teaching) and interim Associate Dean of Sustainability
Schulich School of Engineering
UCalgary

Dr. Marjan Eggermont, PhD, is a professor and interim Associate Dean of Sustainability at the Schulich School of Engineering. Her research focuses on bio-inspired design, biomimicry and computational media design, and she will play a key role in designing the experiential learning components of UCalgary's water-focused United Nations University Hub on Empowering Communities to Adapt to Environmental Change.



Named one of Canada's top 10 women water scientists, York University's Sapna Sharma studies how lakes worldwide respond to climate change. With implications for both humans and wildlife, her research has shown widespread losses of ice and rapid lake warming, which can lead to degradation in water quality, increased proliferation of algae, and threats to freshwater fish survival. Sharma's work advances our understanding of a vital natural resource, enhancing its protection and management.

Sapna Sharma
Associate Professor, Department of Biology, Faculty of Science,
York Research Chair in Global Change Biology
York University



Dr. Leyla Soleymani
Professor, Engineering Physics
Associate Vice-President, Research (Commercialization & Entrepreneurship)
McMaster University

As the Canada Research Chair in Miniaturized Biomedical Devices, Dr. Leyla Soleymani combines innovations in chemistry, materials science and biochemistry to solve the world's most pressing health challenges. Using this multidisciplinary approach, Dr. Soleymani develops rapid diagnostic and pathogen-repellent platforms to improve the management of diseases and quality of healthcare. She is the co-founder of FendX Technologies Inc. – a startup focused on developing nanotech products that reduce the spread of pathogens, including the award-winning REPELWRAP™ film.



Facilitating mentorship for newcomers
Newcomers to Canada can often benefit from the guidance, knowledge and mentorship of an industry professional to navigate challenging career experiences. Dr. Ferzana Chaze, professor in Sheridan's Faculty of Applied Health and Community Studies, examined the reasons why industry professionals become mentors and the barriers that deter them. Findings will assist in future Toronto Region Immigrant Employment Council recruitment efforts, providing recommendations on ways to attract and retain mentors.

Dr. Ferzana Chaze
Professor, Faculty of Applied Health and Community Studies
Sheridan College



FOCUS ON CLIMATE CHANGE RESEARCH IN ACTION

Continued from page 10

UNIVERSITÉ DE SHERBROOKE

Engineers build artificial river to mimic nature

Nearly 300 people were forced to evacuate their homes in Sherbrooke, Que. this summer when intense rainfall raised the risk of severe flooding from the Saint-François River. Research underway on an artificial river and watershed at Université de Sherbrooke could help communities across Quebec, and elsewhere, better predict and prepare for future floods.

Launched in 2021, the \$2.8-million Multiscale Research Complex in Hydrology, Hydraulics, and Environment was designed to replicate real-world conditions for water flow and the presence of contaminants. This unique football field-sized facility includes a small river (50mx3m), a waterfall, and a pond the size of an Olympic pool that is fed by rainwater and melted snow, as well as state-of-the-art scientific equipment for analytical chemistry and water treatment.

The facility provides a realistic setting for testing hydraulic processes that are difficult to accurately reproduce in a laboratory. It draws on multiple scientific disciplines, including civil engineering, chemistry, and applied geomatics, with researchers collaborating with industrial, municipal and government partners.

"This testbed is a controlled, closed-loop system that mimics what occurs in nature," explained Dr. Jean-Pierre Perreault, Vice-President, Research and Graduate Studies, Université de Sherbrooke.

"The goal is to demonstrate how water quality can be improved through better water management practices and new approaches and technologies for water treatment."

Studies will look at mitigating the effects of climate change on rivers, such as riparian strips or fish passes, and even developing new practices to help restore waterways. Other research is examining how the transport of sediments, erosion and the stabilization of riverbanks can help improve flood prediction.

The next step is to apply knowledge gleaned

from the test facility to a real river. The university is currently seeking funding to study the Saint-François River, which is prone to spring floods as a result of ice jams that occur upriver.

"The science being done at this site is not only fundamental basic science, but something that can be applied and make a difference," added Perreault. "We want to give municipalities more advanced warning before disaster strikes."

McMASTER UNIVERSITY

Studying the impacts of climate change on water

Vulnerable communities in the Great Lakes watershed will be the first to benefit from a new cross-border effort to strengthen their resiliency to climate change.

Led by McMaster University's Dr. Gail Krantzberg and Dr. Drew Gronewold from the University of Michigan, the new Global Centre for Understanding Climate Change Impacts on Transboundary Waters will initially focus on the Great Lakes, a

“The goal is to demonstrate how water quality can be improved through better water management practices and new approaches and technologies for water treatment.”

DR. JEAN-PIERRE PERREAULT

Vice-President, Research and Graduate Studies, Université de Sherbrooke

Continued on page 24



CANADA'S Innovation

Canada's innovation community continues to be at the forefront of research and discovery



Biotherapeutics Manufacturing Centre – The Ottawa Hospital.

The **Ottawa Hospital's Biotherapeutics Manufacturing Centre (BMC)** is the most experienced and successful facility of its kind in Canada – and the only one with a track record of both virus and cell manufacturing.

Thanks to the BMC, Ottawa is becoming a destination city for developing new therapies that have the potential to cure disease – not just treat it.

The centre manufactured more than 20 different therapeutic products and vaccines for human clinical trials in Canada, the U.S., Europe, and Asia. Over the last five years, there has been an unprecedented surge in demand for biomanufacturing to produce innovative treatments for cancer, cardiovascular disease, COVID-19, and other conditions.

The BMC can play a key role in strengthening Canada's biomanufacturing ecosystem and supporting made-in-Canada solutions to global health challenges, together with partners such as BioCanRx and the Canadian Pandemic Preparedness Hub.

ohfoundation.ca/worldwide-research-collaborations/

University of Manitoba's health research impact is far reaching, attracting high profile support. UM sits on one of the top 10 universities receiving funding from the Bill & Melinda Gates Foundation worldwide, #1 in Canada. Dr. Jamie Blanchard and Dr. Meghan Azad have received transformational support for maternal and child health initiatives. Azad established and leads the International Milk Composition (IMiC) Consortium – a team of milk, global health, and data science researchers studying breast milk in four countries (Tanzania, Pakistan, Burkina Faso and Canada). Blanchard, Director of UM's Institute for Global Public Health, received funding for a maternal-neonatal health program in India, creating 30,000 public health centres, tackling life-threatening outcomes. Each centre tracks events digitally via front line workers (160,000) equipped with smart phones contributing to the web of community-level information. Since 2018, this program has saved 300,000 lives. UM has received \$384 million to date from the Foundation.

umanitoba.ca/about-um/vice-president-research-and-international



The **B²C Lab** at **Humber College** is a front-facing industry research lab offering leading edge infrastructure including an ATSC 3.0 broadcast system, three 5G core networks, and RF anechoic test chamber. The lab explores multi-sectoral data delivery applications of ATSC 3.0 including convergence with 5G networks and other global IP data delivery standards including Wi-Fi and Bluetooth. Aiming to position Canada as an ATSC 3.0 technology leader, the lab collaborates with key stakeholders such as Sinclair Broadcast, Synamedia, Pelmorex Corp., Avateq Corp., and is part of a global research consortium with the Communications Research Centre Canada (CRC), Ottawa, University of the Basque Country, Spain, and the Electronics and Telecommunications Research Institute in Seoul, South Korea. Published articles showcase contributions to wireless backhaul solutions and the development of an Inter-Tower Communications Network (ITCN) using ATSC 3.0. Exciting events include hosting a Broadcast Positioning System (BPS) Seminar, and hosting the Institute of Electrical and Electronics Engineers (IEEE) Broadband Multimedia Systems and Broadcasting (BMSB) 2024 conference for the first time in Canada.

humber.ca/research



McMaster researcher Ali Emadi and his multidisciplinary research team are powering a new paradigm in green transportation. Emadi leads CERC@MARC – one of the world's leading academic research programs in transportation electrification and smart mobility. The program is pioneering sustainable energy-efficient solutions, many of which have been brought to market by Emadi's start-up company, Enedym.

Headquartered at McMaster Innovation Park and co-founded by Emadi, Enedym has ownership of more than 50 patents, pending patent applications and related inventions developed by Emadi and his research group. With a focus on switched reluctance motor (SRM) technologies, the company supplies sustainable, lower cost electric motor and propulsion solutions to a wide range of industries.

Most recently, Emadi and his team created the Centre of Excellence for Artificial Intelligence and Smart Mobility – focused on building fully integrated, intelligent transportation systems that incorporate diverse accessibility needs to make travel more inclusive, equitable and sustainable.

electrification.mcmaster.ca

By applying physics to health care, Dr. Alla Reznik, Canada Research Chair in the Physics of Radiation Medical Imaging, and her team at **Lakehead University** are making significant advances in cancer screening. Through the spin-off company, Radialis Inc., Reznik's team developed a Positron Emission Mammography (PEM) scanner that is more effective than X-ray mammography at diagnosing early-stage breast cancer in those with dense breast tissue. This compact, plug-in device is designed to easily travel to under-served communities where it provides more accurate and precise images with shorter scanning times and at a lower cost. Now, supported by a \$740,000 grant from the Canadian Institute for Health Research, Reznik and her team are upgrading their technology to scan diagnostic images of other organs. With the goal of commercialization following clinical trials, the innovations of Radialis Inc. will enhance the accuracy of cancer diagnosis and treatment monitoring in patients.

lakeheadu.ca/research-and-innovation/about/news-research-stories/research-stories-archive/node/107804



Photo: Julio Heliano Gomes

Dr. Alla Reznik
Canada Research Chair, Physics of Radiation Medical Imaging
Professor, Physics
Lakehead University



Canadian companies are paying an average of nearly \$7 million in data breach costs – the third highest in the world, according to IBM's 2023 Cost of a Data Breach Report. The **University of Ottawa** teamed up with IBM Canada to launch the uOttawa-IBM Cyber Range, IBM's very first university-based cybersecurity training hub for uOttawa students, governments and businesses. This unique lab offers highly realistic cyber response training exercises that will prepare students entering the workforce and help businesses as well as government organizations across the country strengthen their defences against real-world cyber threats by teaching them how to plan, respond, manage, contain, and remediate cyberattacks. Bringing together some of the university's top experts from numerous fields – engineering, law, social sciences, and business – the uOttawa-IBM Cyber Range will also allow for interdisciplinary research and collaboration. In a digital landscape as vast as Canada, this facility has the potential to be a game-changer.

uottawa.ca/research-innovation/impact-discoveries/cyber-hub/uottawa-ibm-cyber-range

Ontario Tech University's emergence as a powerful voice in Canada's research sector stems from its strategic commitment to listen to industry, community and government partners to fully understand their most pressing needs and challenges. Our differentiated research approach is industry-responsive, results-driven and guided by our tech-with-a-conscience ethos.

We apply and integrate the social and ethical implications of technology in our research enterprise by tackling global challenges such as the reduction of carbon pollution by contributing to Canada's transition to net-zero emissions.

Our unique research facilities include the ACE Climatic Aerodynamic Wind Tunnel and the Clean Energy Research Lab. The university's Brilliant Energy Institute supports our mission to generate innovative clean-energy technologies, integrate low-carbon energy into our communities, and promote climate resilience across the globe.

For Ontario Tech, it's not only about the next tech breakthrough. We lead with our conscience. We've achieved a solid reputation through the company we keep and by adapting to our partners' needs.

ontariotechu.ca/research



COVER STORY

Solving Global Challenges Through Research Partnerships and Collaborations

Continued from page 1

UNIVERSITY OF CALGARY Raising the bar for global water research

The University of Calgary is rapidly becoming a global centre for water research. On Nov. 16, the federal government awarded UCalgary a distinguished Canada Excellence Research Chair in Indigenous Ways of Climate and Water Sustainability for Planetary Health and Well-being, held by Anishinaabe scholar Dr. Deborah McGregor.

Just one week earlier, UCalgary learned it would lead the world's first United Nations University Hub focused

on water. Four research clusters across campus will study essential areas of water studies: understanding changes in aquatic ecosystems, infectious diseases in a changing climate, environmental predictions for water sustainability, and resilience in Indigenous communities.

And in March, news came that UCalgary would host a new UNESCO Chair in Mountain Water Sustainability. Six world-class chairholders, including two from UCalgary, are studying how we forecast the impact of climate warming on water sources, developing new climate change mitigation measures, and

increasing the resilience of communities that rely on mountain waters.

"Our university has a critical mass of interdisciplinary expertise and specialized infrastructure that make us a compelling choice for water research," said Dr. William Ghali, Vice-President (Research), UCalgary. "We're also located in a major mountain watershed zone, so the challenges related to water are also local challenges."

Much of this research happens off campus, including at the UCalgary-operated Kluane Lake Research Station in the Yukon. Another research station at Barrier Lake, just west of Calgary, hosts scholars studying issues such as water sustainability, glaciers, and climate change.

Research is increasingly done in partnership with companies, not-for-profits, Indigenous groups and government – those best equipped to translate

science into solutions. One of UCalgary's most established partners is the City of Calgary.

In one initiative, UCalgary and the city developed a \$36.8-million research facility called ACWA (Advancing Canadian Water Assets) that is integrated into a municipal wastewater treatment plant to study and pilot leading-edge water, stormwater, and wastewater treatment technologies. The facility's 12 naturalized, experimental streams allow scientists to conduct real-world tests without negative impacts to the environment.

"Partnerships with government are particularly important," said Ghali, "as they provide the knowledge governments need to enact policies that protect waterways and enhance water sustainability. The potential for impact is so much greater."

TORONTO METROPOLITAN UNIVERSITY Making Canada more inclusive for immigrants

Canada has set an ambitious target of increasing the number of new permanent residents from 465,000 in 2023 to 500,000 in 2026 to tackle growing labour shortages and to support economic growth.

But integrating these newcomers into Canadian society comes with challenges, including societal polarization, housing crises and leveraging foreign education credentials.

"At the same time, you have technological transformation impacting all of this, from how migration is governed and how permits are processed to how migrants participate in social and political life," said Dr. Anna Triandafyllidou, the Canada Excellence Research Chair

Continued on page 16

Achievements

Through entrepreneurship, commercialization and social innovation, researchers in our universities, hospitals, colleges and companies are turning their leading-edge research into products, technologies and services that advance our economy and improve the lives of citizens the world over. Take a look at how their work is transforming society.



As climate change intensifies, the need to address the risks and threats from wildfires is urgent. **Thompson Rivers University (TRU)** understands this urgency and, with two research chairs dedicated solely to wildfire science, has prioritized research in the field.

The university has growing expertise in wildfire – it's home to BC's first fire science research chair as funded by the province (the BC Innovation Chair in Predictive Services, Emergency Management and Fire Science), a Canada Research Chair in Fire Ecology and an NSERC Industrial Chair in Ecosystem Reclamation. Additionally, TRU's campuses in Kamloops and Williams Lake are located in the epicentre of wildfire response activity.

These world-renowned experts are leading research on various fire-related topics, including wildfire behaviour, landscape fire modelling and ecosystem

changes resulting from wildfire. Their research is supported by undergraduate and graduate students at TRU.

Without question, TRU is advancing world-class wildfire research and is committed to wildfire science research that will make a difference in how we mitigate and adapt to the effects of future wildfire seasons.

Researchers:

Dr. Mike Flannigan, BC Innovation Research Chair in Predictive Services, Emergency Management and Fire Science

Dr. Jill Harvey, Canada Research Chair in Fire Ecology

Dr. Lauchlan Fraser, NSERC Industrial Research Chair in Ecosystem Reclamation

tru.ca/research/research-centres/wildfire-science.html

Picture from L – R: Dr. Mike Flannigan, Dr. Jill Harvey, Dr. Lauchlan Fraser

Through interdisciplinary education, research and innovation, **York University's** leading scientists and scholars are working to understand the complex ways that climate change is globally affecting pollinators, particularly bees. Led by Amro Zayed, the Centre for Bee Ecology, Evolution, and Conservation (BEEc), one of York's 31 organized research units, is advancing critical research in these fields to ensure the long-term sustainability of the insect, which plays an integral role in nature and in agriculture. Conservation scientist Sheila Colla is among the first to quantitatively document the decline of native bee species in Canada, which has led to federal and provincial policy to protect important pollinator species. Bee expert Laurence Packer studies native bees and has built the largest Canadian bee collection, currently estimated at over 500,000 specimens from around the world. He also spearheads the Bee Barcode of Life project, an international effort to develop genetic barcodes for bees on Earth.

yorku.ca/bees



Conservation scientist Sheila Colla.



Bee expert Laurence Packer.



For almost a decade **RRC Polytech's Prairie Research Kitchen (PRK)** has been developing innovative advancements in food production, so it was natural for the PRK team to produce a research report like no other. *From Lab to Table* is a Culinary Research Review in the form of a cookbook that shares the delicious outcomes of applied research conducted since PRK began collaborating with partners in 2014 while documenting the history of Manitoba's only Technology Access Centre that blends food science and culinary arts.

Sustainability is a driving force behind many of PRK's projects. From discovering and developing novel uses for pulse and soybean products to upcycling food industry by-products and embracing insects for protein, the cookbook available at researchrecipes.ca encourages readers to taste the success of eight years of research.

RRC Polytech proudly works with industry to make things possible while providing students with the experiential learning required to drive change.

rrc.ca/research

Investing in research infrastructure to create a cleaner, greener future is a strategic and essential step toward addressing environmental challenges and fostering sustainable development. From how we produce and use energy, to how we build our homes and communities, to how we confront the peril increasingly stressed resources place on humans, the **Canada Foundation for Innovation (CFI)** is supporting researchers as they take on the extraordinary challenges facing our environment. The CFI has invested in hundreds of labs across Canada that are devoted to finding solutions such as equipment that monitors the impacts of a shifting climate, the development of net-zero emissions building practices, and facilities that create clean-technology innovations. CFI-funded infrastructure not only supports innovation that benefits people in Canada and around the world, but they are also the training ground and inspiration for generations to come whose future will be shaped by our response to a changing world.

innovation.ca/leaders

Girma Bitsuamlak, director, Western University's WindEEE Research Institute with graduate students during a tornado simulation.



Photo: Western University

Carleton University and Efficiency Canada's Partnership Envisions an Energy-Efficient Future

Carleton University's James Meadowcroft is the Academic Director of an innovative partnership -- Efficiency Canada. Housed in Carleton's Sustainable Energy Research Centre, the independent pan-Canada think tank aims to bring together a diverse array of allies – from academic researchers and private-sector businesses to utilities and governments – to research and advocate for public policies that move us toward a more energy-efficient future. Under the practical guidance of its Executive Director, Corey Diamond, Efficiency Canada serves as the national voice for an energy efficient economy. The partnership envisions a future where Canada uses energy efficiency – a critical tool to accelerate the decarbonization of our economy – to its fullest potential. For example, the deployment of electric heat pumps to heat homes can improve energy efficiency while reducing building related GHG emissions. Maximizing the benefits of energy efficiency can contribute towards a sustainable environment, a productive net-zero economy, and a just and equitable society.

efficiencycanada.org



James Meadowcroft
Professor, Department of Political Science and the School of Public Policy and Administration
Carleton University



Sheridan's Centre for Elder Research (CER) is renowned for its applied research expertise, innovative approaches and creative partnerships that focus on enhancing the well-being of older Canadians. An integral part of Generator at Sheridan and its longest-running research centre, CER celebrated its 20th anniversary in September. CER's two decades of sustained excellence include completing more than 150 applied research projects; engaging more than 1,000 students; and establishing more than 100 industry, community and academic partnerships. A current collaboration, supported by the Ontario Brain Institute, with industry partners Soul Machines and Winterlight Labs, exemplifies CER's commitment to creative interdisciplinary solutions. This project is exploring the use of virtual human characters, combined with sophisticated machine learning algorithms for speech analysis, to offer remote mental and cognitive health monitoring for older adults.

Visit elderresearch.sheridancollege.ca for more about CER's collaborations addressing timely and relevant issues to an aging society.

Enabling Optimization Through Digital Twins

By optimizing buildings and cities, carbon emissions can be reduced, unusual events or disasters detected, and environments adapted to the needs of the people who live and work there. **Toronto Metropolitan University's** Dr. Jenn McArthur is creating cognitive digital twins – up-to-date digital versions of buildings that integrate data streams such as sensors or computerized systems that are capable of learning, predicting and optimizing building performance.

From supporting campus management to tracking energy consumption across cities, Dr. McArthur's digital twins can provide interactive data viewing, providing tools that can be used to monitor and respond to issues in real time. These tools can also be used for scenario simulation, testing the impacts of new technologies or procedures before implementation. Working with industry and academic collaborators from across Canada, Dr. McArthur leads TMU's Smart Campus Integration and Testing Hub, the world's first fully digitally-enabled building, to advance smart and sustainable building research.

torontomu.ca/research



Dr. Jenn McArthur
Associate Professor
Department of Architectural Science
Toronto Metropolitan University



Supporting Business Growth Through Collaborative Innovation

The Ontario Collaborative Innovation Platform (OCIP), launched by **eCampusOntario**, supports research partnership between companies and Ontario's public postsecondary institutions (PSIs). OCIP is a matchmaking service, connecting companies to PSIs to form collaborative innovation partnerships.

We know that companies that do R&D are more likely to survive and grow, hire more people, export more goods and services, and have a bigger economic impact in their communities. We also know that companies need help navigating the R&D landscape. OCIP helps Ontario businesses find R&D support, workforce training and IP support with Ontario's 56 colleges, universities and Indigenous Institutes. It is one way we are filling a gap in the innovation pipeline.

ocip.ecampusontario.ca

S P O T L I G H T O N

University Research Partnerships and Collaborations 2018-2022



Research Infosource shines the spotlight on university research partnerships and collaborations at full-service universities as measured by grants, contracts or contributions received from corporate, not-for-profit and international government sources between FY2018-FY2022; and, the number of cross-sector and international publications between 2017-2021.

Corporate Research Income FY2018-FY2022					
Corporate Research Income			Corporate Research Income Growth (% Change FY2018-FY2022)		
Rank	Medical	\$000	Rank	Medical	%
1	University of Toronto	\$680,704	1	Memorial University of Newfoundland	52.9
2	McMaster University	\$522,002	2	University of Saskatchewan	49.3
3	Université de Montréal	\$399,515	3	University of Calgary	41.2
4	University of British Columbia	\$388,953	4	University of Toronto	25.3
5	Queen's University	\$313,537	5	Université Laval	24.7
Rank	Comprehensive	\$000	Rank	Comprehensive	%
1	University of Waterloo	\$132,536	1	Carleton University	304.9
2	University of Guelph	\$113,583	2	University of New Brunswick	92.5
3	Université du Québec à Montréal	\$36,084	3	Simon Fraser University	88.9
4	Simon Fraser University	\$33,280	4	Toronto Metropolitan University	70.3
5	Concordia University	\$29,780	5	University of Victoria	66.6
Rank	Undergraduate	\$000	Rank	Undergraduate	%
1	Université du Québec à Chicoutimi	\$34,365	1	University of Lethbridge	734.8
2	Université du Québec en Abitibi-Témiscamingue	\$33,951	2	Ontario Tech University	496.6
3	Laurentian University	\$21,590	3	University of Northern British Columbia	157.3
4	Ontario Tech University	\$17,994	4	Université du Québec à Rimouski	107.0
5	Université du Québec à Rimouski	\$12,922	5	Wilfrid Laurier University	103.8

Not-for-Profit Research Income FY2018-FY2022					
Not-for-Profit Research Income			Not-for-Profit Research Income Growth (% Change FY2018-FY2022)		
Rank	Medical	\$000	Rank	Medical	%
1	University of Toronto	\$1,904,902	1	University of Saskatchewan	66.1
2	University of British Columbia	\$598,933	2	Université de Sherbrooke	56.3
3	Université de Montréal	\$505,636	3	University of Alberta	50.3
4	McGill University	\$442,248	4	McGill University	44.0
5	Université Laval	\$376,613	5	University of Ottawa	31.1
Rank	Comprehensive	\$000	Rank	Comprehensive	%
1	Simon Fraser University	\$121,224	1	University of Guelph	460.1
2	University of Waterloo	\$104,755	2	Concordia University	119.5
3	University of New Brunswick	\$42,888	3	Toronto Metropolitan University	73.9
4	University of Victoria	\$41,915	4	Carleton University	44.4
5	University of Guelph	\$41,160	5	University of New Brunswick	33.3
Rank	Undergraduate	\$000	Rank	Undergraduate	%
1	Lakehead University	\$31,032	1	University of Regina	297.8
2	Université du Québec à Trois-Rivières	\$21,726	2	Université du Québec à Trois-Rivières	270.0
3	Université de Moncton	\$19,313	3	Université du Québec à Chicoutimi	244.9
4	University of Prince Edward Island	\$10,861	4	Ontario Tech University	242.5
5	Université du Québec à Rimouski	\$10,440	5	Saint Mary's University	208.0

International Government Research Income FY2018-FY2022					
International Government Research Income			International Government Research Income Growth (% Change FY2018-FY2022)		
Rank	Medical	\$000	Rank	Medical	%
1	University of Toronto	\$152,541	1	University of Sherbrooke	208.2
2	McGill University	\$110,302	2	University of Calgary	155.7
3	University of British Columbia	\$87,223	3	University of Saskatchewan	93.4
4	Université de Montréal	\$62,135	4	Queen's University	47.6
5	University of Alberta	\$40,440	5	University of British Columbia	43.4
Rank	Comprehensive	\$000	Rank	Comprehensive	%
1	University of Victoria	\$21,442	1	University of New Brunswick	585.2
2	University of Waterloo	\$14,437	2	Concordia University	161.5
3	Simon Fraser University	\$13,457	3	University of Guelph	159.3
4	University of Windsor	\$5,806	4	University of Windsor	82.2
5	York University	\$4,386	5	University of Victoria	77.7
Rank	Undergraduate	\$000	Rank	Undergraduate	%
1	University of Regina	\$3,017	1	Trent University	203.9
2	Université du Québec à Trois-Rivières	\$2,693	2	University of Lethbridge	108.0
3	Ontario Tech University	\$2,358	3	University of Regina	107.4
4	Laurentian University	\$1,837	4	Université du Québec à Trois-Rivières	80.8
5	Lakehead University	\$956	5	Ontario Tech University	35.0

Notes for Research Income:
 1. Based on full-service universities on the Top 50 Research Universities list for all five years; and reported research income in the form of a grant, contract or contribution from corporate, not-for-profit and international government sources between FY2018-FY2022.
 2. Financial data were obtained from Statistics Canada.

Cross-sector Collaboration Publications 2017-2021					
Cross-sector Collaboration Publications			Cross-sector Collaboration Publications Growth (% Change 2017-2021)		
Rank	Medical	#	Rank	Medical	%
1	University of Toronto	37,149	1	Memorial University of Newfoundland	71.6
2	University of British Columbia	15,189	2	Queen's University	60.8
3	McGill University	13,447	3	University of Calgary	60.5
4	Université de Montréal	12,576	4	McMaster University	53.7
5	University of Ottawa	10,659	5	University of Ottawa	53.4
Rank	Comprehensive	#	Rank	Comprehensive	%
1	University of Waterloo	3,484	1	University of Windsor	80.0
2	Simon Fraser University	2,997	2	Concordia University	77.9
3	University of Victoria	2,603	3	Carleton University	55.2
4	University of Guelph	2,451	4	University of Waterloo	45.1
5	Carleton University	2,063	5	Toronto Metropolitan University	38.6
Rank	Undergraduate	#	Rank	Undergraduate	%
1	Université du Québec à Trois-Rivières	478	1	Ontario Tech University	260.9
2	Laurentian University	441	2	Brock University	163.4
3	Trent University	420	3	University of Northern British Columbia	104.8
3	University of Regina	420	4	Université du Québec en Outaouais	97.0
5	Lakehead University	377	5	Université du Québec en Abitibi-Témiscamingue	65.9

International Collaboration Publications 2017-2021					
International Collaboration Publications			International Collaboration Publications Growth (% Change 2017-2021)		
Rank	Medical	#	Rank	Medical	%
1	University of Toronto	45,117	1	Memorial University of Newfoundland	76.5
2	University of British Columbia	27,369	2	Queen's University	57.5
3	McGill University	22,667	3	University of Calgary	51.6
4	University of Alberta	19,662	4	University of Saskatchewan	48.0
5	Université de Montréal	16,488	5	University of British Columbia	45.7
Rank	Comprehensive	#	Rank	Comprehensive	%
1	University of Waterloo	10,527	1	Concordia University	75.9
2	Simon Fraser University	5,843	2	University of Windsor	75.0
3	University of Guelph	5,500	3	York University	64.6
4	University of Victoria	5,449	4	Toronto Metropolitan University	62.6
5	York University	4,745	5	University of New Brunswick	59.9
Rank	Undergraduate	#	Rank	Undergraduate	%
1	University of Regina	1,848	1	Université du Québec en Abitibi-Témiscamingue	177.8
2	Brock University	1,326	2	Ontario Tech University	164.6
3	Wilfrid Laurier University	1,242	2	Université du Québec en Outaouais	136.2
4	Lakehead University	1,183	3	Université du Québec à Trois-Rivières	101.8
5	Ontario Tech University	944	5	University of Northern British Columbia	74.7

Notes for Research Publications:
 1. Based on full-service universities on the Top 50 Research Universities list for all five years; and had cross-sector and international publications between 2017-2021.
 2. University Cross-sector Collaboration Publications: publications that were co-authored with researchers from a Canadian non-university institution.
 3. University International Collaboration Publications: publications that were co-authored with researchers outside of Canada.
 4. Publications with multiple authors from different institutions were counted once for each university listed on the authored publication.
 5. Publication data were obtained from Observatoire des sciences et des technologies (Clarivate Analytics – Web of Science).

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PARTNER PERSPECTIVE

Waterloo partnership with NOSM University is advancing equity in health care and well-being in the north

Office of Research
University of Waterloo

Canada is facing a health care crisis due to escalating costs, a shortage of health-care professionals and increasing needs from an aging population. The effects of this crisis are felt more profoundly in remote, rural and Indigenous communities, where the shortage of health-care workers is greater. That's where the University of Waterloo's partnership with the Northern Ontario School of Medicine University (NOSM University) comes in.

Waterloo and NOSM University have been long-standing partners through clinical collaborations with Waterloo's School of Pharmacy. In 2022, NOSM

University became the first independent medical university in Canada. It signed a collaboration agreement with Waterloo in the same year to allow both institutions to work together towards improving and expanding health care in northern Ontario communities. NOSM University's expertise in social accountability, community-engaged research and medical education complement Waterloo's emphasis on interdisciplinary approaches to health research and extensive community partnerships.

Since the opening of the School of Pharmacy in 2008, the two universities have been partnering to recruit, train and retain health-care professionals in the north. The School of Pharmacy encourages students in its Doctor of Pharmacy program to train in

Northern Ontario communities, centred in Sudbury, Sault Ste. Marie and Thunder Bay, and collaborate with NOSM University's faculty and students. Throughout 24 weeks of patient care rotations, Pharmacy students can take part in inter-professional education initiatives with medical students, organized by the School and NOSM University.

"Practicing in the North is a fantastic opportunity for students to develop their skills and understand the uniqueness of these communities. Waterloo Pharmacy and NOSM University have a shared goal of educating professionals to provide equitable health care, particularly in communities that have limited access to services," says Andrea Edginton, Hallman director, School of Pharmacy at Waterloo.

Waterloo's world-class researchers and entrepreneurs also play a role in this partnership by developing technological advances and health data applications through the Transformative Health Technologies initiative. Waterloo's partnership with NOSM University helps bring together a diverse and interdisciplinary team with strong ties to remote, rural, Indigenous and Francophone communities to build health technologies that create equitable access to care.

As part of The Royal Society of Canada's 2023 Celebration of Excellence and Engagement (COEE), hosted in partnership with the University of Waterloo, a symposium was held on Health and Well-being for All by 2030: Application of

technology to global health problems and included NOSM University's David Savage, director of the Institute for Clinical Evaluative Sciences North. Earlier this year, the Centre for Bioengineering and Biotechnology hosted Waterloo for Health, Technology and Society which included a keynote address by David Marsh, vice dean, Research, Innovation and International Relations at NOSM University on virtual care in Ontario before and during the COVID-19 pandemic.

Additionally, a newly established graduate student exchange program between Waterloo and NOSM University allows Waterloo graduate students to live and engage in research at NOSM University while NOSM University students do the same at Waterloo.

The exchanges run for four to 16 weeks at the host institution.

"The goal of the graduate student exchange program is to encourage new collaborations focused on research and graduate student experience with NOSM University," says Grace Gomashie, project co-ordinator, Health Initiatives at Waterloo. "Having it available to grad students in all six faculties means that collaborative research and knowledge exchange can happen across multiple disciplines. Students in the Faculty of Mathematics, for example, can apply their skills and knowledge in artificial intelligence in creating innovative health solutions for hospitals. At the same time, Engineering students apply their skills in remote sensing and imaging technologies."

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PARTNER PERSPECTIVE



Amir Asif
Vice-President
Research & Innovation
York University

A greener tomorrow relies on academic research and innovation

Ranked among the top 40 universities worldwide for advancing the United Nations Sustainable Development Goals – including climate action – York is well-positioned to steer us towards a more sustainable future for both Canada and the world. Long recognized for our strengths in sustainability-relevant research, teaching, partnerships and campus practices, York University has become an international leader in combating climate change.

Adopting a whole-institution approach, York has accelerated its timeline and pledged to achieve net zero emissions by 2040 – a decade sooner than its previous commitment. We also recently released our own comprehensive emissions data and ecological footprint assessment, the first Canadian institution to do so.

The establishment of a \$1 million Sustainability Innovation Fund for sustainability projects on our campuses supports our ambitious net zero goal. From previous SIF

supported projects on large battery electricity storage to the development of an on-site composting centre to an annual Green Career Fair, York's community of change-makers are dedicated to making tangible impacts and creating more sustainable ways of living.

Through community efforts, York has diverted more than 70 per cent of its waste from landfills, abating more than 26,000 metric tons of carbon, equivalent to planting more than 1.2 million trees or eliminating 61,800 barrels of oil. York boasts the highest recycling rate of any post-secondary institution in Ontario and is among the top 100 greenest employers in Canada.

York's commitment to sustainability extends even further with a \$2 million investment from the federal government's decarbonization incentive program, enhancing our capacity to deliver energy efficient utilities on our campuses. With more than 1.2 million square feet of green buildings, York operates

as a living lab for our researchers, spanning the Keele and Glendon Campuses, along with Las Nubes, our EcoCampus in Costa Rica, which focuses on environmental conservation.

But perhaps most notable is York's research enterprise, supported by a new Strategic Research Plan 2023-2028, which has long prioritized studying climate change. Research in this area is a York tradition, dating back to 1968 when we took the pioneering step to become the first university in Canada to establish a faculty of environmental studies.

York broke new ground once more in 2020 when we launched the Faculty of Environmental and Urban Change, which combined the environmental studies faculty with the department of geography, bringing together a critical mass of physical geographers, ecologists, social scientists, humanities researchers, and artists to address a broad range of global environmental concerns.

York's leading expertise on climate-related research spans all 11 faculties, with distinct strengths in bee ecology, refugee studies, and water. For example, when it comes to water, the University delivers more than 30 programs relevant to SDG 6 - clean water and sanitation. York is also the academic lead for the UNITAR Global Water Academy, a multi-stakeholder collaboration that delivers innovative training and builds human capacities on large scale water-related issues.

Recent investments of more than \$4 million from York's Catalyzing Interdisciplinary Research Clusters program have funded projects that include engineer Satinder Brar's studies of water remediation and geographer Tarmo Remmel's investigation into the effects of climate change on ecosystems and human populations.

As an institution founded on the principles of social justice, York has a unique lens that also views climate change as an

equity issue. The work of political scientist Yvonne Su exemplifies this perspective. Her research on migration uncovers the unequal consequences of climate change, disproportionately affecting low-income and vulnerable people in the Global South and in Indigenous communities, who more often face displacement after a climate-related disaster.

Universities play a pivotal role in the knowledge economy and in the formulation of robust policies to address climate change. Investment in research and innovation is crucial to fostering forward-thinking ideas and creative solutions that serve the public good and aid public policy.

In the world's ongoing fight against climate change, global higher education is one of society's most valuable resources. York University stands ready to continue to lead on this issue and act as a trusted partner for the public and private sector.

Governments and companies hold the power to turn big ideas into action, and policymakers hold the pen to implement real-world solutions. Leveraging academic research and innovation offers the best bet for our planet, and our future.

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McMaster University



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Nuclear Energy would be a clean win for remote and northern communities

As Canada and the world strive to reach net-zero emissions by 2050, the need to take urgent action is clear.

Record-breaking wildfires, extreme weather events and alarming temperature spikes in the Arctic and in Antarctica underline the urgency to decarbonize our energy generation to help minimize the negative effects of climate change. Yet, moving toward a more sustainable future has been a disappointingly slow process.

Greater use of nuclear power – especially small modular reactors (SMRs) and microreactors – is key for Canada, particularly for our remote and northern communities, where traditional grid options are not feasible.

That's why it's so welcome that the Ontario government made recent commitments to boosting the province's nuclear energy portfolio by expanding Bruce Power's generating capacity; building a

total of four SMRs at Darlington; and refurbishing the province's existing nuclear facilities.

The decision to move Ontario toward a more modern, carbon-neutral energy grid and to create the infrastructure that can drive electrification across all sectors will help to ensure a robust economy and our net-zero future. These forward-looking steps will help provide stable, clean, safe and reliable electricity for decades.

That's great news for those in populated areas where electricity is readily available. But what about the nearly 300 remote and northern communities across Ontario and Canada that are not connected to the electricity grid and are suffering from energy poverty?

Many of these communities rely on dirty and limited power from diesel generators that are proven to be detrimental to human and environmental health.

These communities need to be central to the country's national energy agenda. The addition of nuclear energy would be transformative for them.

The cost of connecting these communities by power lines to traditional centralized grids is prohibitive, measuring in the billions of dollars per community.

Microreactors – very small SMRs – offer a promising solution to address this gross disparity, and to enable remote and Indigenous communities to be partners in Canada's clean energy future.

Microreactors can provide clean, safe and abundant energy. They can create power to help provide clean drinking water through better treatment and purification, as well as power greenhouses to grow fresh vegetables and fruit, creating greater food security. They can also produce carbon-neutral fuels such as hydrogen to drive economic growth and

achieve energy independence regionally.

Microreactors are safe, compact, cost-effective and ideal for small-community deployment.

At McMaster University, we know first-hand that small reactors can be safely and productively embedded within communities. We've been home to one for nearly 65 years.

Our reactor is unique in Canada. It's set in the heart of the campus in the west end of Hamilton and is an international hub for vital research, as well as a source of medical isotopes for patients in Canada and around the world.

Our experts are advancing research in SMR technologies to advise our industry and government partners on design, safety and deployment. As the headquarters for Canada's small modular advanced reactor training (SMART) program, we're developing highly skilled professionals

to be the country's next generation of nuclear scientists, engineers and policymakers.

This past spring, we hosted a meeting of the Indigenous Advisory Council for Canada's SMR action plan – designed to ensure a national Indigenous leadership voice on the development of SMRs in Canada. The council's commitment to the action plan is a positive step that will help interested Indigenous communities advance clean-energy solutions and nuclear educational programs.

Together, the university, the government, Indigenous partners and remote communities can find a way to use nuclear power to create a clean-energy future that leaves no community behind and builds a sustainable path toward net-zero emissions.

Originally published in Policy Options

COVER STORY

Solving Global Challenges Through Research Partnerships and Collaborations

Continued from page 12



in Migration and Integration at Toronto Metropolitan University and Scientific Director of Bridging Divides.

TMU is leading a new seven-year program to understand the socio-economic and technological changes that can help immigrants – as well as all Canadians – improve their health, employment, citizenship and social engagement.

The Migrant Integration in the Mid-21st Century: Bridging Divides program received \$98.6 million in April from the Canada First Research Excellence Fund – the single largest grant in TMU's history. The program's 35 research leaders are collaborating with more than 100 scholars from TMU, Concordia University, University of British Columbia and University of Alberta.

"Our university's excellence in this area is predicated on over 30 years of research related to migration and settlement," explained Dr. Steven N. Liss, TMU's Vice-President, Research and Innovation. "We also have a deep pool of faculty cutting across several faculties. It allows us, in collaboration with our partners, to look at the issue of migrant integration from a variety of lenses."

The goal is to produce practical solutions that can be used by governments and not-for-profit groups to modernize immigration policies to build communities that are equitable, resilient and inclusive to migrants. This is a particular challenge in smaller cities with labour shortages and an aging population.

"It comes down to the basic infrastructure and support systems that allow people the freedom to be productive members of society," said Liss. "We don't want to leave any Canadians behind, including new Canadians."

"Compared to many other countries, Canada is doing generally great in terms of migration and migrant integration," added Triandafyllidou. "But it's a bit like a marriage. You have to keep working at it."

eCAMPUSONTARIO Collaborative portal makes innovating easier

If governments want more than 2% of Canadian businesses to invest in research and development, don't make innovation so difficult.

In Ontario alone, there are 56 post-secondary institutions, along with myriad accelerators, funding programs and other

innovation supports. Where is a small or medium company with limited time and resources to start?

A new online matchmaking platform is using artificial intelligence to offer a solution.

"With the Ontario Collaborative Innovation Platform (OCIP), we're working with our partners to create 'no wrong door' to the innovation ecosystem," said Robert Luke, CEO, eCampusOntario, a consortium of the province's publicly assisted colleges, universities and Indigenous institutes whose mission is to advance innovation, collaboration and digital by design education.

Officially rolled out in September and funded by the Ontario Ministry of Colleges and Universities, OCIP provides an easy-to-use portal where companies can register and then fill out a form providing an overview of their challenge, and some basic information about their business. The platform then matches them to an expert who provides a confidential assessment on what's needed to go from idea to invoice.

"The system connects with our member institution research offices to ensure faster facilitation of projects and grant applications should the business wish to do this," said Luke.

As of November, more than 80 businesses had registered with OCIP. Over the past two years more than 100 projects have been supported, including with the City of Toronto and in conjunction with the Richmond Hill Small Business Enterprise Centre.

PharmaGuide, for example, needed expert help to advance a new cloud-based pharmacy tool. OCIP matched the Richmond Hill, Ont. company with OCAD University and funding to further develop an inventory management system powered by a machine-learning algorithm. Pharmaceutical giant Pfizer has since invested in the startup.

OCIP has also partnered with the Industrial Research Assistance Program to make it easier for Indigenous businesses in rural and remote areas to connect to innovation accelerators in large cities.

"This pilot project is funding the scoping process that can help Indigenous businesses accelerate their innovation journey," said Luke. "These are vital entrepreneurial activities that are helping to support economic reconciliation."

UNIVERSITY OF WATERLOO Using AI and 5G to quickly identify structural defects

Canada is facing an estimated \$150 billion infrastructure deficit, with extreme weather related to climate change putting thousands of bridges, buildings and other aging structures at even greater risk of catastrophic failure.

Prioritizing which structures are in greatest need of repair or replacement is difficult and time consuming, especially in rural and remote areas.

That's about to change. Rogers Communications is leveraging an established partnership with the University of Waterloo to test a technology that uses 5th generation (5G) cellular networks, artificial intelligence (AI), sensors, robots and augmented and virtual reality to assess in real-time the structural integrity of bridges, cellular and hydro towers, and other civic infrastructure.

"For all those technologies to work, you need a high-speed, low-latency, high-capacity network, which is what Rogers brings to the table with its 5G network," said Neel Dayal, Senior Director, Partnership and Innovation, Rogers Communications.

Rogers wants to transform the technology into a service aimed at government departments, such as transportation and civil engineering companies. Initially, it will likely be used to inspect Roger's national network of over 4,000 cell towers.

"There aren't enough inspectors to visit every site, especially in remote areas. This is a particular challenge with bridges which are supposed to be inspected every two years," said Dr. Chul Min Yeum, Assistant Professor in Waterloo's Civil and Environmental Engineering department, and Rogers' collaborator on the project.

The goal of the Remote Inspection Platform is to develop immersive representations of job sites that provide inspectors with far more information than would be possible with a typical onsite visual inspection. Drones in the air and robots on the ground scan the structure, transferring data from cameras and sensors to a remote server via the Rogers 5G network for processing with AI.

"We want to create a type of industrial virtual space where onsite and remote

human engineers and their robotic counterparts work together in an immersive environment in real-time to do inspections," said Yeum.

"As more data is collected over time," added Dayal, "we will be able to develop a comprehensive catalogue that can inform how we design structures to be more resilient to climate change."

HUMBER COLLEGE Developing a "safety net" for GPS failures

Much of North America's critical infrastructure, from transportation systems and stock markets to electric grids and air-traffic control, rely on GPS for uninterrupted access to satellite positioning, navigation and timing services. But GPS transmissions are vulnerable to disruptions caused by interference, solar flares, cyber attacks and other risks. Without these vital timing capabilities, the Canadian and U.S. economies would come to a standstill.

"We're looking at a resilient solution, called Broadcast Positioning System (BPS), that could provide a GPS safety net for many sectors. It's a solution that is possible through the new television broadcast standard known as ATSC 3.0. This new terrestrial transmission stan-

“Panic quickly ensues in organizations when a cyberattack happens. We're trying to mimic that panic in an immersive and interactive simulated environment, with the uOttawa-IBM Cyber Range.”

DR. SYLVAIN CHARBONNEAU
Vice-President, Research and Innovation, University of Ottawa

dard offers precision timing capabilities that can help augment potential outages or massive kinds of system failures that might happen," said Orest Sushko, Director of the Broadcast-Broadband Convergence B²C Lab, located at Humber College.

Established in 2022, the B²C Lab is the first-of-its kind front-facing industry research facility in North America. It is equipped with both an ATSC 3.0 broadcast system and multiple 5G core networks, combining the best of global data delivery standards technologies. The ATSC 3.0 next-generation television standard can converge with other networks including 5G, Wi-fi and Bluetooth.

"Convergence allows the formation

of a heterogeneous network where IP (internet protocol) data can move across all these systems creating a network of networks," said Sushko.

The B²C Lab was granted Canada's first and only ATSC 3.0 developmental (experimental) broadcast license, with three broadcast transmitter sites covering the Toronto region. A fourth site will soon be co-located atop the CN Tower, expanding coverage to 25% of Canada's marketplace.

"Humber's testbed configuration offers the triangulation necessary to further develop terrestrial Position Navigation and Timing solutions," said Sushko.

Current research on BPS has been presented and demonstrated on Humber's testbed with Avateq Corporation, a Markham, Ont.-based RF equipment manufacturer, New Jersey-based Triveni Digital, a broadcast solutions company, and the U.S. National Association of Broadcasters.

Sushko described the research as "a work in progress", adding that BPS is but one component of B²C Lab research. "We work with a variety of industry stakeholders that are interested in developing both television and non-television applications using the new ATSC standard."

UNIVERSITY OF OTTAWA Mimicking a cyberattack to protect victims

Canada experienced nearly 71,000 malicious cyber threats with over \$530 million stolen in 2022, according to the Canadian Anti-Fraud Centre.

A new partnership between the University of Ottawa and IBM is countering this threat with a unique training and research hub that uses hyper realistic simulations to train students, government bureaucrats and industry professionals on how to identify, respond to, manage, contain, and remediate cyberattacks.

"Panic quickly ensues in organizations when a cyberattack happens. We're trying to mimic that panic in an immersive and interactive simulated environment," said Dr. Sylvain Charbonneau, uOttawa's Vice-President, Research and Innovation.

Launched in October, the uOttawa-IBM Cyber Range is IBM's third training hub globally and the only one in an academic institution. IBM pledged more than \$21 million in-kind contributions over five years to support the hub, and uOttawa committed nearly \$7 million.

Charbonneau said IBM was drawn by the university's strengths in cybersecurity, as well as its proximity to federal government departments, national security agencies, and the country's largest high-tech park. The hub involves academic experts from multiple disciplines, including software engineering, computer science, business management, law, and ethics.

Continued on page 17



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COVER STORY

Solving Global Challenges Through Research Partnerships and Collaborations

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Cyber Range will also train undergraduate and graduate students to help fill a workforce shortage of cybersecurity professionals. New microprograms and micro-credentials, including industry certifications, will also be offered to private and public sector professionals.

To better prepare business professionals in uncovering and investigating a cyberattack, some simulations will require them to scramble to respond to the technical, legal, and public relations demands associated with a data breach.

Researchers can watch this realistic chaos unfold in real-time from observing rooms to better understand the psychology and behaviour of both victim and perpetrator. One project with the Université de Montréal, bringing together experts from the faculties of law, social science and engineering, is examining the gap between legal frameworks and cybersecurity practices to inform more ethical policies and regulations.

Added Charbonneau: "Research and training need to be ongoing because the hackers will always be developing new tools to bypass our defences."

NIAGARA COLLEGE

Bringing AI-powered soil maps to farmers

Farmers have a new high-tech tool to measure and map the health of their soil, thanks to a seven-year collaboration between Niagara College and SoilOptix, a soil-mapping company in Southern Ontario.

But the process was time-consuming, taking each data analyst about eight hours to map every field.

To help, SoilOptix approached Dr. Mike Duncan, a research chair in computer technologies at Niagara College's Walker Advanced Manufacturing Innovation Centre. The research team used a mixed bag of technologies, including artificial intelligence and geographic information system (GIS) technology, to automate the process and reduce that time to less than an hour. They are now working to get this down to seconds.

"SoilOptix went from having one analyst map one field per day to 20 fields per day, with the ultimate target of having one analyst able to map a thousand fields per day by 2030," said Dr. Marc Nantel, Vice-President – Research, Innovation & Strategic Enterprises, Niagara College.

As a result of this partnership, SoilOptix has gone from mapping about 110,000 acres in 2019 to 500,000 acres in 2022, with its target this year set at approximately 800,000 acres. The company recently announced plans to expand its service to farmers in 51 European countries, including Ukraine.

Niagara College drew on its expertise in computer science and data programming to advance SoilOptix's technology. The company has since hired several Niagara College students who worked on the project.

"We help companies develop technol-

“ We help companies develop technology and products, but to commercialize and scale that up they need talent, and that's why they keep hiring our students. ”

DR. MARC NANTEL

Vice-President – Research, Innovation & Strategic Enterprises, Niagara College

SoilOptix's top-soil mapping sensor attaches to farm equipment that travels across fields collecting gamma rays emitted from the soil to measure soil nutrients, and minerals such as calcium, magnesium and potassium. The high-definition maps help farmers optimize the performance of their inputs (e.g., fertilizer, seeds, irrigation), strengthen soil health, and produce more food at less cost.

ogy and products, but to commercialize and scale that up they need talent, and that's why they keep hiring our students," said Nantel.

"The biggest advantage to working with college applied research is that we don't just give companies a solution at the end," he added. "We try to make sure that they have the in-house capacity to continue to be innovative."

SENECA POLYTECHNIC

New rapid test could help save citrus industry

Seneca Polytechnic recently partnered with an Ottawa biomarker manufacturer to develop a new diagnostic that could help save the USD\$3-billion citrus industry.

Huanglongbing disease, or citrus greening, is the most serious disease affecting citrus, according to the U.S. Department of Agriculture. The bacterial disease is difficult for farmers to detect as trees can remain asymptomatic for months to years after infection.

Evik Diagnostic Innovations approached Seneca for specialized expertise in developing a rapid test that would allow farmers to quickly identify the disease to prevent the spread. The concept is similar to a do-it-yourself COVID-19 test.

Evik manufactures medical diagnostic components such as assay reagents in the form of freeze-dried pellets. The assay reagents are used in point-of-care disposable tests to detect and analyze medical symptoms and infectious diseases such as COVID-19, HIV and anthrax. Evik approached Seneca for assistance in developing primers – key ingredients in DNA synthesis – that can detect this specific citrus pathogen.

"We have worked with Evik on numerous projects supporting the development of foundational molecular testing technologies and reagents to detect pathogens, including for a bacteria that causes Legionnaires' disease, so we were a logical partner to help in adapting their platform for agricultural applications," said Ben Rogers, Dean, Seneca Applied Research.

The research collaboration succeeded in developing a proof-of-concept, and discussions have begun on refining the technology and developing a more sophisticated lab test that would provide farmers with more detailed information about specific pathogens. Once commercialized, this new application would allow Evik to break into the plant diagnostics market.

Seneca Applied Research works with more than 100 small- and medium-sized companies and community partners in three priority areas: artificial intelligence, health and social innovation, and life sciences.

"Seneca Applied Research provides a single point of contact where partners can leverage our equipment and expertise, and access to funding to solve partner-driven challenges," said Rogers. "Working with our students is one of the biggest benefits, and our research partners frequently hire student research assistants after they graduate."

PROTEIN INDUSTRIES CANADA

A plant-based solution to food security

Global food systems account for 20-25% of global CO2 emissions, with a large portion of that coming from animal agriculture and the use of synthetic fertilizers.

Protein Industries Canada believes a global shift to more plant-based protein can significantly reduce the food sector's emissions, while ensuring everyone on the planet has healthy and nutritious food. The organization is working with partners here and abroad to maximize the innovation potential of crops like pulses and canola to build a \$25-billion industry employing 17,000 workers by 2035.

"The development of supply chains over the next number of years requires us

“ We have about 500 scientists but have access to about 4,000 more through our collaborations with our partners internationally and in Canada. Putting all those brains together can amplify and fast-track solutions. ”

DR. JASPINDER KOMAL
Assistant Deputy Minister at DRDC

to incentivize innovation and ingredient manufacturing so we can be at the forefront of a once-in-a-generation economic opportunity that plant-based foods represent," said Bill Greuel, CEO of Protein Industries Canada, one of Canada's five industry-led Global Innovation Clusters.

Protein Industries Canada recently received \$150 million in renewed federal funding to establish the infrastructure, expertise and processing innovation to transition Canada from a commodity supplier of crops to a leading supplier of plant-based ingredients and finished food products.

Building a successful industry depends on developing products that consumers want.

"The biggest innovation gaps in this sector are around taste, texture and price," said Greuel. "If it doesn't taste good and it's too expensive, consumers are not going to eat it."

In one project, Protein Industries Canada collaborated with Toronto-based New School Foods on a proprietary technology that uses a plant-based protein to mimic the whole muscle cuts of meat. "It cuts and flakes just like a real salmon fillet," he said.

Protein Industries Canada also struck a new \$20-million partnership with Innovate UK, the UK's national innovation agency, to develop new plant-based ingredients, foods and animal feed. It is working to forge similar partnerships between companies in Canada, Asia, the

U.S., and the Netherlands – the world's second-largest exporter of agricultural products.

"The first pillar of our international engagement strategy is creating new markets," said Greuel. "That means having more high-value Canadian ingredients and food products embedded in the supply chains of food manufacturers on a global basis."

DEFENCE RESEARCH AND DEVELOPMENT CANADA

Securing a more complex world

Defence and security are growing areas of concern for Canada and its allies. To mitigate potential threats, Canada collaborates with NATO's 30-plus member countries, the Five Eyes intelligence alliance, and other allied nations such as Japan.

Defence Research and Development Canada (DRDC) is a major player in these collaborations. The S&T organization of the Department of National Defence operates seven research centres across Canada, focusing on a broad range of challenges, from designing better body armour for female soldiers to using artificial intelligence to improve decision making in the field.

"We have about 500 scientists but have access to about 4,000 more through our collaborations with our partners internationally and in Canada. Putting all those brains together can amplify and fast-track solutions," said Dr. Jaspinder Komal, Assistant Deputy Minister at DRDC.

The United States is Canada's largest and longest standing S&T partner when it comes to defence and security. A significant collaboration is a \$4.23-billion program for modernizing the North American Aerospace Defence Command (NORAD), which includes initial funding of \$266 million for priorities such as hypersonic and advanced cruise missile defence, undersea surveillance, quantum technologies, and enabling defence R&D in the Arctic.

DRDC also collaborates with the Department of Homeland Security S&T Directorate on S&T for critical infrastructure protection and border security.

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Université du Québec à Trois-Rivières

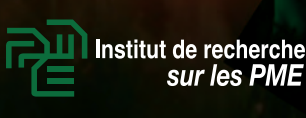
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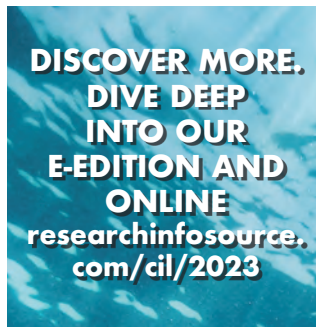
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Canada's TOP 40 RESEARCH HOSPITALS 2023

Rank		Health Organization	Research Spending			Research Intensity		Prov	Main Affiliated Research Centre(s)/Institute(s)
2022	2021		FY2022 \$000	FY2021 \$000	% Change 2021-2022	Researcher \$ per Researcher \$000	Hospital \$ as % of Total Hospital Spending		
1	1		University Health Network (UHN)	\$474,600	\$452,954	4.8	\$581.6		
2	2	Hospital for Sick Children	\$294,224	\$278,139	5.8	\$690.7	27.3	ON	SickKids Research Institute
3	3	McGill University Health Centre (MUHC)	\$231,655	\$196,780	17.7	\$463.3	14.0	QC	Research Institute of the MUHC
4	5	Vancouver Coastal Health Authority	\$168,824	\$174,510	-3.3	\$381.1	3.5	BC	Vancouver Coastal Health Research Institute (VCHRI), Providence Research
5	4	Provincial Health Services Authority	\$162,523	\$188,828	-13.9	\$172.7	3.5	BC	BC Cancer Research Institute, BC Children's Hospital Research Institute, Women's Health Research Institute
6	6	Ottawa Hospital	\$153,481	\$149,560	2.6	\$395.6	8.6	ON	Ottawa Hospital Research Institute, Ottawa Heart Institute Research Corp
7	9	London Health Sciences Centre/St. Joseph's Health Care London (a)	\$137,414	\$129,832	5.8	\$776.4	7.1	ON	Lawson Health Research Institute
8	7	Hamilton Health Sciences	\$133,563	\$138,423	-3.5	\$235.6	7.3	ON	Population Health Research Institute, Thrombosis and Atherosclerosis Research Institute, Escarpment Cancer Research Institute
9	10	Sunnybrook Health Sciences Centre	\$128,441	\$102,896	24.8	\$329.3	9.8	ON	Sunnybrook Research Institute
10	8	CHU de Québec - Université Laval	\$120,173	\$136,807	-12.2	\$349.3	7.3	QC	Centre de recherche du CHU de Québec - Université Laval
11	11	Unity Health Toronto	\$104,489	\$94,618	10.4	\$924.7	7.6	ON	Li Ka Shing Knowledge Institute, Keenan Research Centre for Biomedical Science
12	13	Centre hospitalier de l'Université de Montréal (CHUM)	\$95,619	\$84,887	12.6	\$191.2	5.7	QC	Centre de recherche du CHUM
13	12	Sinai Health	\$93,664	\$92,528	1.2	\$720.5	12.8	ON	Lunenfeld-Tanenbaum Research Institute, Bridgepoint Collaboratory for Research and Innovation
14	15	CIUSSS de la Capitale-Nationale	\$88,255	\$76,899	14.8	\$258.1	3.9	QC	CERVO, VITAM, CRUJeF, CIRRIIS
15	14	Centre for Addiction and Mental Health	\$86,585	\$79,669	8.7	\$512.3	16.3	ON	Campbell Family Mental Health Research Institute, Krembil Centre for Neuroinformatics, Azrieli Centre for Neuro-Radiochemistry
16	19	Alberta Health Services - Edmonton Zone	\$66,706	\$51,921	28.5	\$195.0	na	AB	
17	16	CIUSSS de l'Estrie - Centre Hospitalier Universitaire de Sherbrooke (CHUS)	\$62,027	\$61,874	0.2	\$124.3	3.5	QC	Centre de recherche du CHUS, Centre de recherche sur le vieillissement, Institut universitaire de première ligne en santé et services sociaux
18	18	CHU Sainte-Justine	\$58,360	\$53,246	9.6	\$205.5	8.7	QC	Centre de recherche du CHU Sainte-Justine
19	17	CIUSSS du Centre-Ouest-de-l'île de Montréal	\$58,011	\$56,119	3.4	\$262.5	4.8	QC	Lady Davis Institute for Medical Research
20	20	Montreal Heart Institute	\$41,117	\$46,793	-12.1	\$399.2	14.9	QC	Montreal Heart Institute Research Centre
21	21	CIUSSS de l'Est-de-l'Île-de-Montréal	\$34,750	\$33,117	4.9	\$181.0	1.7	QC	Centre de recherche de l'Hôpital Maisonneuve-Rosemont, Centre de recherche de l'Institut universitaire de santé mentale de Montréal
22	24	St. Joseph's Healthcare Hamilton	\$33,792	\$27,676	22.1	\$185.7	4.5	ON	Research Institute of St. Joe's Hamilton
23	22	Institut universitaire de cardiologie et de pneumologie de Québec - Université Laval	\$32,892	\$32,865	0.1	\$427.2	8.8	QC	Centre de recherche de l'Institut universitaire de cardiologie et de pneumologie de Québec - Université Laval
24	28	Alberta Health Services - Calgary Zone	\$32,613	\$25,282	29.0	\$407.7	na	AB	
25	23	Kingston Health Sciences Centre	\$31,393	\$29,056	8.0	\$106.8	4.3	ON	Kingston General Health Research Institute
26	27	Children's Hospital of Eastern Ontario	\$31,022	\$26,278	18.1	\$233.2	7.7	ON	Children's Hospital of Eastern Ontario Research Institute
27	30	Nova Scotia Health Authority	\$27,881	\$24,318	14.7	\$91.4	1.0	NS	
28	26	Baycrest	\$25,966	\$26,332	-1.4	\$961.7	12.7	ON	Rotman Research Institute
29	25	CIUSSS de l'Ouest-de-l'Île-de-Montréal	\$25,662	\$26,565	-3.4	\$383.0	1.9	QC	Douglas Hospital Research Centre
30	31	CIUSSS du Centre-Sud-de-l'Île-de-Montréal	\$25,624	\$23,419	9.4	\$94.9	1.0	QC	Centre de recherche-Institut universitaire de gériatrie de Montréal, Institut universitaire sur la réadaptation en déficience physique de Montréal, universitaire sur les dépendances
31	32	Women's College Hospital	\$19,732	\$17,394	13.4	\$346.2	10.4	ON	Women's College Research Institute, Women's College Hospital Institute for Health System Solutions and Virtual Care
32	33	The Royal	\$17,289	\$15,253	13.3	\$221.7	8.8	ON	University of Ottawa Institute of Mental Health Research
33	29	Health Sciences Centre Winnipeg	\$17,094	\$24,419	-30.0	\$110.3	2.4	MB	
34	35	St. Boniface Hospital	\$12,834	\$12,971	-1.1	\$356.5	3.1	MB	Albrechtsen Research Centre
35	34	Holland Bloorview Kids Rehabilitation Hospital	\$12,664	\$13,094	-3.3	\$666.5	12.2	ON	Bloorview Research Institute
36	36	IWK Health Centre	\$12,587	\$12,220	3.0	\$114.4	3.9	NS	Centre for Pediatric Pain Research
37	39	Bruyère	\$12,369	\$10,275	20.4	\$274.9	5.4	ON	Bruyère Research Institute
38	40	Hôpital Montfort	\$11,810	\$9,454	24.9	\$107.4	4.4	ON	Institut du Savoir Montfort
39	37	Trillium Health Partners	\$11,790	\$11,382	3.6	\$153.1	0.9	ON	Institute for Better Health
40		Health Sciences North	\$10,363	\$9,009	15.0	\$82.2	1.7	ON	Health Sciences North Research Institute

Notes:

1. Research spending includes all funds (direct and indirect) spent on all sources (internal and external) to support research.
2. Data were obtained through a survey of public health organizations.
3. FY2021 figures may have been adjusted as more accurate information became available.
4. Researcher headcounts include full and part-time researchers, scientists, investigators and clinician-researchers with a faculty appointment who actively conducted research in Fiscal 2022.
5. Data are provided for the main health organization including their affiliated hospitals and research centres/institutes, where applicable.

na = Not available

(a) Research spending amounts were combined as these hospitals have one research institute.

CANADA'S TOP 40 Research Hospitals

Hospital Research Spending Rebounds
In Fiscal 2022, *Canada's Top 40 Research Hospitals* posted a respectable gain in research spending of 4.7% over Fiscal 2021. The combined research spending of the Top 40 was \$3.20 billion, up from \$3.06 billion. Research spending increased at 30 Hospitals, Hospital Networks and Health Authorities and declined at only 10 of the others. The number of health researchers was 10,135, a 2.6% increase over Fiscal 2021.

University Health Network (UHN) led the national ranking, with outlays of \$474.6 million, up 4.8% from Fiscal 2021. Hospital for Sick Children ranked in second spot (\$294.2 million, up 5.8%), followed by McGill University Health Centre (MUHC) in third (\$231.7 million, up 17.7%). Vancouver Coastal Health Authority moved into fourth spot (\$168.8 million, down -3.3%). Provincial Health Services Authority dropped to fifth place (\$162.5 million, down -13.9%). Ottawa Hospital maintained sixth position (\$153.5 million, up 2.6%). With an increase of 5.8% in their research spending in Fiscal 2022 to \$137.4 million, London Health Sciences Centre/St. Joseph's Health Care London moved into seventh place, up from ninth in Fiscal 2021.

\$100 Million Club

In Fiscal 2022, 11 institutions – up from 10 – each recorded research spending in excess of \$100 million. The elite group in the *\$100 Million Club* recorded

\$100 Million Club		
2022 Rank	Hospital	Research Spending \$000
1	University Health Network (UHN)	\$474,600
2	Hospital for Sick Children	\$294,224
3	McGill University Health Centre (MUHC)	\$231,655
4	Vancouver Coastal Health Authority	\$168,824
5	Provincial Health Services Authority	\$162,523
6	Ottawa Hospital	\$153,481
7	London Health Sciences Centre/St. Joseph's Health Care London	\$137,414
8	Hamilton Health Sciences	\$133,563
9	Sunnybrook Health Sciences Centre	\$128,441
10	CHU de Québec - Université Laval	\$120,173
11	Unity Health Toronto	\$104,489

combined research spending of \$2.11 billion, up 8.2% over Fiscal 2021, and accounted for 66% of total national research spending, up from 64% of the total the year prior. New to the Club this year was Unity Health Toronto.

Research Spending Growth

Compared with the national research spending gain of 4.7%, 15 organizations recorded increases of more than 10% in their research activity in Fiscal 2022. Six of them reported research spending growth of more than 20%: Alberta Health Services – Calgary Zone and Edmonton Zone were both up 29.0% and 28.5% respectively in Fiscal 2022. Others of note were Hôpital Montfort (up 24.9%), Sunnybrook Health Sciences Centre (up 24.8%), St. Joseph's Healthcare Hamilton (up 22.1%) and Bruyère (up 20.4%).

Researcher Intensity

Research Infosource measures research intensity in two ways: by researcher (research spending per researcher), and by hospital (hospital research spending as a percent of total hospital spending). In Fiscal 2022, at the national level, researcher intensity increased by 2.0% to an average of \$315,700 of spending per researcher, and the national hospital intensity was 6.3%, a decrease of -3.7% between Fiscal 2021 and Fiscal 2022.

At \$924,700 of spending per researcher, Unity Health Toronto led its Large hospital peers, followed by London Health Sciences Centre/St. Joseph's Health Care London (\$776,400 per researcher) and University Health Network (\$581,600 per researcher). In the Medium hospital category, Sinai Health (\$720,500 spending per researcher) was the most researcher-intensive institution, followed by Hospital for Sick Children (\$690,700 spending per researcher) and in third spot, Centre for Addiction and Mental Health (\$512,300 per researcher). In the Small category Baycrest (\$961,700 spending per researcher) was the most researcher-intensive institution and also led the national results. In second place in the Small category was Holland Bloorview Kids Rehabilitation Hospital (\$666,500 spending per researcher), followed in third by Institut universitaire de cardiologie et de pneumologie de Québec - Université Laval (\$427,200 spending per researcher).

Measured by hospital intensity (proportion of total hospital spending accounted for by research), University Health Network led the Large hospital category, devoting 16.9% of its total hospital spending to research in Fiscal 2022. Hospital for

Spotlight on Hospital Research Activity FY2022

Top Researcher-Intensive Organizations (Research Spending per Researcher)

Rank	Large	\$000	Rank	Medium	\$000	Rank	Small	\$000
1	Unity Health Toronto	\$924.7	1	Sinai Health	\$720.5	1	Baycrest	\$961.7
2	London Health Sciences Centre/St. Joseph's Health Care London	\$776.4	2	Hospital for Sick Children	\$690.7	2	Holland Bloorview Kids Rehabilitation Hospital	\$666.5
3	University Health Network (UHN)	\$581.6	3	Centre for Addiction and Mental Health	\$512.3	3	Institut universitaire de cardiologie et de pneumologie de Québec	\$427.2

Top Hospital-Intensive Organizations (Research Spending as % of Total Hospital Spending)

Rank	Large	%	Rank	Medium	%	Rank	Small	%
1	University Health Network (UHN)	16.9	1	Hospital for Sick Children	27.3	1	Montreal Heart Institute	14.9
2	McGill University Health Centre (MUHC)	14.0	2	Centre for Addiction and Mental Health	16.3	2	Baycrest	12.7
3	Sunnybrook Health Sciences Centre	9.8	3	Sinai Health	12.8	3	Holland Bloorview Kids Rehabilitation Hospital	12.2

Note: Hospital size is based on Fiscal 2022 total hospital spending: Large = more than \$1 billion; Medium = \$400 million to \$1 billion; Small = less than \$400 million.

Top 40 – Leading Provinces

Province	% of Total
Ontario (20)	57
Quebec (12)	27
British Columbia (2)	10

Sick Children (27.3%), the leader for the Medium category also posted the highest portion of research spending nationally. Montreal Heart Institute topped the Small category (14.9%).

Provincial Performance

In Fiscal 2022, 20 Ontario health organizations on the Top 40, accounted for \$1.82 billion of the total national hospital research spending, or 57% of the total (up 6.5%). Quebec's 12 institutions accounted for \$874.1 million, representing 27% of the national total (up 5.4%). Two health organizations from British Columbia posted \$331.3 million of research spending (down -8.8%), or 10% of the national total, down from 12% of the total the year prior.

This Year and Next

Fiscal 2022 was a healthy year for hospital research compared with Fiscal 2021. Research spending reached an all-time high of \$3.20 billion. Thirty health organizations saw their research spending increase compared with last year, when a majority (23) reported spending declines. Presumably, emergency COVID-19 research funding was flowing freely in Fiscal 2022 and that accounted for much of the robust results.

Of course, year-on-year results typically fluctuate, which is why it is more important to consider

Top 10 Research Hospitals by Research Spending Growth

2022 Rank	Hospital	% Change 2021-2022
1	Alberta Health Services - Calgary Zone	29.0
2	Alberta Health Services - Edmonton Zone	28.5
3	Hôpital Montfort	24.9
4	Sunnybrook Health Sciences Centre	24.8
5	St. Joseph's Healthcare Hamilton	22.1
6	Bruyère	20.4
7	Children's Hospital of Eastern Ontario	18.1
8	McGill University Health Centre (MUHC)	17.7
9	Health Sciences North	15.0
10	CIUSSS de la Capitale-Nationale	14.8

longer term trends. Research spending growth of 4.7% this year follows tepid growth of 0.1% last year and strong 5.8% growth the prior year. One wonders, though, about the real spending power of available resources. Clearly, high inflation will erode effective spending and if it persists, then rising research spending figures may simply mask an eroding position.

Governments are the largest funders of health research and it is no secret that their budgets are strained. The Federal Government has already signaled cutbacks in next year's spending. While next year's results – Fiscal 2023 – might dodge cutbacks, future years' resources might not.

REGENERATIVE MEDICINE | PARKINSON'S | PATIENT DECISION AIDS | NEWBORN HEALTH | BLOOD CLOTS
CAR-T IMMUNOTHERAPY | SPACE TRAVEL | DIGITAL HEALTH | BIOMANUFACTURING | TUBERCULOSIS

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COVER STORY

Solving Global Challenges Through Research Partnerships and Collaborations

Continued from page 17

That partnership has since expanded to include law enforcement and a broader range of emergency management threats such as fires, floods, and extreme weather.

"In the early 2000s, we were looking at threats from biological weapons like anthrax," said Komal. "Now we're facing other threats, such as a drone dropping a bomb, a cybersecurity attack, or wildfires and flooding, like we saw across Canada this summer."

DRDC partnered with DHS S&T this summer to test new ground sensors

for early detection of wildfires. Sensors were deployed at Canadian Forces Base Valcartier and the municipality of Baie-Comeau to detect airborne levels of particulate matter and volatile organic compounds (e.g., carbon monoxide) from a controlled burn. Early results were promising, with several wildfires identified within 30-60 minutes of starting.

"Early detection of wildfires will allow responders to act earlier and more effectively to save communities," said Komal.

INTERNATIONAL DEVELOPMENT RESEARCH CENTRE

Partnering with the Global South

More than 80% of the estimated 110 million refugees and migrants worldwide are hosted in countries in the Global South. But more than 90% of the science that informs decisions about these forcibly displaced people comes from researchers and funders based in the Global North.

"Grand challenges like climate change, inequality and forced migration are borderless. They require global solutions, but also local context. By working with researchers from those countries you have a better chance of influencing policymakers and turning research into impact," said Julie Delahanty, President and CEO of the International Development Research Centre (IDRC), a Crown corporation established over 50 years ago to help developing countries use science and technology to find practical,

long-term solutions to social, economic, and environmental problems.

That's the goal behind the IDRC Research Chairs on Forced Displacement Network, an \$8-million program that funds 12 research chairs in Africa, the Middle East, Southeast Asia, and the Americas. The program is administered by Carleton University on behalf of IDRC.

Each chair will recruit 15 or more graduate students and post-doctoral fellows to work on various research projects, which Delahanty said helps build a critical mass of local expertise on forced displacement.

IDRC's support of scholars in the Global South is also providing developing countries with the evidence they need to mitigate the effects of climate change. For example, last year's Intergovernmental Panel on Climate Change (IPCC) report included the most comprehensive chapter to date on how a

warming climate is impacting the African continent.

The evidence for that chapter came from a team of African researchers funded through the Climate Adaptation and Resilience (CLARE) research program – a joint initiative of IDRC and the United Kingdom's Foreign, Commonwealth and Development Office (FCDO).

"There had never been a very strong Africa section to the IPCC report before then," said Delahanty, who describes the \$180-million initiative as one of the world's largest climate action research programs. Its first competition recently funded 16 projects across 26 countries in Africa and the Asia Pacific, with the aim of implementing socially inclusive and sustainable solutions.

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CANADA'S TOP
50
RESEARCH
COLLEGES



nc **Niagara**
College
Canada



HUMBER

Sheridan



Lambton
College

Seneca
POLYTECHNIC

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Canada's TOP 50 RESEARCH COLLEGES 2023

Rank		College	Sponsored Research Income			Researchers	Research Intensity	Prov	Main Affiliated Research Centre(s)/Institute(s)
2022	2021		FY2022 \$000	FY2021 \$000	% Change 2021-2022	2021-2022 #	\$ per Researcher \$000		
1	2	Niagara College	\$32,031	\$18,116	76.8	56	\$572.0	ON	Walker Advanced Manufacturing Innovation Centre
2	1	Cégep de Trois-Rivières	\$26,236	\$19,864	32.1	142	\$184.8	QC	Centre de Métallurgie du Québec, Innofibre, C2T3
3	3	Lambton College	\$16,095	\$14,210	13.3	201	\$80.1	ON	Centre of Excellence in Energy & Bio-Industrial Technologies
4	10	Olds College	\$13,522	\$7,564	78.8	58	\$233.1	AB	Technology Access Centre for Livestock Production (TACLPL), Field Crop Development Centre
5	4	British Columbia Institute of Technology	\$12,794	\$13,317	-3.9	115	\$111.3	BC	Centre for Applied Research and Innovation (CARI)
6	5	Southern Alberta Institute of Technology (SAIT)	\$12,707	\$12,964	-2.0	75	\$169.4	AB	Centre for Energy Research and Clean Unconventional Technology Solutions (CERCUTS)
7	12	Mohawk College	\$12,546	\$7,414	69.2	152	\$82.5	ON	IDEAWORKS
8	7	NAIT - Northern Alberta Institute of Technology	\$11,928	\$9,696	23.0	72	\$165.7	AB	
9	17	Saskatchewan Polytechnic	\$9,923	\$5,890	68.5	270	\$36.8	SK	Digital Integration Centre of Excellence (DICE), Sustainability-Led Integrated Centres of Excellence (SLICE)
10	25	Cégep de Thetford	\$9,442	\$4,153	127.4	73	\$129.3	QC	COALIA, Kemitek
11	16	Lethbridge College	\$9,345	\$7,078	32.0	47	\$198.8	AB	Centre for Applied Research, Innovation and Entrepreneurship; Integrated Agriculture Technology Centre (IATC)
12	6	Sheridan College	\$9,080	\$10,340	-12.2	231	\$39.3	ON	Screen Industries Research and Training Centre
13	14	Cégep de La Pocatière	\$7,782	\$7,351	5.9	153	\$50.9	QC	Solutions Novika, Biopterre et Optech
14	11	RRC Polytech	\$7,427	\$7,426	0.01	116	\$64.0	MB	Prairie Research Kitchen (PRK), Technology Access Centre
15	22	Humber College	\$7,047	\$5,074	38.9	437	\$16.1	ON	Barrett Centre for Technology Innovation
16	21	Seneca Polytechnic	\$6,951	\$5,384	29.1	116	\$59.9	ON	Seneca Centre for Innovation in Life Sciences (SCILS)
17	15	Conestoga College	\$6,844	\$7,083	-3.4	369	\$18.5	ON	SMART Centre; Conestoga Food Research and Innovation Lab; Canadian Institute for Safety, Wellness, and Performance; Canadian Institute for Senior's Care
18	24	College of the North Atlantic	\$6,359	\$4,400	44.5	53	\$120.0	NL	Centre for Innovative Mining Solutions (CIMS), Newfoundland and Labrador Workforce Innovation Centre
19	37	Durham College	\$5,813	\$2,688	116.3	73	\$79.6	ON	AI Hub, Centre for Cybersecurity Innovation, The Mixed-Reality Capture (MRC) Studio
20	8	Cégep de la Gaspésie et des Îles	\$5,439	\$8,609	-36.8	157	\$34.6	QC	CIRADD, Merinov, Nergica
21	23	Cégep de Saint-Jérôme	\$5,436	\$4,948	9.9	66	\$82.4	QC	Institut du véhicule innovant, Centre de développement des composites du Québec
22		Cégep de Sept-Îles	\$5,406	\$3,393	59.3	63	\$85.8	QC	ITMI, CR2ie, CEFRAIL
23	20	Centennial College	\$5,325	\$5,563	-4.3	109	\$48.9	ON	Wearable Interactive Mobile Technologies Access Centre / Aerospace Innovation
24	18	Cégep de Shawinigan	\$5,245	\$5,756	-8.9	39	\$134.5	QC	Centre National en Électrochimie et en Technologies Environnementales (CNETE)
25		NorQuest College	\$5,100	\$1,914	166.5	98	\$52.0	AB	NorQuest Innovation Studio, Colbourne Institute for Inclusive Leadership
26	43	La Cité	\$5,028	\$2,025	148.3	50	\$100.6	ON	Centre d'accès à la technologie en Bio-innovation (CAT-B)
27	9	George Brown College	\$4,897	\$8,425	-41.9	91	\$53.8	ON	Food Innovation and Research Studio (FIRST)
28	35	Fleming College	\$4,858	\$2,914	66.7	64	\$75.9	ON	CAWT, CIAP, CAMIIT
29	26	Cégep de Rimouski	\$4,351	\$4,060	7.2	60	\$72.5	QC	SEREX, Innovation maritime
30	29	Selkirk College	\$4,306	\$3,715	15.9	27	\$159.5	BC	Selkirk Technology Access Centre in Advanced Manufacturing
31	42	Aurora College	\$3,812	\$2,077	83.5	54	\$70.6	NT	Aurora Research Institute
32	41	Nova Scotia Community College	\$3,726	\$2,220	67.8	56	\$66.5	NS	SEATAC
33	31	Collège d'Alma	\$3,399	\$3,324	2.3	33	\$103.0	QC	Agrinova
34	28	Cégep de l'Abitibi-Témiscamingue	\$3,378	\$3,717	-9.1	42	\$80.4	QC	Centre technologique des résidus industriels (CTRI)
35	39	Holland College	\$3,272	\$2,558	27.9	28	\$116.9	PE	Canada's Smartest Kitchen
36	44	Loyalist College	\$3,193	\$2,023	57.8	27	\$118.3	ON	Centre for Natural Products and Medical Cannabis
37	34	Cégep de Saint-Laurent	\$3,173	\$2,917	8.8	48	\$66.1	QC	Cteau, Artensio
38	33	Lakeland College	\$3,098	\$3,047	1.7	49	\$63.2	AB	G.N. Sweet Livestock Research Facility
39		Cégep de Rivière-du-Loup	\$2,865	\$2,893	-1.0	47	\$61.0	QC	Groupe de recherche en environnement et biotechnologie, Le laboratoire en innovation ouverte
40	40	Collège communautaire du Nouveau-Brunswick	\$2,575	\$2,527	1.9	29	\$88.8	NB	CCNB-INNOV
41	36	Cambrian College	\$2,499	\$2,763	-9.6	26	\$96.1	ON	Glencore Centre for Innovation & Centre for Smart Mining
42		Georgian College	\$2,238	\$1,011	121.4	57	\$39.3	ON	Research, Innovation and Entrepreneurship Centre (RIE)
43	38	Red Deer Polytechnic	\$2,084	\$2,593	-19.6	201	\$10.4	AB	CIM-TAC, EIC
44		Collège de Bois-de-Boulogne	\$2,032	\$1,808	12.4	32	\$63.5	QC	JACOB - Centre d'intelligence artificielle appliquée
45	46	Algonquin College	\$1,850	\$1,746	6.0	99	\$18.7	ON	Data Analytics Centre, Social Innovation Lab, Victimology Research Centre
46	47	New Brunswick Community College	\$1,775	\$1,500	18.3	65	\$27.3	NB	Centre for Applied Research and Ubiquitous Computing
47	32	Camosun College	\$1,760	\$3,073	-42.7	19	\$92.6	BC	Camosun Technology Access Centre
48		Bow Valley College	\$1,721	\$783	119.8	70	\$24.6	AB	
49		Cégep de Drummondville	\$1,694	\$1,158	46.3	22	\$77.0	QC	Centre collégial d'expertise en gérontologie (CCEG-CCTT)
50	45	Collège Boréal	\$1,647	\$1,814	-9.2	36	\$45.8	ON	

Notes:

1. Sponsored research income includes all funds to support research received in the form of a grant, contract or contribution from all sources external to the institution. Excludes funds from technical service agreements.
2. Data were obtained through a survey of publicly-funded colleges.
3. Fiscal 2021 figures may have been adjusted as more accurate information became available.

4. Researcher headcounts include full and part-time faculty, teachers, researchers and technicians who conducted research in Fiscal 2022.
5. Data are provided for the main college including affiliated research centres/institutes, where applicable.

Research Infosource Inc. is Canada's source of R&D intelligence. For further information, please visit researchinfosource.com

CANADA'S TOP 50 Research Colleges

College Research Income Soars

The combined sponsored research income of the colleges and cégeps on *Canada's Top 50 Research Colleges List* reached \$331.1 million in Fiscal 2022, a sizeable gain of 24.0% over Fiscal 2021. Research income was in the form of research grants, contracts and contributions (cash and in-kind) from third parties. In Fiscal 2022, Total Government funding accounted for \$210.3 million or 64% of the total. Federal government sources accounted for 42% of total funding (\$137.4 million), while Provincial governments contributed 22% (\$71.5 million) to the total. Industry funding was responsible for 30% (\$99.8 million) of all funding, while Non-Industry sources provided 4% to the total.

Niagara College moved into first place and led the national Top 50 Research Colleges ranking, reporting sponsored research income in Fiscal 2022 of \$32.0 million, a 76.8% increase over Fiscal 2021. Cégep de Trois-Rivières dropped into second place posting research income of \$26.2 million, a substantial increase of 32.1%. Lambton College maintained 3rd position with \$16.1 million, a gain of 13.3%. Overall, in Fiscal 2022, 36 institutions posted research income increases against 14 where research income declined.

Provincial Performance

In Fiscal 2022, 17 Ontario colleges accounted for 39% of the Top 50 total (\$127.9 million, up 29.8%) and 14 Quebec colleges and cégeps accounted for 26% (\$85.9 million, up 16.1%). Alberta's eight colleges were responsible for 18% of the national total (\$59.5 million, up 30.4%) and British Columbia's three institutions contributed 6% (\$18.9 million, down -6.2%).

Top 50 - Leading Provinces	
Province	% of Total
Ontario (17)	39
Quebec (14)	26
Alberta (8)	18
British Columbia (3)	6

Average per-college provincial research income was highest in Saskatchewan, where Saskatchewan Polytechnic reported \$9.9 million of sponsored research income, followed by two of the larger provinces: Ontario colleges which garnered an average of \$7.5 million and Alberta's colleges averaged \$7.4 million. In Manitoba, RRC Polytech also received \$7.4 million in Fiscal 2022. British Columbia colleges attracted \$6.3 million per institution on average and Quebec's colleges and cégeps attracted \$6.1 million per institution on average.

Research Income Growth

In Fiscal 2022, six of the institutions on the Top 50 reported triple-digit growth in sponsored research income. Among the top gainers were NorQuest College (166.5%), La Cité (148.3%), Cégep de Thetford (127.4%), Georgian College (121.4%), Bow Valley College (119.8%) and Durham College (116.3%).

Research Intensity

A number of colleges stood out in terms of research intensity - research income per researcher - in Fiscal 2022. The top three were Niagara College (\$572,000 per researcher), Olds College (\$233,100 per researcher) and Lethbridge College (\$198,800 per researcher). The national average research intensity in Fiscal 2022 was \$70,800 per researcher.

Research Partnerships and Projects

Measuring a college's or cégep's volume of research partnerships and completed research projects provides a good indication of its levels of activity and output. In Fiscal 2022, the Top 50 Research Colleges engaged in a total of 5,191 research partnerships

and 3,804 completed research projects. A number of institutions stood out on these measures. Among Large institutions, Sheridan College led reporting 187 research partnerships in Fiscal 2022. Lambton College (257) was the leader in the Medium category, while Cégep de Trois-Rivières headed the Small tier with 454 partnerships.

In terms of completed research projects the leaders by tier were: Saskatchewan Polytechnic in the Large tier completed 382 projects, Niagara College in the Medium tier completed 208 projects and Cégep de Trois-Rivières in the Small tier completed 561 projects in Fiscal 2022.

Students provide a large element of the college research workforce and receive experience and payment in return. A total of 3,851 students engaged in some kind of paid applied research projects. The top institutions by tier were: Centennial College in the Large tier employed a total of 571 students on its research projects, while Lambton College in the Medium tier employed 222 and Cégep de Trois-Rivières in the Small category hired 123 students.

This Year and Next

Fiscal 2022 was a strong year for college research funding. Nearly three-quarters of colleges reported increased research income. Federal Government sources boosted their investments by 24.0%, mostly based on increased funding by NSERC. Provincial support was up by 27.3%. Best of all, colleges reported a substantial 36.2% jump in research income from Industry. Thus, overall research income growth was broadly based.

Last year we wrote, "economic conditions are in flux". Even more so this year. Given that colleges are reliant on governments for around two-thirds of their research income, it's clear that Federal and Provincial budgets will weigh strongly on available resources next year. It is no secret that government budgets are increasingly strained, so there is some uncertainty on that front.

This year's strong jump in research support from companies is encouraging. We can only hope that firms will maintain their research collaborations. Overall, Fiscal 2022 provided a good jumping-off point for the coming year.

Spotlight on College Research Activity FY2022

Research Partnerships*

Rank	Large	#	Rank	Medium	#	Rank	Small	#
1	Sheridan College	187	1	Lambton College	257	1	Cégep de Trois-Rivières	454
2	Saskatchewan Polytechnic	185	2	Mohawk College	224	2	Cégep de La Pocatière	248
3	Algonquin College	180	3	Niagara College	222	3	Cégep de la Gaspésie et des Îles	211

Completed Research Projects*

Rank	Large	#	Rank	Medium	#	Rank	Small	#
1	Saskatchewan Polytechnic	382	1	Niagara College	208	1	Cégep de Trois-Rivières	561
2	Algonquin College	127	2	Lambton College	176	2	Selkirk College	142
3	George Brown College	110	3	RRC Polytech	170	3	Cégep de La Pocatière	138

Paid Student Researchers**

Rank	Large	#	Rank	Medium	#	Rank	Small	#
1	Centennial College	571	1	Lambton College	222	1	Cégep de Trois-Rivières	123
2	Saskatchewan Polytechnic	347	2	Durham College	208	2	Selkirk College	58
3	Sheridan College	324	3	Mohawk College	174	3	Cégep de La Pocatière	45

Notes:
 1. College size tiers are based on a rolling average of the past five years of total college income: Large = \$250 million or more; Medium = \$75 million to less than \$250 million; Small = less than \$75 million.
 * Research partnerships and completed research projects with external organizations governed by formal written agreements. Excludes technical services agreements.
 ** Students that were involved in applied research projects that were paid for their work.

Top 10 Research Colleges by Research Income Growth

2022 Rank	College	% Change 2021-2022
1	NorQuest College	166.5
2	La Cité	148.3
3	Cégep de Thetford	127.4
4	Georgian College	121.4
5	Bow Valley College	119.8
6	Durham College	116.3
7	Aurora College	83.5
8	Olds College	78.8
9	Niagara College	76.8
10	Mohawk College	69.2

Top 10 Research Colleges by Research Intensity

2022 Rank	College	\$ per Researcher \$000
1	Niagara College	\$572.0
2	Olds College	\$233.1
3	Lethbridge College	\$198.8
4	Cégep de Trois-Rivières	\$184.8
5	Southern Alberta Institute of Technology (SAIT)	\$169.4
6	NAIT - Northern Alberta Institute of Technology	\$165.7
7	Selkirk College	\$159.5
8	Cégep de Shawinigan	\$134.5
9	Cégep de Thetford	\$129.3
10	College of the North Atlantic	\$120.0

Spotlight on College Industry Research Income 2018-2022

Research Infosource shines the spotlight on college industry research income, as measured by grants, contracts or contributions received from industry sources between FY2018-FY2022.

Industry Research Income			Industry Research Income as % of Total College Research Income			Industry Research Income Growth (% Change FY2018-FY2022)		
Rank	Large	\$000	Rank	Large	%	Rank	Large	%
1	Humber College	\$21,302	1	Humber College	49.3	1	Southern Alberta Institute of Technology (SAIT)	356.8
2	Southern Alberta Institute of Technology (SAIT)	\$18,103	2	Centennial College	35.9	2	British Columbia Institute of Technology	250.7
3	NAIT - Northern Alberta Institute of Technology	\$13,777	3	Southern Alberta Institute of Technology (SAIT)	35.8	3	Sheridan College	239.6
4	Sheridan College	\$12,856	4	Conestoga College	33.9	4	Saskatchewan Polytechnic	154.1
5	British Columbia Institute of Technology	\$10,820	5	Sheridan College	33.6	5	NAIT - Northern Alberta Institute of Technology	53.4
Rank	Medium	\$000	Rank	Medium	%	Rank	Medium	%
1	Niagara College	\$53,178	1	Niagara College	64.0	1	Niagara College	1,414.3
2	Mohawk College	\$21,867	2	Mohawk College	46.5	2	Lethbridge College	1,050.2
3	Lambton College	\$20,145	3	Lambton College	30.7	3	La Cité	286.4
4	RRC Polytech	\$7,018	4	Fleming College	30.4	4	Camosun College	118.5
5	Fleming College	\$5,049	5	La Cité	26.6	5	Cambrian College	49.3
Rank	Small	\$000	Rank	Small	%	Rank	Small	%
1	Cégep de Trois-Rivières	\$31,223	1	Cégep de La Pocatière	61.1	1	Cégep de Saint-Jérôme	459.5
2	Cégep de La Pocatière	\$21,591	2	Cégep de Trois-Rivières	34.0	2	Collège d'Alma	230.5
3	Cégep de Thetford	\$7,315	3	Cégep de Shawinigan	27.8	3	Cégep de l'Abitibi-Témiscamingue	189.9
4	Cégep de Shawinigan	\$6,667	4	Cégep de Thetford	22.1	4	Cégep de Shawinigan	175.5
5	Olds College	\$4,474	5	Cégep de Saint-Jérôme	20.7	5	Olds College	149.3

Notes:
 1. Based on colleges on the Top 50 Research Colleges list for all five years; and reported research income in the form of a grant, contract or contribution from industry sources between FY2018-FY2022. Excludes income from technical service agreements.
 2. College size tiers are based on a rolling average of the past five years of total college income: Large = \$250 million or more; Medium = \$75 million to less than \$250 million; Small = less than \$75 million.

Applied Research and Innovation

Saskatchewan Polytechnic is a Canadian leader in applied research. Sustainability is at the heart of everything we do. With applied research centres focused on healthcare, sustainability and the circular economy, digital integration and more, we connect industry and community with learners and researchers to find innovative solutions to tomorrow's challenges.



Learn more at saskpolytech.ca/appliedresearch.

#1 Completed research projects (large tier)*

#2 Research partnerships (large tier)*

#2 Paid student researchers (large tier)*

* Research Infosource Inc's Top 50 Research Colleges 2023



TOP 5
Research College
8 Consecutive
Years

DRIVING INNOVATION THROUGH SUSTAINABLE AND CIRCULAR ECONOMY RESEARCH

#3
Research College
in Canada
2023

▶ lambtonresearch.ca

Source: Research Infosource Inc. 2023

PARTNER PERSPECTIVE

Seneca Polytechnic partners with Just Vertical to improve harvestable yields in non-ideal growth conditions

Applied research project results in "recipe" to optimize hydroponic gardening crops

While completing his master's degree, Kevin Jakiela worked in the Northwest Territories where he researched food growing strategies for Indigenous communities. "My goal was to determine how to elongate growing seasons in the harshest conditions when temperatures were -40°C, with roughly 20 hours of darkness," he said.

With that objective in mind, the idea for a business was born.

In 2016, Mr. Jakiela co-founded Just Vertical, an indoor, vertical farming company in Toronto that builds, sells and supports highly scalable, hydroponic indoor gardening and farming modules.

"Our main mission and vision for our company is to be a part of

the solution for food insecurity," said Mr. Jakiela, who now serves as Just Vertical's President.

Hydroponic gardening – the practice of growing produce without soil – can use 95 per cent less water and grow crops faster than traditional agriculture methods making it ideal in harsh environments like Canada's Arctic.

And while indoor vertical farming is becoming more popular, it is currently limited by the varieties that can be grown and the nutritional density of the crops.

That's where Seneca Polytechnic comes in.

Mr. Jakiela recently collaborated on an applied research project with Seneca Applied Research and the School of Biological Science



A researcher holds a basil plant grown in an experimental hydroponics setting.

& Applied Chemistry (BSAC) to develop a series of "crop recipes" to determine ideal indoor light

intensity and frequency for optimum growth.

The objective of this project

was to optimize the conditions for growing basil and mint plants, enabling customers to increase the total yield and improve the nutrient content of their food compared to crops grown under standard conditions.

BSAC professors George Clark and Jamie Cote oversaw the project.

"By helping Just Vertical optimize food crop growth conditions, we got to participate in the development of this exciting growth area of agriculture in Canada," Mr. Cote said. "Students developed analytical methods for nutrients in plant samples and learned how to change growing conditions using Just Vertical's AEVA growth system."

Just Vertical is now working

with Seneca Polytechnic to renovate the vertical farm housed inside the two-storey retrofit ed shipping container at Newnham Campus.

Once complete, the first floor will produce food for First Peoples @Seneca and Seneca Dining Services. The second floor will be a designated research and development hub for growing various plants and studying and deploying renewable energy technologies.

"Our goal is to have students working in Seneca Polytechnic's greenhouse," Mr. Jakiela said. "We want to be able to cater to all spaces and have a positive impact as we grow, and I think that's where we align with Seneca really nicely."

Celebrating Strong Industry Partnerships

▶ humber.ca/research

#1

IN INDUSTRY RESEARCH
INCOME FOR FY2018-FY2022
(LARGE TIER)*

#4

PAID STUDENT
RESEARCHERS
(LARGE TIER)*

*Research Infosource Top 50 Research Colleges 2023.



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PARTNER PERSPECTIVE



Marc Nantel, PhD
Vice-President – Research,
Innovation & Strategic Enterprises
Niagara College

The SONAMI success story

Developing educational alliances as economic engines

around bolstering Canada's position in the global manufacturing market. The network operates on a collaborative model, where industry partners identify their research and development needs. SONAMI then matches these needs with the expertise available within its member institutions, providing support to industry partners through specialized facilities, expedited product timelines, access to student innovators, and highly skilled technical experts and researchers. SONAMI stands not as a competitor to industry but as a visionary ally and its research arm. By leveraging the combined strengths of its member institutions, SONAMI aims to accelerate the development and adoption of cutting-edge manufacturing technologies. This, in turn, contributes to the growth and competitiveness of small- and medium-sized enterprises (SMEs) within the manufacturing sector.

Since its formation, SONAMI's assistance to more than 327 unique industry partners in creating and implementing 357 projects has spurred significant industry growth. This success is evident in the launch of 149 new products or services in the marketplace and



Hamill Machine Co. owner and president Bob Benner (right) credits his SONAMI Niagara College partnership as a vital contribution to his company's ability to expand into new markets, doubling his machine shop, increasing his workforce, and moving his sales figures into the millions.

One are the days of colleges and universities functioning as two solitudes, pursuing individual research agendas and educational goals. Global challenges transcending borders and disciplines have necessitated a more collaborative approach. Issues such as climate change, public health crises, and technological advancements have underscored the need for diverse expertise and resources, leading to an era where collaboration is beneficial and indispensable. This reflects a broader understanding that complex challenges require multifaceted, interdisciplinary approaches, and Niagara College is proud to lead that charge.

Launched in 2015 with the contribution of the Federal Economic Development Agency for Southern Ontario (FedDev Ontario), the Southern Ontario Network for Advanced Manufacturing Innovation (SONAMI) is an 11-member network of post-secondary institutions led by Niagara College bringing unique capabilities and expertise in advanced manufacturing. This collaborative environment, coupled with the FedDev Ontario support, makes possible industry-led research projects to develop new products, processes, and services at the speed of business.

SONAMI's mission is centred

the creation of more than 300 jobs in Southern Ontario, underscoring the pivotal role of these projects in driving regional economic growth. Collaborators can achieve more

by assembling resources, sharing knowledge, and combining expertise. SONAMI maximizes

SONAMI maximizes the impact of each dollar spent, allowing for larger-scale research and development initiatives than what might be possible through individual investments, ensuring that government funds are utilized more efficiently

the impact of each dollar spent, allowing for larger-scale research and development initiatives than what might be possible through individual investments, ensuring

that government funds are utilized more efficiently. Networks such as SONAMI also create ecosystems that encourage continuous rapid innovation, attracting businesses and investors, leading to new industries and economic opportunities. For governments, this means sustainable economic growth powered by high-value industries. Integrating students into real-world projects leads to a more skilled workforce, essential for long-term economic growth and competitiveness. Governments benefit from having a more educated and capable population ready to meet the challenges of a modern economy.

The COVID-19 pandemic was a watershed moment for industries worldwide, highlighting the vulnerabilities in global supply chains. Canada was grappling with shortages of critical items like personal protective equipment (PPE), medical devices, and sanitization products. As another example of the benefits of post-secondary collaborations and networks, SONAMI rose to the occasion, showcasing the power and agility of local research and manufacturing capabilities. Within the first six months of the pandemic, SONAMI members utilized their advanced manufacturing capabilities, such as 3D printing and mate-

rials engineering, to execute more than 32 COVID-19 projects to produce PPE, sanitization materials, physical-distancing apps, and pharmacological advances.

SONAMI has deployed a powerfully successful model, which its members are seeking to expand. Alliances and networks such as SONAMI, stand as testaments to the power of collective action, proving that when diverse minds and talents come together, the possibilities for progress are boundless. The future of collaborations and networks such as this is not just bright; it's fundamental to shaping a more innovative and interconnected world.

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*Research Infosource Top 50 Research Colleges 2023

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FOCUS ON

Climate Change Research in Action

Continued from page 11

cross-border region shared by two Canadian provinces, eight U.S. states and more than 150 Indigenous communities. The findings will later be applied to other water systems that encompass or intersect multiple sovereign nations, including those of Indigenous Peoples.

As communities continue to see the threat to water resources due to climate change in the form of floods, droughts, worsening water quality, shoreline erosion and damage to homes and infrastructure, we are forced to adapt," said Krantzberg, professor of engineering and public policy at McMaster's W. Booth School of Engineering Practice, and an international expert on the health of the Great Lakes.

The new centre recently received CDN\$3.75 million, along with USD\$5 million from the National Science Foundation Global Centres – a joint initiative between the Natural Sciences and Engineering Research Council of Canada, the Social Sciences and Humanities Research Council of Canada, the U.S. National Science Foundation, Australia's Commonwealth Scientific and Industrial Research Organisation and UK Research and Innovation to encourage and support international collaborative research on climate change and clean energy.

Research teams – crossing disciplines, universities and communities – will model and project the impacts of climate change on water resources, improve the understanding of these impacts on ecosystems and diverse communities, and increase capacity for governance, management and disaster resilience based on community leadership engagement. The centre will include a special focus on collaborating with Indigenous nations.

Krantzberg says the centre's multidisciplinary approach ensures the knowledge gained will have widespread relevance to communities around the world.

"The tools and knowledge for adapting to worsening extremes must be consolidated or created with direct input from practitioners on the front line," she says. "The Global Centres will enable this work."

THOMPSON RIVERS UNIVERSITY

Wildfire research links experts and students

This past summer was the most destructive wildfire season on record in British Columbia and the most expensive, with insurable losses topping \$720 million. Researchers predict the frequency and intensity of these fires will worsen as the planet warms.

Thompson Rivers University (TRU) is located in British Columbia's Interior region and has campuses in Kamloops and Williams Lake. The university's wildfire science team is the only one in

Canada with two research chairs dedicated solely to wildfire science.

The research team is headed by Dr. Mike Flannigan, BC's first fire science research chair and an expert in studying the interaction of fire with weather and climate.

"We have a fantastic cohort of wildfire expertise at TRU, including Mike Flannigan, as well as a Canadian Research Chair in Fire Ecology [Dr. Jill Harvey] and an NSERC Industrial Chair in Ecosystem Reclamation [Dr. Lauchlan Fraser]," said Dr. Shannon Wagner, TRU's Vice-President Research.

The team of experts is supported by dedicated Master of Environmental Science students and enthusiastic undergraduate students pursuing their degrees in Natural Resource Sciences. These passionate individuals play a crucial role in conducting fieldwork, collecting and analyzing data, and actively participating in ongoing research projects. Their commitment not only strengthens the collaborative efforts within the research team but also contributes fresh perspectives and energy to advancing the work in wildfire science.

"Our students engage in collaboration with renowned researchers, and delving into the realm of wildfire science not only grants them invaluable chances for mentorship but also opens doors for the creation and mobilization of knowledge," said Dr. Wagner.

With rising temperatures resulting in increased drought conditions, Canada can anticipate longer and more extreme fire seasons. TRU has built a strong team of experts in wildfire science and ecological restoration and will continue to build capacity for wildfire science research at the university.

SASKATCHEWAN POLYTECHNIC

Advancing sustainable resource management

A centre of excellence at Saskatchewan Polytechnic launched in 2022 is providing a Regina-based company with a living lab to demonstrate a renewable fuel from prairie biomass that has the potential to reduce the potash industry's greenhouse gas emissions by up to 80%.

Prairie Clean Energy recently partnered with the Sustainability-Led Integrated Centres of Excellence (SLICE) to implement a pilot operation at Saskatchewan Polytechnic's field site near Moose Jaw.

"This project aligns perfectly with SLICE's focus on the circular economy," said SLICE Director Dr. Robin Smith. "Their initial focus is on taking agricultural waste like flax straw, that would normally be burned in the fields, and processing it into low-carbon pellets that can be used in modern biomass boilers to generate heat."

Based in the Faculty of Technology and Skilled Trades, SLICE has collaborated with about 60 industry and community partners to address complex sustainability issues.

"With SLICE, we're able to provide our partners with a single entry point for the expertise, tools and technology they need to solve complex, sustainability issues," said Smith.

SLICE researchers are also working with community advisors from Big River First Nation in Northern Saskatchewan to identify culturally significant sites.

“Genetic research at U of G is already helping dairy producers lower their carbon footprint while supporting their bottom line.”

DR. RENE VAN ACKER
Interim Vice-President Research, University of Guelph

The project utilizes drones equipped with sensors and cameras, in tandem with First Nation oral history and land knowledge, to scan the tree canopies of forested areas identified by Elders as culturally significant. The team anticipates locating heritage sites, artifacts, traditional footpaths and more in advance of any logging or resource extraction activities.

About 30% of forestry workers in Northern Saskatchewan are First Nations or Métis people, and many of the companies are Indigenous-owned.

"Identifying these boreal forest sites in advance will help to better protect them through planning processes," said Smith. "Sustainability is a growing priority for the resource sector, and they're looking for partners like SLICE for assistance in addressing their own environmental and social governance goals. It also fits within our vision of advancing sustainability in Saskatchewan and beyond through collaborative and applied research that benefits our economy, environment, society and future generations."

UNIVERSITY OF GUELPH

Making farms more resilient

Extreme weather, erratic rainfall and prolonged droughts have become the new reality for farmers across Canada. Analysts predict Canada's agricultural sector could lose about \$4 billion over the next 28 years as a result of climate change.

"The challenge is the resilience of crops and animals against what is increasingly not only unpredictable weather, but extreme weather," said Dr. Rene Van Acker, Interim Vice-President Research at the University of Guelph (U of G). "The green revolution and its focus on monoculture have

also made farming systems less resilient. Nature achieves resiliency through diversity and being dynamic and our farming systems were going in the opposite direction."

The university is working on several main fronts to reverse this trend. One is genetics, "so breeding for more resilience plants and animals," said Van Acker. "This is increasingly becoming one of the frontiers for big data and artificial intelligence to understand the ability of new genetic traits to better withstand drought, heat or frost, while also increasing yields."

Genetic research at U of G is already helping dairy producers lower their carbon footprint while supporting their bottom line.

U of G researchers collaborate with farmers, farm organizations, crop input providers, seed producers and technology companies to strengthen Ontario's \$47-billion agri-food sector. This includes simple solutions like crop rotation, as well as adding other species such as red clover to minimize erosion, replenish nutrients in the soil and increase yields.

The Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) has been a critical partner in these efforts. In March, the province invested \$353 million in the Ontario Agri-Food Innovation Alliance, a longstanding collaboration between U of G, OMAFRA and the Agricultural Research Institute of Ontario.

The university also manages 14 research centres on behalf of OMAFRA. Real-world field tests at the centres promote agri-food discoveries, validate laboratory findings, stimulate further research and provide valuable information for Ontario's agri-food sector.

"When we want to field trial a technology at scale, we have the means to do it," said Van Acker. "Our laboratories are this vast network of research stations that allow us to conduct field trials in every heat zone and every soil type in the province."

OCEAN FRONTIER INSTITUTE

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Continued on page 26



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#1

for research partnerships*

#3

for number of student researchers*

#5

for completed research projects*

*Large tier, Canada's Top 50 Research Colleges 2023
Source: Research Infosource Inc.



Research Infosource Inc. is Canada's source of R&D intelligence. Data used for this table were extracted from our proprietary Canadian Corporate R&D Database. Companies wishing to be included in future editions of the Top 100 List, or who wish to adjust their figures should contact us directly

For further information, please visit researchinfosource.com

Canada's TOP 100 CORPORATE R&D SPENDERS 2023

Rank		Company	R&D Spending			Revenue	R&D Intensity	Industry
2022	2021		FY2022 \$000	FY2021 \$000	% Change 2021-2022	FY2022 \$000	R&D Spending as % of Revenue**	
1	1	Shopify Inc.*	\$1,956,158	\$1,070,969	82.7	\$7,287,103	26.8	Software & Computer Services
2	2	Constellation Software Inc.*	\$1,314,313	\$965,195	36.2	\$8,617,209	15.3	Software & Computer Services
3	4	Magna International Inc.*	\$844,544	\$794,719	6.3	\$49,241,192	1.7	Automotive
4	3	TELUS Corporation	\$819,000	\$799,000	2.5	\$18,412,000	4.4	Telecommunications Services
5	11	AMD Canada (fs)	\$698,819	\$480,016	45.6	nd		Computer Equipment
6	8	Bausch Health Companies Inc.*	\$688,388	\$582,878	18.1	\$10,571,761	6.5	Pharmaceuticals/Biotechnology
7	6	BCE Inc.	\$644,000	\$618,024	4.2	\$24,174,000	2.7	Telecommunications Services
8	7	Pratt & Whitney Canada Corp. (fs)	\$641,364	\$590,002	8.7	nd		Aerospace & Defence
9	12	Canadian Natural Resources Limited	\$587,000	\$450,000	30.4	\$42,298,000	1.4	Energy/Oil & Gas
10	10	Open Text Corporation*	\$573,155	\$528,284	8.5	\$4,546,539	12.6	Software & Computer Services
11	5	Rogers Communications Inc.	\$496,605	\$682,428	-27.2	\$15,396,000	3.2	Telecommunications Services
12		IBM Canada Ltd. (fs)	\$461,000	\$455,000	1.3	\$4,446,208	10.4	Software & Computer Services
13	14	Ericsson Canada Inc. (fs)	\$446,000	\$390,000	14.4	nd		Comm/Telecom Equipment
14	16	BRP Inc.**	\$367,700	\$289,800	26.9	\$10,033,400	3.7	Other Manufacturing
15	15	CGI Group Inc.	\$321,680	\$303,170	6.1	\$12,867,201	2.5	Software & Computer Services
16	18	Zymeworks Inc.*	\$271,446	\$250,389	8.4	\$536,763	50.6	Pharmaceuticals/Biotechnology
17	17	BlackBerry Limited* ++	\$269,369	\$274,517	-1.9	\$853,653	31.6	Software & Computer Services
18	19	CAE Inc.	\$217,600	\$202,800	7.3	\$3,371,300	6.5	Aerospace & Defence
19	20	Cisco Canada (fs)	\$197,812	\$186,476	6.1	nd		Comm/Telecom Equipment
20	22	Sanofi Canada (fs)	\$166,301	\$143,416	16.0	\$814,529	20.4	Pharmaceuticals/Biotechnology
21	40	Lightspeed Commerce Inc.*	\$157,652	\$68,676	129.6	\$713,596	22.1	Software & Computer Services
22	23	Teck Resources Limited	\$157,000	\$129,000	21.7	\$17,316,000	0.9	Mining & Metals
23	24	Repare Therapeutics Inc.*	\$156,772	\$114,253	37.2	\$171,550	91.4	Pharmaceuticals/Biotechnology
24	21	Hydro-Québec	\$154,000	\$144,300	6.7	\$16,567,000	0.9	Electrical Power & Utilities
25	33	AbCellera Biologics Inc.*	\$140,383	\$77,795	80.5	\$631,682	22.2	Pharmaceuticals/Biotechnology
26		Xenon Pharmaceuticals Inc.*	\$137,635	\$94,593	45.5	\$12,276	1,121.2	Pharmaceuticals/Biotechnology
27	29	Bombardier Inc.*	\$135,335	\$88,999	52.1	\$8,995,887	1.5	Aerospace & Defence
28	32	Ballard Power Systems Inc.*	\$124,862	\$77,920	60.2	\$109,031	114.5	Machinery
29	25	Novelis Inc.* (fs)	\$119,720	\$104,041	15.1	\$22,315,994	0.5	Mining & Metals
30	26	GlaxoSmithKline Inc. (fs)	\$112,972	\$94,137	20.0	\$955,668	11.8	Pharmaceuticals/Biotechnology
31	30	Evertz Technologies Limited	\$102,438	\$79,895	28.2	\$441,016	23.2	Comm/Telecom Equipment
32	39	Kinaxis Inc.*	\$96,487	\$71,981	34.0	\$477,433	20.2	Software & Computer Services
33	41	MDA Ltd.	\$94,000	\$66,000	42.4	\$641,200	14.7	Aerospace & Defence
34	31	Descartes Systems Group Inc.* ++	\$91,550	\$78,431	16.7	\$632,450	14.5	Software & Computer Services
35	38	Canadian Solar Inc.*	\$90,859	\$73,213	24.1	\$9,718,902	0.9	Energy/Oil & Gas
36	36	AstraZeneca Canada Inc. (fs)	\$79,012	\$75,886	4.1	\$1,255,408	6.3	Pharmaceuticals/Biotechnology
37	34	Northland Power Inc.	\$78,217	\$77,660	0.7	\$2,448,815	3.2	Electrical Power & Utilities
38		Fusion Pharmaceuticals Inc.*	\$76,640	\$70,643	8.5	\$1,901		Pharmaceuticals/Biotechnology
39	37	BELLUS Health Inc.* +	\$76,639	\$74,003	3.6	\$21		Pharmaceuticals/Biotechnology
40	56	Thales Canada Inc. (fs)	\$75,600	\$40,100	88.5	\$570,000	13.3	Aerospace & Defence
41	28	Imperial Oil Limited	\$74,000	\$89,000	-16.9	\$59,413,000	0.1	Energy/Oil & Gas
42	35	Enghouse Systems Limited	\$72,262	\$77,197	-6.4	\$427,585	16.9	Software & Computer Services
43	43	Rio Tinto Iron & Titanium Inc. (fs)	\$70,729	\$61,025	15.9	\$1,623,000	4.4	Mining & Metals
44	51	Celestica Inc.*	\$60,250	\$48,134	25.2	\$9,434,425	0.6	Electronic Systems & Parts
45	42	Aurinia Pharmaceuticals Inc.*	\$58,543	\$64,103	-8.7	\$174,413	33.6	Pharmaceuticals/Biotechnology
46	62	Absolute Software Corporation* +	\$58,266	\$29,161	99.8	\$256,761	22.7	Software & Computer Services
47	44	D2L Inc.* ++	\$56,044	\$58,412	-4.1	\$219,134	25.6	Software & Computer Services
48		Milestone Pharmaceuticals Inc.*	\$52,423	\$49,048	6.9	\$6,507	805.6	Pharmaceuticals/Biotechnology
49	55	Cascades Inc.	\$49,873	\$40,522	23.1	\$4,466,000	1.1	Forest & Paper Products
50	58	Theratechnologies Inc.*	\$48,480	\$35,789	35.5	\$104,178	46.5	Pharmaceuticals/Biotechnology
51	48	Synchrude Canada Ltd.	\$46,223	\$53,890	-14.2	nd		Energy/Oil & Gas
52	50	Pharmascience Inc.	\$44,752	\$49,461	-9.5	nd		Pharmaceuticals/Biotechnology
53	66	Sangoma Technologies Corporation*	\$44,450	\$27,194	63.5	\$291,949	15.2	Computer Equipment
54	54	Martinrea International Inc.	\$44,294	\$41,155	7.6	\$4,757,588	0.9	Automotive
55	69	Magnet Forensics Inc.*	\$43,411	\$25,940	67.4	\$128,743	33.7	Software & Computer Services
56	53	Titan Medical Inc.*	\$42,952	\$47,577	-9.7	\$0		Medical Devices & Instrumentation
57	74	Coveo Solutions Inc.*	\$39,168	\$20,154	94.3	\$112,547	34.8	Software & Computer Services
58	59	Pason Systems Inc.	\$37,573	\$32,220	16.6	\$334,998	11.2	Software & Computer Services
59	68	Vecima Networks Inc.	\$36,552	\$26,247	39.3	\$186,814	19.6	Comm/Telecom Equipment
60	45	Aptose Biosciences Inc.*	\$36,551	\$57,642	-36.6	\$0		Pharmaceuticals/Biotechnology
61	65	mdf commerce inc.	\$35,957	\$28,399	26.6	\$108,259	33.2	Software & Computer Services
62	71	Thinkific Labs Inc.*	\$35,721	\$24,382	46.5	\$66,986	53.3	Software & Computer Services
63	57	Dorel Industries Inc.*	\$34,820	\$36,199	-3.8	\$2,043,398	1.7	Other Manufacturing
64	67	Docebo Inc.*	\$33,403	\$26,701	25.1	\$185,971	18.0	Software & Computer Services
65	46	Canopy Growth Corporation	\$32,344	\$57,582	-43.8	\$582,218	5.6	Pharmaceuticals/Biotechnology
66	61	Essa Pharma Inc.*	\$31,771	\$30,409	4.5	\$0		Pharmaceuticals/Biotechnology
67	60	Westport Fuel Systems Inc.*	\$30,577	\$31,581	-3.2	\$397,805	7.7	Other Manufacturing
68	63	IMV Inc.*	\$30,296	\$28,931	4.7	\$0		Pharmaceuticals/Biotechnology
69	70	Neo Performance Materials Inc.*	\$27,080	\$24,893	8.8	\$833,220	3.3	Mining & Metals
70	77	Blackline Safety Corp.	\$24,684	\$16,394	50.6	\$72,931	33.8	Software & Computer Services
71	73	Winpak Ltd.*	\$23,747	\$22,351	6.2	\$1,537,008	1.5	Rubber & Plastics
72	81	Q4 Inc.*	\$23,694	\$13,894	70.5	\$72,970	32.5	Software & Computer Services
73		ProMIS Neurosciences Inc.*	\$20,934	\$6,310	231.8	\$0		Pharmaceuticals/Biotechnology
74	98	Appili Therapeutics Inc.	\$20,744	\$10,222	102.9	\$1,391		Pharmaceuticals/Biotechnology
75	75	TECSYS Inc.	\$20,392	\$18,568	9.8	\$137,200	14.9	Software & Computer Services
76	93	Cardiol Therapeutics Inc.	\$18,962	\$10,870	74.4	\$0		Pharmaceuticals/Biotechnology
77	96	Eupraxia Pharmaceuticals Inc.	\$17,624	\$10,256	71.8	\$0		Pharmaceuticals/Biotechnology
78	78	Computer Modelling Group Ltd.	\$17,581	\$15,864	10.8	\$66,202	26.6	Software & Computer Services
79		Sernova Corp.	\$17,569	\$5,758	205.1	\$0		Pharmaceuticals/Biotechnology
80	72	Edesa Biotech, Inc.*	\$17,353	\$22,497	-22.9	\$0		Pharmaceuticals/Biotechnology
81	93	Medicenna Therapeutics Corp.	\$17,169	\$10,870	57.9	\$0		Pharmaceuticals/Biotechnology
82	86	AcutyAds Holdings Inc. +	\$16,805	\$12,680	32.5	\$121,039	13.9	Telecommunications Services
83		NervGen Pharma Corp.	\$16,613	\$6,872	141.7	\$0		Pharmaceuticals/Biotechnology
84		AEterna Zentaris Inc.*	\$16,274	\$8,241	97.5	\$7,339	221.7	Pharmaceuticals/Biotechnology
85	83	Optiva Inc.*	\$15,703	\$13,174	19.2	\$80,393	19.5	Software & Computer Services
86	84	Oncolytics Biotech Inc.	\$15,432	\$12,920	19.4	\$0		Pharmaceuticals/Biotechnology
87	76	Liminal BioSciences Inc.	\$15,298	\$18,347	-16.6	\$401		Pharmaceuticals/Biotechnology
88		Revive Therapeutics Ltd.	\$15,156	\$6,705	126.0	\$0		Pharmaceuticals/Biotechnology
89	85	Knight Therapeutics Inc.	\$14,755	\$12,692	16.3	\$293,563	5.0	Pharmaceuticals/Biotechnology
90	80	Antibe Therapeutics Inc.	\$14,444	\$14,434	0.1	\$0		Pharmaceuticals/Biotechnology
91	97	POET Technologies Inc.*	\$13,985	\$10,235	36.6	\$720		Electronic Systems & Parts
92	82	Baylin Technologies Inc.	\$13,280	\$13,682	-2.9	\$120,860	11.0	Comm/Telecom Equipment
93	99	TC Energy	\$12,779	\$10,110	26.4	\$14,977,000	0.1	Energy/Oil & Gas
94	95	Stingray Group Inc.	\$12,755	\$10,689	19.3	\$282,626	4.5	Telecommunications Services
95		Cameco Corporation	\$12,175	\$7,168	69.9	\$1,868,003	0.7	Mining & Metals
96	100	Alpha Cognition Canada Inc.*	\$11,474	\$9,994	14.8	\$0		Pharmaceuticals/Biotechnology
97	88	Servier Canada Inc. (fs)	\$10,775	\$12,157	-11.4	\$125,954	8.6	Pharmaceuticals/Biotechnology
98	91	Aurora Cannabis Inc.	\$10,389	\$11,447	-9.2	\$253,303	4.1	Pharmaceuticals/Biotechnology
99		Taiga Motors Corporation	\$10,266	\$5,895	74.1	\$3,212	319.6	Automotive
100	92	DiaMedica Inc.*	\$10,201	\$10,987	-7.2	\$0		Pharmaceuticals/Biotechnology

Notes:

- Data were obtained through annual reports, financial statements, securities commission filings, other company issued documents, and/or through a survey.
- We have attempted, whenever possible, to provide gross R&D spending before deduction of investment tax credits or government grants.
- We have attempted, wherever possible, to provide revenue net of interest and investment income.
- FY2021 R&D spending figures may have been adjusted as more accurate information became available.
- Canadian-owned company results include worldwide revenue and R&D spending; foreign subsidiaries (fs) for their Canadian operations only.

- *Converted to CDN\$ at annual average 2022 = 1.3013; 2021 = 1.2535 (Bank of Canada)
- **Based on companies with \$2 million or more of revenue
- +Not current name/acquired/merged
- ++Fiscal 2023 figures were used for year-ended January or February
- fs = Foreign subsidiary (includes revenue and R&D spending for Canadian operations only)
- nd = Not disclosed

CANADA'S TOP 100

Corporate R&D Spenders

Corporate R&D Spending Accelerates

Canada's Top 100 Corporate R&D Spenders posted \$16.05 billion in combined research and development (R&D) spending in Fiscal 2022. This was a significant increase of 20.2% over Fiscal 2021. Encouragingly, R&D spending increased at 81 companies and declined at only 19. Combined revenue of 94 of the Top 100 that disclosed their data was \$403.62 billion. This produced an overall R&D intensity (R&D spending as % of revenue) of 3.5%.

In Fiscal 2022, the leading Corporate R&D spender was Shopify Inc. which devoted \$1.96 billion to R&D (up 82.7%), followed by Constellation Software Inc. (\$1.31 billion, up 36.2%) and Magna International Inc. (\$844.5 million, up 6.3%). TELUS Corporation Inc. landed in 4th spot with \$819.0 million of R&D spending (up 2.5%) and AMD Canada rounded out the top five R&D spenders with \$698.8 million (up 45.6%).

\$100 Million Club

Thirty-one Top 100 firms each reported R&D spending in excess of \$100 million in Fiscal 2022, thus qualifying for membership in Research Infosource's \$100 Million Club. In Fiscal 2022, total Club members' R&D spending was \$13.48 billion, accounting for 84% of total Top 100 R&D spending.

R&D Spenders Tiers

Grouping the Top 100 companies into three R&D spending tiers (Tier 1 = \$100 million or more of R&D spending, Tier 2 = \$30 million-\$99.9 million, Tier 3 = less than \$30 million), three firms emerged as the respective tier leaders: Tier 1 – Shopify Inc. (\$1.96 billion), Tier 2 – Kinaxis Inc. (\$96.5 million) and Tier 3 – Neo Performance Material Inc. (\$27.1 million).

R&D Spending Growth

The leading firms in Fiscal 2022 for growth in R&D spending in Tier 1 were Lightspeed Commerce

Inc. (129.6%), Shopify Inc. (82.7%) and AbCellera Biologics Inc. (80.5%). The Tier 2 leaders were Absolute Software Corporation (99.8%), Coveo Solutions Inc. (94.3%) and Thales Canada Inc. (88.5%). Tier 3 R&D growth leaders were: ProMIS Neurosciences Inc. (231.8%), Semova Corp. (205.1%) and NervGen Pharma Corp. (141.7%).

R&D Intensity

Combined Top 100 R&D intensity (R&D spending as a percent of revenue) was 3.5% in Fiscal 2022. Among the 94 firms for which complete data were available, a number posted very strong gains in R&D intensity. In Tier 1, the leading firms were: Xenon Pharmaceuticals Inc. (1,121.2%), Ballard Power Systems Inc. (114.5%) and Repare Therapeutics Inc. (91.4%). Tier 2 leaders were: Milestone Pharmaceuticals Inc. (805.6%), Thinkific Labs Inc. (53.3%) and Theratechnologies Inc. (46.5%). Heading Tier 3 were: Taiga Motors Corporation (319.6%), AEterna Zentaris Inc. (221.7%) and Blackline Safety Corp. (33.8%).

Regional Performance

In Fiscal 2022, 46 companies headquartered in Ontario reported combined R&D spending of \$9.16 billion, representing 57% of the Top 100 total, followed by 25 Quebec-based companies (\$4.02 billion, 25% of the total) and 27 firms located in Western Canada (\$2.82 billion, 18% of the total). Overall R&D growth jumped by a combined rate of 23.0% in Ontario, 17.8% in Western Canada and 15.7% in Quebec.

Industry Performance

In Fiscal 2022, a selection of industry sectors posted the most R&D spending: 23 companies in the Software & Computer Services sector accounted for 36% of total Top 100 R&D spending, 36 Pharmaceuticals/Biotechnology firms accounted for

a combined 16% of R&D spending, five Telecommunications Services companies accounted for 12% of the top 100 total, five Aerospace & Defence companies accounted for 7% of the total, three Automotive companies accounted for 6% of the total. Five Energy/Oil & Gas companies and five companies in the Comm/Telecom Equipment sector each respectively accounted for 5% of all R&D spending total in Fiscal 2022.

R&D spending growth among these industry sectors was strongest in Fiscal 2022: Software & Computer Services (up 36.5%), Energy/Oil & Gas (up 19.9%), Aerospace & Defence (up 17.8%), Pharmaceuticals/Biotechnology (up 17.2%) and Comm/Telecom Equipment (up 14.3%).

Bucking the Trend

Normally, Research Infosource expects R&D spending trends to broadly align with revenue trends. In Fiscal 2022, several industry sectors performed counter to expectations: The Telecommunications Services sector experienced a combined increase of revenue of 4.8%, but posted an overall drop in R&D spending of -6.3%. The Energy/Oil & Gas sector posted revenue gains of 44.4% in Fiscal 2022, while posting a combined R&D spending increase of 19.9%. The Comm/Telecom Equipment sector had a combined revenue gain of 31.5% and expanded its R&D spending by less than half, at 14.3%. However, the Software & Computer Services sector had revenue gains of 13.8%, while posting a much higher combined R&D spending increase of 36.5%, as did the Pharmaceutical/Biotechnology sector with revenue gains of 9.1%, while posting a 17.2% increase in R&D spending in Fiscal 2022.

This Year and Next

Corporate R&D spending appears to be on a roll. Following a 10.9% gain in Fiscal 2021, the Top 100 Corporate R&D Spenders lodged an impressive

Top 100 – Leading Industries

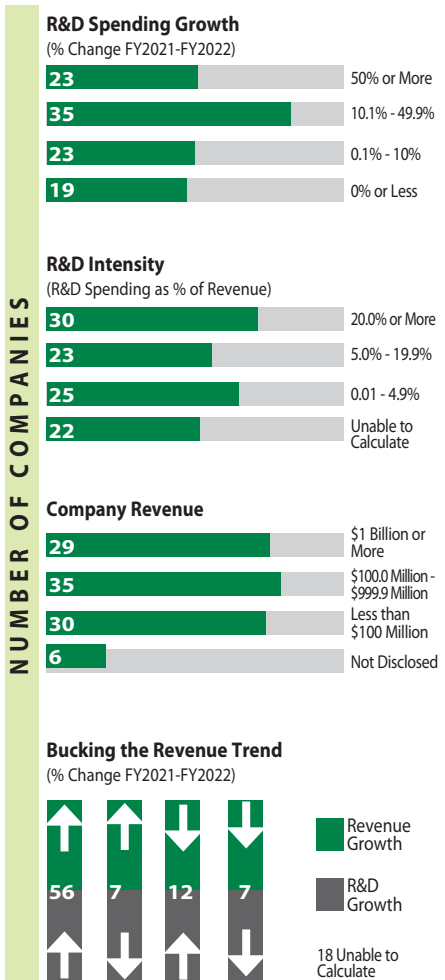
Industry	% of Total
Software & Computer Services (23)	36
Pharmaceuticals/Biotechnology (36)	16
Telecommunications Services (5)	12
Aerospace & Defence (5)	7
Automotive (3)	6
Energy/Oil & Gas (5)	5
Comm/Telecom Equipment (5)	5

20.2% increase in their combined R&D spending in Fiscal 2022, to \$16.05 billion. (Note that the composition of the Top 100 does change from year to year.)

The Fiscal 2022 results run counter to expectations. Clearly, economic conditions did not deteriorate sufficiently to hobble R&D spending. Rather, the opposite was the case; 58 of the Top 100 reported triple and double-digit increases in R&D spending in Fiscal 2022.

A big question is whether the torrid Fiscal 2022 results can continue, against a backdrop of rising interest rates, slowing interest rates and a cloudy political economy. Regardless, let us celebrate our firms' R&D performance and hope that it will herald an era of ongoing growth.

Top 100 Corporate R&D Spenders Key Demographics FY2022



Top Corporate R&D Spenders by Tier FY2022								
R&D Spending			R&D Spending Growth (% Change FY2021-FY2022)			R&D Intensity* (R&D Spending as % of Revenue)		
Rank	Tier 1	\$000	Rank	Tier 1	%	Rank	Tier 1	%
1	Shopify Inc.	\$1,956,158	1	Lightspeed Commerce Inc.	129.6	1	Xenon Pharmaceuticals Inc.	1,121.2
2	Constellation Software Inc.	\$1,314,313	2	Shopify Inc.	82.7	2	Ballard Power Systems Inc.	114.5
3	Magna International Inc.	\$844,544	3	AbCellera Biologics Inc.	80.5	3	Repare Therapeutics Inc.	91.4
Rank	Tier 2	\$000	Rank	Tier 2	%	Rank	Tier 2	%
1	Kinaxis Inc.	\$96,487	1	Absolute Software Corporation	99.8	1	Milestone Pharmaceuticals Inc.	805.6
2	MDA Ltd.	\$94,000	2	Coveo Solutions Inc.	94.3	2	Thinkific Labs Inc.	53.3
3	Descartes Systems Group Inc.	\$91,550	3	Thales Canada Inc. (fs)	88.5	3	Theratechnologies Inc.	46.5
Rank	Tier 3	\$000	Rank	Tier 3	%	Rank	Tier 3	%
1	Neo Performance Materials Inc.	\$27,080	1	ProMIS Neurosciences Inc.	231.8	1	Taiga Motors Corporation	319.6
2	Blackline Safety Corp.	\$24,684	2	Sernova Corp.	205.1	2	AEterna Zentaris Inc.	221.7
3	Winpak Ltd.	\$23,747	3	NervGen Pharma Corp.	141.7	3	Blackline Safety Corp.	33.8

Notes:
1. R&D Spending Tiers: Tier 1 = \$100 million or more of R&D spending, Tier 2 = \$30 million-\$99.9 million, Tier 3 = less than \$30 million.
fs = Foreign subsidiary (included revenue and R&D spending for Canadian operations only)
*Based on companies with \$2 million or more of revenue



FOCUS ON Climate Change Research in Action

Continued from page 24

"The ocean is by far the biggest carbon sink in the world. It protects us against the worst impacts of a warming planet. But exactly how, and for how long it can do so, are critical scientific questions that need answers urgently," said Dr. Anya Waite, Chief Executive Officer and Scientific Director of the Ocean Frontier Institute (OFI) led by Dalhousie University.

Launched in 2015, the OFI has emerged as a global leader for innovative ocean research, uniting researchers across Dalhousie and its partner institutions. It also collaborates with public and private sector groups across Canada and in 10 countries, including partners from Germany, U.S., Ireland, Norway and France.

"Together we are creating the foundation for a global alliance on ocean research," said Waite.

With a focus on the North Atlantic and Canadian Arctic, the institute supports solutions-oriented, transnational and interdisciplinary research in three key areas: achieving net zero, protecting biodiversity and sustaining bioresources such as fisheries and aquaculture.

"We are very keen to make research work for society, to make it useful. To do that we have to build partnerships beyond the research community itself, including with industry, policymakers and NGOs," added Waite, who is also Dalhousie's Associate Vice-President (Ocean).

Meeting Canada's ambitious emission targets will require solutions that can be tested and scaled quickly. To help get there, Dalhousie recently launched a \$400-million research program, which includes a \$154 million federal contribution – the largest ever made in research at the

university – to establish a new OFI-led program, Transforming Climate Action: Addressing the Missing Ocean. It brings together 170 researchers, 86 postdoctoral fellows and more than 40 national and international partners to study the ocean's changing ability to absorb and hold carbon.

"Without a better understanding of the ocean's role in mitigating global warming, our efforts to meet global climate targets and avert the worst impacts of climate change are at serious risk," said Waite.

McGILL UNIVERSITY Overcoming the barriers to electrification

The Quebec government and multinational corporations are investing billions to build Quebec's battery production capacity and electrify its transport, heating, and part of its industrial sector by 2050.

A key player in this mission is the Centre for Innovation in Energy Storage and Conversion at McGill University. Established in 2021, the McISCE brings together some 50 researchers and more than 150 graduate students – all exploring solutions related to large-scale energy storage, both for electricity grids and large industrial processes.

"Now that the electrification of transport is well under way, a huge amount of development work needs to be done in order to make batteries more efficient," said Sylvain Coulombe, physical engineer and Director of McISCE.

Roughly a third of the researchers at McISCE are investigating new materials to make anodes and cathodes and to develop solid electrolytes, which would have the advantage of not being flammable.

McGill researchers are also exploring different ways to store and convert energy. Quebec's abundance of renewable energy makes it possible to produce either hydrogen or green ammonia, which, when they react or are "broken," release large quantities of energy.

Other research looks at metallic fuels such as iron or aluminum powder. When they react with air or water, these powdered metals can create energy immediately, without producing carbon emissions.

"This is the principle behind the rocket engines of space shuttles, which use aluminum powder as fuel," explained Benoit Boulet, Associate Vice-Principal (Innovation and Partnerships) at McGill.

Metallic fuels could decarbonize energy-intensive industrial processes, such as those used to produce steel or concrete. But their first application, added Boulet, may be in maritime transport. "Our researchers have already patented the burner."

In addition to engineers, physicists, and chemists, McISCE also brings together architects, political scientists, economists and communications specialists to consider non-technical issues – such as regulations, building codes and affordability – that could hinder the adoption and acceptance of these technologies.

"Energy efficient houses and electric cars won't achieve anything if they are unaffordable to half the population," said Coulombe.

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PARTNER PERSPECTIVE

Building a climate resilient Canada through research



Marianne Armstrong
Director, Special Initiatives,
Climate Resilient Built Environment
National Research Council
Canada

Since 2016, in partnership with Infrastructure Canada (INFC), the National Research Council of Canada (NRC) has been leading research to adapt Canada's infrastructure, including buildings, to climate change and extreme weather.

Through this work, NRC scientists are improving our understanding of how climate change affects the durability, reliability, safety, and service life of Canada's infrastructure. These advances in science have an important role to play in the way we design, build, and maintain our buildings, roads, bridges, transit systems and other infrastructure moving forward.

To bring science and innovation through to application, we have collaborated with over 150 different experts from across the country, including climate scientists, hydrologists, engineers, wildfire experts, builders and architects. Together, we have developed tools, guidance documents and knowledge that enable the Canadian construction industry to consider climate change and weather extremes in building and infrastructure design.

Climate research in action

Early in our efforts, we recognized the need to start designing buildings and bridges for future climates, instead of continuing to rely on historic climate data. To this end, scientists with expertise in climate change projections across Canada and civil engineers worked together to understand how Canada's climate is changing, and to present the data in a usable format for structural design. The results can now be explored through the Pacific Climate Impacts Consortium's Design Value Explorer tool. This ground-breaking research marks the first time some future climate design variables were made available in Canada, including wind pressure and design snow loads. The Canadian Highway Bridge Design Code intends to be the first national code to include this future-looking data in their upcoming 2025 edition.

In 2021, the NRC developed and published a National Guide for Wildland-Urban Interface Fires, the first of its kind in Canada. Based on the latest national and international guidance, and input from a committee of national stakeholders, the Guide provides measures for reducing the impacts of wildfires on buildings, lots, and communities. The Guide is informing PacificCan's Lytton Homeowner Resilient Rebuild Program, and can help inform broader discussions on wildfire resilience across the country. Together with the Standards Council of Canada, we are now working to broaden the impact of the Guide by using it to inform the development of two new national standards.

Currently, the NRC's Climate Resilient Built Environment Initiative has over 60 active projects, ranging from preventing corrosion

on bridges to studying technologies to replace sandbags for flooding mitigation. This year, we also launched new research projects to support the retrofit of existing residential buildings, focused on providing science-based guidance to help make our homes safer and more durable in a changing climate. Our Canadian Construction Materials Centre has also started a pilot study to develop evaluation criteria for resilient building materials and systems. The goal is to help ensure products are available to meet resilience needs, while enabling Canadian industry to differentiate their products.

Building on climate resilience research

With a growing body of research results, our challenge now turns to ensuring this information is reaching those who need it most. Information about our research on climate-resilient buildings and infrastructure is available online. We are also working closely with INFC to support the development of the Climate Toolkit for Infrastructure, including an online platform to offer the latest science-informed guidance on adaptation.

The NRC and partners will continue to respond to the urgency of climate adaptation and will work to ensure Canada's construction sector has the knowledge, tools, and technologies it needs for a sustainable and resilient future.

To explore this climate resilience research, please visit:
<https://nrc.canada.ca/en/research-development/research-collaboration/our-research-climate-resilient-buildings-infrastructure>

<https://www.infrastructure.gc.ca/climate-resilience-climatique/codes-standards-normes-guidances-eng.html#resources>

<https://pacificclimate.org/analysis-tools/design-value-explorer>

Net zero communities of the future

Advancing next-generation clean energy solutions.

As Canada looks toward a low-carbon future, there is an urgent need for solutions that will deliver energy to communities efficiently, affordably and sustainably.

That's why McMaster engineer Jim Cotton is working with the university's nuclear experts to advance his Integrated Community Energy and Harvesting (ICE-Harvest) systems – designed to capture heat that would otherwise be wasted. Their vision is to combine this energy-versatile technology with small modular reactors (SMRs) to transform clean energy production nationally and globally.

SMRs offer a promising solution to provide clean, safe and abundant energy to communities – both urban and remote. Combined with an ICE-Harvest system, this thermal energy can be harvested, transferred and stored to power, heat and cool communities in a way that's cost effective and provides a pathway to net zero.

With decades of expertise in energy research and state-of-the-art facilities, McMaster is pioneering innovations that will bring Canada closer to net zero – one community at a time.

Learn more at nuclear.mcmaster.ca



Jim Cotton

Community energy expert and co-director of the McMaster Institute of Energy Studies

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