

University of Toronto Research Expertise

CleanTech



UNIVERSITY OF
TORONTO

Mar 2023

U of T Global Rankings

#1 in Canada | #18 worldwide

THE World University Rankings (2021-2022)

#1 in Canada | #34 worldwide

QS World University Rankings (2021-2022)

A POWERHOUSE FOR INNOVATION & ENTREPRENEURSHIP

600 Startups

More than **\$2.5B** in investment secured by **600+** startups over the past decade.

350+ Private Sector Partners

U of T's global reputation as a top research university and its vibrant innovation and entrepreneurship culture attracts industry partners from across Canada and worldwide.

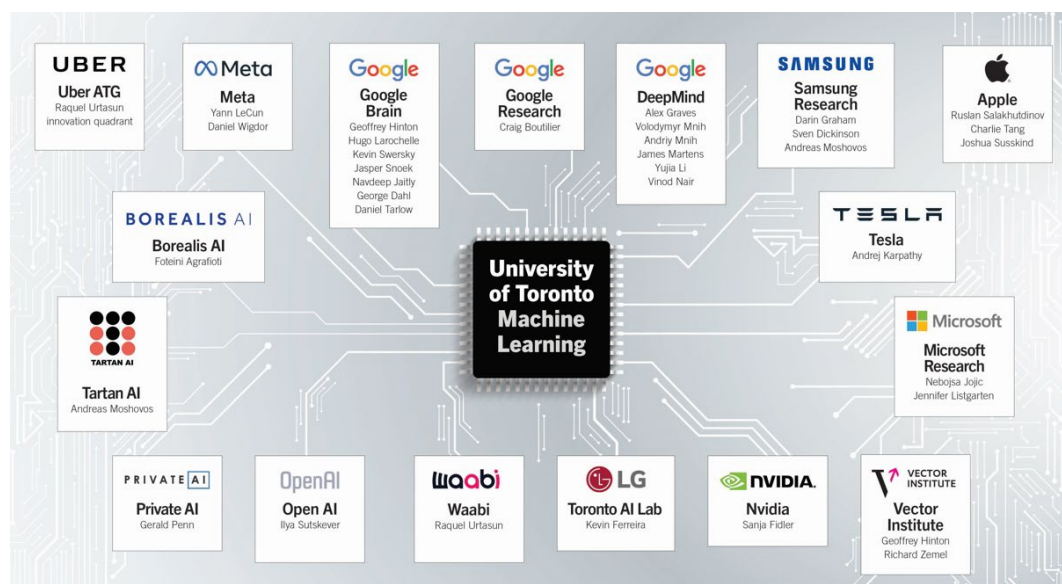
1000+ Patent Applications

U of T is a leader among North American universities for research-based startups, inventions, licenses and options.

U of T EXPERTISE IS SOUGHT BY GLOBAL GIANTS

U of T Faculty and Alumni are hired by some of the most influential tech companies worldwide

(As an example, the graphic below depicts engagements in the AI/Machine-Learning sector over the past several years, but may not reflect current status in all cases.)



TORONTO'S CLEANTECH & RENEWABLE ENERGY SECTOR

Annual economic impact:

\$50B

People employed:

29,000+

Number of firms:

1,700+

U of T'S CONTRIBUTION Bench Strength in Related Research & Innovation

Research funding attracted in last 5 years:

\$496M

Canada Research Chairs:

23

Faculty members:

491

Graduate students supervised:

1,378

Startups created in last 10 years:

107

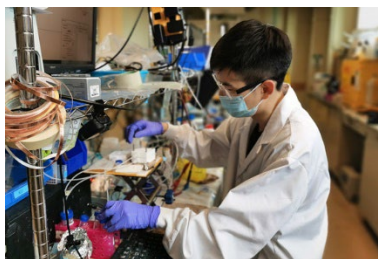
Canada's cleantech sector ranks fourth in the world and first in the G20 in terms of its potential to produce entrepreneurial cleantech start-up companies that will commercialize clean technology innovations over the next 10 years, and the Toronto region is a dynamic global hub of activity in the renewable energy and clean technology sectors. The City of Toronto ranks in the top 10 in Siemen's US and Canada Green City Index, ahead of Chicago, Philadelphia, and Atlanta.

Impact Stories



[This U of T-designed lab on wheels roams the city, gathering data on air pollution](#)

Feb 26, 2021



[Low-pH system developed by U of T researchers recycles more CO2 into valuable products](#)

Jun 7, 2021



[U of T researcher leads project focused on transitioning health-care system to 'net-zero' emissions](#)

Jun 7, 2021



[Study by U of T, international researchers finds potentially harmful 'forever chemicals' in makeup: CBC](#)

Jun 16, 2021



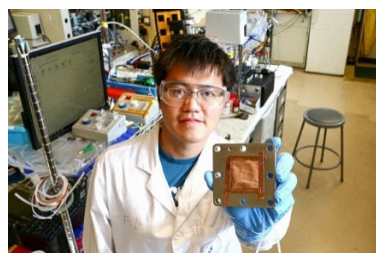
[Sustainability research gets boost from DC microgrid at U of T Engineering](#)

Dec 21, 2020



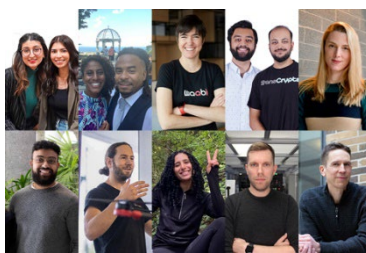
[With U of T as a partner, advanced materials research facility in Mississauga to focus on clean energy](#)

Nov 17, 2020



[U of T and Caltech collaborate on pathway to carbon-neutral plastics](#)

Apr 20, 2021



[U of T Entrepreneurship Week 2023: Top 10 startups to watch](#)

Mar 2, 2023



[Researchers enhance durability of low-cost solar cells made from nano-sized crystals](#)

Feb 23, 2023

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INITIATIVES – KEY RESEARCH CENTRES AND INFRASTRUCTURE

With internationally recognized strengths across a wide breadth and depth of disciplines, the University of Toronto is one of the few global institutions able to implement innovative strategic initiatives that span fields and faculties.

Institutional Initiatives are large-scale, cross-divisional research centres supporting interdisciplinary teams of University of Toronto researchers and partners, addressing grand challenges and pursuing bold ideas that require true collaboration and the integration of various disciplinary research approaches.

These are just some of the collaborative initiatives we are supporting.

Schwartz-Reisman Institute for Technology and Society

<https://srinstitute.utoronto.ca/>

The Schwartz Reisman Institute draws on U of T's signature strengths in the sciences, humanities and social sciences to explore the benefits and challenges that AI, biotechnology and other technological advances present for our economy, our society and our day-to-day lives.

Acceleration Consortium

<https://acceleration.utoronto.ca>

The **Acceleration Consortium** is leading a paradigm shift in scientific discovery through the development of self-driving artificial intelligence-guided robotic labs that accelerate the discovery of advanced materials and small molecules, from decades to years. The consortium addresses fundamental topics, such as deep learning algorithms, materials modelling, and robotics and applied challenges, such as discovering materials for a wide range of commercial applications. The Acceleration Consortium supports a commercialization-focused ecosystem that aims to translate materials discoveries through start-ups and industry partnerships.

A3MD

<https://light.utoronto.ca/a3md/>

The **Alliance for AI-Accelerated Materials Discovery (A3MD)** seeks to leverage the power of artificial intelligence to design the next generation of high-performance materials. Uniting recent advances in machine learning and high-throughput experimentation, the team seeks to accelerate the discovery and commercialization of new, efficient catalysts and consumer electronic materials. A3MD brings together world-leading researchers from the University of Toronto, McMaster University and the National Research Council of Canada, as well as industrial partners LG and Total.

Centre for Analytics and Artificial Intelligence Engineering (CARTE)

<https://www.engineering.utoronto.ca/carte/>

The **Centre for Analytics and Artificial Intelligence Engineering (CARTE)** brings together more than 30 professors with expertise in optimization, analytics and AI, as well as diverse domains such as energy, transportation and life sciences. Artificial intelligence (AI) is increasingly part of our daily lives, with applications from voice-activated assistants to self-driving cars — and its influence continues to grow. This multidisciplinary research centre leverages the power of AI to address challenges in a wide range of fields, including human health, sustainability and advanced manufacturing.

School of Cities

<https://www.schoolofcities.utoronto.ca/>

The **University of Toronto School of Cities** convenes urban-focused researchers, educators, students, practitioners and the general public to explore and address complex urban challenges. The interdisciplinary research is conducted with the aim of making cities and urban regions more sustainable, prosperous, inclusive and just.

University of Toronto Robotics Institute

<https://robotics.utoronto.ca>

The **University of Toronto Robotics Institute** is home to the largest and most diversified robotics research program in Canada. We unite, grow, and catalyze collaborations among the many exceptional robotics research clusters at the University. Serving as the headquarters for robotics collaboration at U of T, we unite leading robotics experts from across the University around three research pillars: Autonomous Field Robotics; Healthcare Robotics; Advanced Manufacturing.

UofT Transportation Research Institute (UTTRI)

<https://uttri.utoronto.ca/>

Faculty members at the **University of Toronto Transportation Research Institute (UTTRI)** specialize in systems analysis and policy evaluation, and are leaders in building and applying cutting-edge computer simulation models to the analysis and design of complex transportation systems. U of T has an internationally recognized critical mass of researchers with extensive experience in the analysis, planning and design of urban transportation systems, covering roads, transit, freight and active transport modes (walk and bike) across a range of perspectives – travel behaviour, system performance, economics and environmental impacts. We have extensive experience with comprehensive, system-wide, evidence-based policy analysis and decision support, leading to successful transportation facilities implementation and operations.

Collaboration Centre for Green Energy Materials (CC-GEM)

<https://nrc.canada.ca/en/research-development/research-collaboration/collaboration-centres/nrc-university-toronto-collaboration-green-energy-materials>

The NRC-University of Toronto Collaboration Centre for Green Energy Materials (CC-GEM) builds on a strong, long-term relationship between the University of Toronto and the National Research Council of Canada (NRC), leveraging their strengths in reducing the environmental impacts of the transformation, transmission and storage of energy. This collaboration centre advances critical platform technologies for accelerating the development of clean materials and production processes. CC-GEM's focus is on next-gen photovoltaics, renewable carbon-based feedstocks, renewable fuels and fuel cells, next-gen consumer-scale energy, and AI-enabled materials discovery. The Centre is scheduled to open in 2022.

School of the Environment

<https://environment.utoronto.ca/>

The **School of the Environment** serves as an interdisciplinary hub for education and scholarship on the environment and sustainability. We create new knowledge; train future leaders; engage and forge partnerships with the wider community; and contribute to positive environmental and social change from the local to the global scale.

University of Toronto Electric Vehicle Research Centre (UTEV)

<https://utev.utoronto.ca/>

The **University of Toronto Electric Vehicle (UTEV) Research Centre** is a game-changing university-industry partnership, focused on next generation of EV technologies. Research is focused in a state-of-the-art battery and power electronics lab, with multi-disciplinary collaborations alongside leading professors from Electrical and Computer Engineering, as well as from other engineering units. In partnership with Industry and Government partners, UTEV researchers study Energy Management and Storage, Advanced Power Modules, Next-generation powertrain, Ubiquitous Charging, and generally new opportunities for EVs.

The UTEV Centre will also be linked to the nascent **University of Toronto Electrification Hub**, bringing together Engineering, Public Health, Urban Planning, Cybersecurity, and Anthropology experts to contribute to the electrification revolution with multidisciplinary research and innovations on material discovery, batteries, chargers, and stationary energy storage, in collaboration with Canada's fast-growing e-mobility sector.

Pulp and Paper Centre

<http://www.pulpandpaper.utoronto.ca/>

The Pulp & Paper Centre at the University of Toronto, which exists within the umbrella of the Department of Chemical Engineering and Applied Chemistry, was founded in 1987. The Centre has grown and changed with the challenges that face the industry, but its mission has remained the same: ***to continue to facilitate partnerships between the University of Toronto and the pulp and paper industry in order to provide excellence in education, research, and information transfer.***


U of T RESEARCHERS

This is not intended as an exhaustive list of our faculty members in this field, but highlights some of our relevant researchers. Appearance on this list should not be interpreted as indicative of any individual's availability for a specific external engagement.

For additional researchers in the related field of Sustainability, please see the companion [Sustainability sector summary](#) document, which highlights complementary research. (Note: some researchers appear in both documents).

TARGET AREA: POWER/SMART GRIDS


Cristina Amon

	University Affiliations: Mechanical & Industrial Engineering Electrification Hub
	Website: Cristina Amon
	Keywords: CFD Thermofluids Sustainability Renewable Energy CleanTech

Cristina Amon pioneered the field of Computational Fluid Dynamics and the development of multidisciplinary multi-scale hierarchical modelling. Her current research includes nanoscale thermal transport, clean energy systems; thermal battery management in electric vehicles; and hemodynamics and transport in biomedical systems. This research has applications in electronics and electric vehicles, renewable energy, and biomedical devices.

Professor Amon is **Dean Emerita** of the **Faculty of Applied Science and Engineering**. She has recently been named a **Member of the Order of Canada** and the **Royal Society of Canada**. She is a fellow of all major professional societies in her field. Professor Amon was awarded the **2020 Engineers Canada Gold Medal**, the highest honour in the field.


Ali Hooshyar

	University Affiliations: Electrical & Computer Eng'rg Energy Systems Group
	Website: Ali Hooshyar
	Energy Smart Grid Renewable Energy CleanTech

Ali Hooshyar conducts research into the protection and control of renewable energy systems and smart power grids. This includes monitoring, fault protection, and error-detection. He also edits several IEEE journals on renewable energy systems and smart grids.

Professor Hooshyar holds the **Canada Research Chair in Electric Power Systems**. He is also a **Senior Member** of the **IEEE**, and a Member of **CIGRE**, the **International Council on Large Electric Systems**.


Reza Iravani

	University Affiliations: Electrical & Computer Eng'rg Energy Systems Group Centre for Applied Power Electronics
	Website: Reza Iravani
	Keywords: Energy Smart Grid Electric Vehicles Renewable Energy CleanTech

Reza Iravani has developed innovative solutions to several engineering problems associated with the applications of power electronics and emerging control and operational concepts in electrical energy systems, including utilization and grid-integration of renewable energy resources, efficient utilization of the legacy-grid asset, and modernization of the electric grid.

Professor Iravani is the former **editor-in-chief** of **IEEE Transactions on Power Delivery** and co-author of the reference book 'Voltage-sourced Converters'. He is a **Fellow** of both the **IEEE**, and the **Royal Society of Canada**.


Deepa Kundur

	University Affiliations: Electrical & Computer Eng'rg Communications Group
	Lab website: Deepa Kundur
	Keywords: Cybersecurity Signal processing Complex dynamical networks Computer communications Smart Grid Digital Forensics

Deepa Kundur's research interests lie at the interface of cybersecurity, signal processing and complex dynamical networks. She is a recognized authority on cybersecurity issues, especially in the automotive sector. These issues are also particularly relevant in securing Smart power grids. Her work also investigates steganalysis and authentication of digital video signals, as well as image fusion and blind image restoration.

Professor Kundur is currently the **Chair of the Edward S. Rogers Sr. Department of Electrical & Computer Engineering**. In 2015, she was elevated to **IEEE Fellow** for her contributions to signal processing techniques for multimedia and cyber security.


Zeb Tate

	University Affiliations: Electrical & Computer Eng'rg Energy Systems Group
	Website: Zeb Tate
	Keywords: Energy Smart Grid Smart Home Renewable Energy CleanTech

Zeb Tate focuses his current research on combining advanced telemetry, data processing, and visualization techniques to facilitate renewable integration and improve the reliability and efficiency of the power grid. For example, his team studies incorporating wind forecasts, load forecasts, generator reserves, and outage information to quantify the impact of wind variability on system reliability; and using advanced system architectures to improve system simulation tools.

Professor Tate serves as an Executive Member of the **Ontario Network for Sustainable Energy Policy (ONSEP)**, and co-chairs several working groups within **IEEE**.

Olivier Trescases


	University Affiliations: Electrical & Computer Eng'rg Energy Systems Group UT EV Research Centre Electrification Hub
	Website: Olivier Trescases
	Keywords: Renewable Energy Transportation Electric Vehicles Sustainability System Control Autonomous Vehicles

Olivier Trescases conducts research on high-efficiency switched-mode power converters for automotive, industrial, aerospace, solid-state lighting and renewable energy applications. He is one of the academic Leads on the UofT Electric Vehicle Research Centre, which focuses on power electronic converters for EV drivetrains; charging infrastructure; energy storage for EVs; and autonomous operation of EVs.

Professor Trescases hold the **Canada Research Chair in Power Electronic Converters**. He also serves on several **IEEE** committees.

TARGET AREA: REMEDIATION/RESILIENCE


Jonathan Abbatt

	University Affiliations: Chemistry Centre for Global Change Science
	Website: Jonathan Abbatt
	Keywords: Physical Chemistry Analytical Chemistry Environmental Health

Jonathan Abbatt and his team use state-of-the-art instrumentation to study chemical processes involved in environmental change at both the local and global levels. Focus on the chemical phenomena at the molecular level assists in translating lab results to environmental models. His current research focuses on the chemistry of the indoor environment, Arctic chemistry and connections to global warming, and the role that aerosol particles play in the chemistry of the atmosphere.


Professor Abbatt is the faculty lead on the **NETCARE** initiative (the Network on Climate and Aerosols), winner of the **2020 NSERC Brockhouse Prize for Interdisciplinary Research in Science and Engineering** for its work on understanding how aerosols and ultrafine particles contribute to climate change in the Arctic. He also serves as **Associate Director** of the **Centre for Global Change Science**.

Matthew Adams

	University Affiliations: Geography, Geomatics, and Environment (UTM) Urbanization, Transportation & Health School of Cities School of the Environment Centre for Global Change Science
	Website: Matthew Adams
	Keywords: Pollution Environmental Health Sustainability CleanTech

Matthew Adams and his team conduct research into refining geographic information systems/science (GIS), exposure to environmental irritants, and particularly, urban pollution. His recent research focuses on individuals' exposure to air contaminants in the urban environment. This research has implications across the social and natural sciences, and he leverages and advances the science of spatial analysis while considering social factors, such as the relationship between human behaviour and exposures in the built environment. He is studying space-time modelling of these effects, and pollution impacts of disruptive and sustainable transportation. His recent work has included studying Air Quality impacts in Toronto resulting from COVID-19 induced traffic pattern changes.


D. Grant Allen

	University Affiliations: Chemical Engineering BioZone
	Website: D. Grant Allen
	Sustainability Environmental Health Bioremediation Remediation Environmental Resilience Pulp & Paper

Grant Allen focuses his research on the growing field of Environmental Bioprocess Engineering – the application of chemical engineering principles to biologically-based processes. The field is interdisciplinary, drawing on chemistry, engineering, microbiology, and biochemistry; and has implications for the production of food, pharmaceuticals, chemicals, and waste treatment. Professor Allen has a particular interest in bioremediation of wastewater from the pulp and paper industry, and extracting useful materials and energy from this waste.

Professor Allen served as **Chair** of the **Department of Chemical Engineering and Applied Chemistry** from 2011 until mid-2021. He is a **Fellow** of the **AAAS**, the **Chemical Institute of Canada**, the **Canadian Academy of Engineering**, and other Societies.


Miriam Diamond

	University Affiliations: Earth Sciences Chemical Engineering Dalla Lana School of Public Health School of the Environment Centre for Global Change Science
	Website: Miriam Diamond
	Keywords: Sustainability Environmental Health Life Cycle Management

Miriam Diamond's research is motivated by the need to develop defensible strategies to reduce chemical contaminants in the environment. To accomplish this aim, she and her team strive to identify and connect sources of chemical emissions to the movement of chemicals through systems and ultimately to exposure. She focuses on systems with relatively high levels of contaminants, such as indoor environments and outdoor urban systems.

Professor Diamond is a **Fellow** of the **Royal Society of Canada** and the **Royal Geographical Society**, and has won the Faculty of Arts and Science **Dean's Excellence Award** in multiple years. She is a member of the **Board of Directors** for the **Canadian Environmental Law Association**.


Steve Easterbrook

	University Affiliations: Computer Science Sustainability Informatics School of the Environment Centre for Global Change Science
	Website: Steve Easterbrook
	Keywords: Sustainability Complex Systems Environmental Health CleanTech

Steve Easterbrook's current research focuses on climate Informatics; specifically, the application of computer science and software engineering to the challenge posed by global climate change. He also studies the role of computational models in teaching key concepts in climate science, and the application of web-based collective intelligence tools to the development of consensus solutions to climate change. His early career focused on systems analysis for complex software-intensive systems, and how the views of multiple stakeholders can be compared and merged; and the bidirectional interplay between human activities and software systems, and how each shapes the other.

Professor Easterbrook is the **Director** of the **School of the Environment**.

Elizabeth Edwards

	University Affiliations: Chemical Engineering Cell & Systems Biology BioZone School of the Environment
	Website: Elizabeth Edwards
	Keywords: Sustainability Environmental Health Bioremediation Remediation Environmental Resilience

Elizabeth Edwards studies the biological processes involved in Environmental science and engineering. Her lab researches better fundamental understanding of environmentally relevant biological processes to inform environmental decision-making at all levels. Specifically, they seek understanding of how organic contaminants (such as tailings) can be biotransformed by microorganisms in subsurface environments, discovering new biodegradation pathways and bacterial cultures along the way, which have demonstrated the efficacy of bioremediation in the field.

Professor Edwards holds the rank of **University Professor**, accorded only to the top scholars at UofT. She also holds the **Canada Research Chair in Anaerobic Biotechnology**. She has been recognized with many prestigious research awards, such as the **Killam Prize in Engineering** and the **NSERC Synergy Award**, and in 2020 was named an **Officer of the Order of Canada**.

Greg Evans


	University Affiliations: Chemical Engineering Occupational & Environmental Health School of Cities School of the Environment SOCAAR ISTEP Centre for Global Change Science
	Website: Greg Evans
	Keywords: Pollution Environmental Health Sustainability

Greg Evans devotes much of his research to the study of particulate matter polluting urban air, and impacts on human health and the environment. He focuses on traffic related air pollution, identifying the sources of pollution, development of inexpensive sensors, creation of large datasets, and understanding how the sources and composition of particulate matters influences its potential to induce oxidative stress.

Professor Evans is also deeply engaged in studying how engineering students use their skills and competencies to the betterment of society, and how transdisciplinary skills can optimize their future success.

Professor Evans is the **Director** of **SOCAAR**, the Southern Ontario Centre for Atmospheric Aerosol Research, an interdisciplinary centre with medical, chemical, environmental, and public health expertise. In 2021, Professor Evans was awarded both NSERC's **Brockhouse Canada Prize**, and the **Environment Division Research and Development Dima Award** from the **Chemical Institute of Canada**.


Heather MacLean

	University Affiliations: Civil Engineering Chemical Engineering School of Cities School of the Environment UTTRI CARTE
	Website: Heather MacLean
	Keywords: Sustainability Smart Cities Life Cycle Management Bioenergy Urban Infrastructure CleanTech

Heather MacLean's primary area of research involves developing and applying life cycle assessment and techno-economic methods to evaluate the technical and externality impacts of conventional and alternative energy and transportation systems, and elements of the built environment more generally.

Professor MacLean is a **Fellow of the Engineering Institute of Canada**, and has also been named to the **Canadian Academy of Engineering**. In 2017, she won the **Dr. Albert E Berry Medal** from the **Canadian Society for Civil Engineering** for outstanding contributions to the field of environmental engineering. She currently holds the **Canada Research Chair in Sustainable Systems and Technology Assessment**, and serves as the **Vice Dean Strategic** for the Faculty of Applied Science and Engineering.


Krishna Mahadevan

	University Affiliations: Chemical Engineering BioZone
	Website: Krishna Mahadevan
	Sustainability Environmental Health Bioremediation Remediation Environmental Resilience CleanTech

Radakrishnan (Krishna) Mahadevan conducts research into systems biology, synthetic biology, metabolic engineering, gut microbiome and microbial communities. This research has applications in bioproducts such as renewable chemicals and fuels, environmental engineering, and bioprocess optimization. Current research focuses on optimization and control of biological processes, a quantitative approach made possible only by recent models for such biological activity

Professor Mahadevan holds the **Canada Research Chair in Metabolic Systems Engineering**. He is also a member of the **American Institute of Chemical Engineering** and the **American Society for Microbiology**. In 2021, he was awarded the **DG Fisher Award** by the **Canadian Society for Chemical Engineering**.


Liat Margolis

	University Affiliations: Architecture Green Roof Innovation Testing Lab (GRITLab)
	Website: Liat Margolis
	Keywords: Sustainability Urban Infrastructure CleanTech

Liat Margolis' research focuses on the knowledge transfer of multi-performance materials and technologies across disciplines, and she is most interested in understanding and articulating the emerging relevance of performative landscapes as urban infrastructure. Specific topics include investigating the promise of contemporary technologies and approaches to hybrid vegetal systems at multiple scales, and the design implications for dynamic systems. Her recent research and instruction has primarily focused on water and wastewater infrastructure in arid climates; and investigating the intersection between the natural and fabricated as ecology and technological invention.

Professor Margolis is **Director** of the **Green Roof Innovation Testing Laboratory (GRITLab)**, and also serves as the **Associate Dean Research** for the Daniel Faculty.


Fadi Masoud

	University Affiliations: Architecture School of Cities
	Website: Fadi Masoud
	Keywords: Smart Cities Sustainability Urban Infrastructure

Fadi Masoud's research and design work engages the landscape and its underlying environmental systems as operational forces in shaping urbanism. His current work focuses on establishing relationships between large-scale dynamic environmental systems, design, and the instrumentality of planning frameworks, policies, and [codes](#). In collaboration with research and government partners, Masoud is developing an interactive geo-socio-spatial platform designed to increase awareness and bridge the gap between different stakeholders of urban development through a data-driven, web-based toolkits for climate-based adaptation planning and design strategies.

Professor Masoud is **Director** of the **Centre for Landscape Research**, and has been awarded a **Fulbright Fellowship**, the **ASLA certificate of Honor**, the **Jacob Weidenman Prize**, and was the 2015 recipient of the **Charles E. Beverage Fellowship** by the Olmsted Friends of Fairsted.


Emma Master

	University Affiliations: Chemical Engineering BioZone
	Website: Emma Master
	Keywords: Sustainability Environmental Health Bioremediation Bioplastics/Biochemicals Environmental Resilience CleanTech

Through her research, Emma Master and her team develop products supporting the rapidly growing global market for biochemicals and bioplastics from forest and agricultural sources. This creates new opportunities for forest and agricultural sectors important to Canada's economy. Plants sustainably synthesize an amazing array of biochemical useful via modern scientific advances such as genomics, bioinformatics, and the characterization of biocatalysts. These compounds can impart new functionality to various biomaterials.

Professor Master is a member of the **Canadian Society of Microbiologists** and the **American Society for Microbiology**. She was awarded a **Future and Emerging Technologies (FET) Open** grant in 2020, to integrate bioscience, computational sciences and materials sciences to advance biotechnologies in circular bio-based economies.


John Robinson

	University Affiliations: Munk School of Global Affairs School of the Environment School of Cities
	Website: John Robinson
	Keywords: Sustainability Urban Design

John Robinson's research focuses on the intersection of climate change mitigation, adaptation and sustainability; the use of visualization, modelling, and citizen engagement to explore sustainable futures; sustainable buildings and urban design; the role of the university in contributing to sustainability; creating partnerships for sustainability with non-academic partners; and, generally, the intersection of sustainability, social and technological change, behaviour change, and community engagement processes.

Professor Robinson currently serves as the **Presidential Advisor on the Environment, Climate Change, and Sustainability**. As such, he oversees many university research engagements, as well as the university's internal projects on enhancing its sustainability and eliminating/negating our carbon footprint.

Barbara Sherwood Lollar

	University Affiliations: Earth Sciences Chemical Engineering Chemistry BioZone School of the Environment
	Website: Barbara Sherwood Lollar
	Keywords: Geology Exobiology Bioremediation Remediation Sustainability


Barbara Sherwood Lollar is best known these days for her pioneering research into ancient waters and the deep subsurface biosphere. These deep crustal fluids have been isolated from the planetary surface biosphere for millions, in some cases billions, of years. Her work has demonstrated the role of such H₂-rich fluids in sustaining microbial communities kilometers beneath the surface, independent of sunlight; as such, her research provides insight into astrobiology and the exploration of other planets.

Professor Sherwood Lollar's research also examines groundwater quality and remediation issues, in both biotic and abiotic processes.

Professor Sherwood Lollar holds the rank of **University Professor**, accorded only to the top scholars at UofT. She holds the **Canada Research Chair in Isotopes of the Earth and Environment**, and is the recipient of many major prizes in recognition of her work, including the **2019 Herzberg Gold Medal**, and the **2020 Killam**

Prize for Natural Sciences. She is a **Companion of the Order of Canada**, a **Fellow** of the **Royal Society of London** and the **Royal Society of Canada**, and also a **Fellow** of the **Royal Canadian Geographical Society**, along with a host of other national/international fellowships and awards.

Kimberly Strong


	University Affiliations: Physics Centre for Global Change Science School of the Environment
	Website: Kimberly Strong
	Keywords: CleanTech Atmospheric Physics Planetary Physics

Kimberly Strong studies the atmosphere, on a planetary scale. Recent attention to issues such as ozone depletion, climate change, and tropospheric pollution all affect not just the atmosphere, but the entire biosphere of Earth. Professor Strong uses ground-based, balloon-based, and orbital satellite technologies to measure atmospheric composition and changes, gaining insight into fundamental physics and chemistry, with implications for anthropogenic changes. Nor is she limited to Earth: her work has contributed to the Galileo mission to Jupiter, and studies of the Martian atmosphere.

Professor Strong is a **Fellow** of the **Royal Society of Canada**. She was previously **Director** of the **School of the Environment**, and currently serves as **Chair** of the **Department of Physics**. Professor Strong also serves as **Chair** of the **SNOLAB Institute Board of Directors**, and in 2022, was awarded both the **Patterson Distinguished Service Medal** from the Meteorological Service of Canada, and the **Willet G. Miller Medal** from the Royal Society of Canada.

TARGET AREA: RENEWABLES/RESOURCES

Gisele Azimi


	University Affiliations: Chemical Engineering Materials Science & Engineering
	Website: Gisele Azimi
	Keywords: Energy Sustainability Waste Reduction/Recycling CleanTech

Gisele Azimi's research lies at the intersection of Process Engineering, Electrochemistry, and Materials Science; it combines fundamental science and engineering principles to develop real-world solutions in her areas of interest. These areas include Urban Mining (advanced recycling of electrical/electronic waste materials); Carbon Management through development of green electrochemical technology for the iron/steel

industry; Waste Valorization to reclaim rare earths, lithium, and cobalt, reducing industrial solid waste; and Energy Storage in the development of post-lithium rechargeable batteries.

Professor Azimi holds the **Canada Research Chair in Urban Mining Innovation**; she has also earned much recognition for her work, such as the **Dean's Spark Professorship (2018)**, the **McCharles Prize for Early Career Research Distinction (2020)**, and the **Canadian Society for Chemical Engineers Innovation Award (2020)**.


YH Cathy Chin

	University Affiliations: Chemical Engineering
	Website: Cathy Chin
	Keywords: Sustainability Catalysis CleanTech

Cathy Chin's research advances catalytic technology, mainly in sectors spanning the environment, health, medicine, and energy. Her team seeks a deep understanding of the catalytic technology at the molecular level, leading to its application in the design of novel materials promoting desired chemical reactions. She designs and fabricates small "chemical plants on a chip" as lightweight micro-reactor systems for small scale fuel and chemical processing.

Professor Chin holds the **Canada Research Chair in Advanced Catalysis for Sustainable Chemistry (Tier 2)**. She represents Canada at the **Commonwealth Science Conference** on low-carbon fuels, and served as a judge for the global **NRG-COSIA Carbon X-Prize** (a \$20M prize for development of CO₂ utilization technologies). In 2018, she was awarded a prestigious **Alexander von Humboldt Research Fellowship**.


Marie-Josée Fortin

	University Affiliations: Ecology & Evolutionary Biology Statistics Geography
	Website: Marie-Josée Fortin
	Keywords: Sustainability Geomatics

An ecologist by training, Marie-Josée Fortin has four main research areas: spatial ecology, disturbance ecology, conservation, and spatial statistics. Her research program studies the effects of global change (land-use and climate) on species spatial dynamics at the landscape and geographical range levels both in multiuse forested ecosystems and aquatic networks to maintain biodiversity and species conservation.

Professor Fortin holds the rank of **University Professor**, accorded only to the top scholars at UofT. She is a **Fellow** of the **Royal Society of Canada**, and holds the **Canada Research Chair in Spatial Ecology** (Tier 1).


Geoffrey Ozin

	University Affiliations: Chemistry Solar Fuels Group Materials Science & Engineering
	Website: Geoff Ozin
	Keywords: Nanomaterials Physical Chemistry Inorganic Chemistry Polymers Material Chemistry CO2 Utilization CleanTech

Informally considered to be “father of Nanochemistry,” Geoff Ozin’s work includes pioneering studies of new classes of nanomaterials, photonic crystals, and nanomachines. His contributions to science and industry include photonic ink and elastic ink, photonic crystal technologies developed by the start-up he founded, Opalux. More recently he has focused on nanomaterials for “artificial photosynthesis” sequestering atmospheric CO₂ for use in feedstocks.

Professor Ozin holds the rank of **University Professor**, accorded only to the top scholars at UofT. He held the **Canada Research Chair in Materials Chemistry** until its expiry in Dec 2021.


W. Richard Peltier

	University Affiliations: Physics Centre for Global Change Science School of the Environment Polar Climate Stability Network
	Website: Richard Peltier
	Keywords: CleanTech Atmospheric Physics Planetary Physics

Richard Peltier studies atmospheric and oceanic waves and turbulence; as well as fluid dynamics on a planetary scale, the physics of the Earth’s core, and climate on a planetary scale. He is renowned for his seminal contributions to planetary science, particularly the interactions between convection of Earth’s mantle and the continents and large ice-sheet loads. His work successfully interpreted Ice/Earth/Ocean interactions and their effect on sea-levels over geologic time-scales.

Professor Peltier holds the rank of **University Professor**, accorded only to the top scholars at UofT. He is a past recipient of the **Herzberg Gold Medal**, awarded annually to a scientist working in Canada whose research is characterized by both excellence and influence. Professor Peltier is a **Fellow** of the **Royal Society of Canada**. In addition to being the **Director** of the **Centre for Global Change Science**, he is also the **Scientific Director** of **SciNet**, Canada's largest supercomputer centre, for the use of Canadian researchers.


Mohini Sain

	University Affiliations: Daniels Forestry Mechanical & Industrial Engineering Chemical Engineering Low-Carbon Renewable Materials Centre
	Website: Mohini Sain
	Keywords: Sustainability Biocomposites CleanTech

Mohini Sain specializes in advanced nanocellulose technology, biocomposites and bio-nanocomposites. In particular, his work on Bio-inspired Advanced Materials and nanocellulose technology has been transformed from pure research into business opportunities, with the creation of several start-ups. His current research interests include fuzzy neuro-networks in next-generation transportation, bio-nano cellulose and carbon material for functional materials, low-carbon and carbon-negative technology development for the construction sector, and advanced portable electronic devices.

Professor Sain is a founding member of the **Canadian Natural Composites Council**, the **Ontario BioAuto Council**, and the **Ontario-Jianshu Nano-Innovation Centre** in Suzhou, China.

David Sinton


	University Affiliations: Mechanical & Industrial Engineering Climate Positive Energy Green Energy Materials
	Website: David Sinton
	Keywords: Thermofluids Materials Sustainability Renewable Energy CleanTech

David Sinton researches energy and the environment, with particular focus on carbon management, CO₂ conversion, and renewable fuels. He also studies fluid mechanics, microfluidics, and nanofluidics. These two areas converge in his research into the development of fluid systems to produce renewable fuels from CO₂, energy-efficient industrial working fluids, and quantifying the environmental impacts of future climate

conditions. His lab's previous work in industrial fluid testing systems gave rise to a start-up, Interface Fluidics Ltd.

Professor Sinton holds the **Canada Research Chair in Microfluidics and Energy**. He is a **Fellow** of the **AAAS**, as well as the **Engineering Institute of Canada**, the **Canadian Society for Mechanical Engineering**, and the **American Society of Mechanical Engineers**. In 2022, he was named a **Fellow** of the **Royal Society of Canada**.

Robert Wright

	University Affiliations: Architecture Landscape Design Mass Timber Institute Knowledge Media Design Institute
	Website: Robert Wright
	Keywords: Urban Design Sustainability CleanTech Renewable Building Materials

Robert Wright's research is design-centered and interdisciplinary in nature, with a focus on creative experimentation in landscape architecture, urban design, and industrial art. He has received several awards for his work, including the 2018 Ontario Association of Architects Award for Design Excellence in honour of his landscape contributions to the new McEwen School of Architecture building at Laurentian University. In 2017, he was awarded a Connaught Global Challenge Award as a part of the Urban Genome Project, which looks at city formation and evolution over time. Most recently he oversaw the creation of the Mass Timber Institute, guiding the development of the new generation of tall wood buildings in urban settings.

Professor Wright is **Interim Dean** of the **Daniels Faculty of Architecture, Landscape, and Design** until July 2021. He previously served as the **Dean** of the **Faculty of Forestry**, overseeing its recent merger with the Daniels Faculty; prior to that, he was **Associate Dean Research** at the Daniels Faculty and **Director** of the **Knowledge Media Design Institute**. He is currently the **Principal Investigator of MTI**, the Mass Timber Institute

SELECT TECHNOLOGY OPPORTUNITIES

U of T has flexible IP terms available to sponsoring partners. U of T's interest in IP developed through this research is "Inventors' Choice" where the inventors have the option to manage IP themselves, or to transfer IP to the university for management/commercialization (via the Innovations & Partnerships Office).

For all U of T technologies currently available for licensing, visit <http://uoft.me/tech-opps>

Infera AI: Platform for Digital Twins and Better Decision Making

<https://research.utoronto.ca/technology-opportunities/db/infera-ai-platform-digital-twins-and-better-decision-making>

A software platform that leverages statistical inference and machine learning to make more informed decisions. Through a novel combination of deep Bayesian learning and Bayesian analytics, the platform delivers accurate prediction statistics for robust, quantifiable, and interpretable analytics to scenarios that were previously too expensive or too slow.

Employing Wayfinding, Bottom-Up Knowledge Discovery and Information Flow in Infrastructure & Construction Projects

<https://research.utoronto.ca/technology-opportunities/db/employing-wayfinding-and-bottom-knowledge-discovery-and-information>

This invention is a system that presents an original contribution in the form of a knowledge base implemented as an Web Ontology Language (OWL). This system also combines customized wayfinding and recommender systems to support this knowledge base and automate the communication process. The resulting process automates the extraction of project knowledge, specifically construction impacts and functions, and the communication between project teams and the public. This process is also context-sensitive due to the rapid integration of project-specific parameters such as geographic specifics, socio-economic factors, and cultural attitudes. This process has traditionally been manual and time-consuming.

Nanostructured Solar Selective Catalytic Supports

<https://research.utoronto.ca/technology-opportunities/db/nanostructured-solar-selective-catalytic-supports>

The vast majority of energy consumed by the human population is derived from burning fossil fuels because of their abundance and remarkably high energy density. The new catalytic supports prepared by Dr. Ozin's lab offer a large improvement in yield of the gaseous process at ambient conditions, together with the discovery of both photochemical and photothermal activation in the system. This process resulted in a bold vision of a large scale photocatalytic energy plant, using sunlight to power the conversion of carbon dioxide and water to form natural gas and oxygen.

Multi-Port Converter Structure for DC/DC Power Conversion

<https://research.utoronto.ca/technology-opportunities/db/multi-port-converter-structure-dcdc-power-conversion>

The invention is for a new power electronic converter topology suitable for modularly configured solar photovoltaic or battery storage applications. Its highest value is seen within the space of battery storage applications where the topology offers unprecedented levels of electrical power process conversion efficiencies, with preliminary prototypes offering efficiencies on the order of 99%. Unlike competing technologies that typically address only a subset of system level and battery features, the proposed topology addresses all features that are viewed as critical for the formation of scalable energy storage systems. The topology also employs the lowest volume of magnetic components of any battery storage converters developed to date, save for switch capacitor circuits that suffer from drastically higher conversion losses. This makes the topology suitable not only for stationary battery storage applications, but also a premiere candidate for mobile applications, such as hybrid or electric vehicles.

Nanostructured Metal Oxides Compositions for Applied Photocatalysis

<https://research.utoronto.ca/technology-opportunities/db/nanostructured-metal-oxides-compositions-applied-photocatalysis>

This invention is a novel indium-based photocatalyst that is capable of reducing CO₂ (carbon dioxide) into CO (carbon monoxide). Currently there are 5.5 billion metric tons of CO₂ produced annually with 2 billion tons consumed worldwide. CO₂ emissions account for 82% of all US greenhouse gas emissions. The market for CO₂ sequestration consists of a spectrum of offerings through either storage or recycling. Discovering a material capable of photocatalytic reduction of CO₂ is a crucial step for the solar fuels economy.

Deep Learning Performance and Energy Optimization Techniques

<https://research.utoronto.ca/technology-opportunities/db/deep-learning-performance-and-energy-optimization-techniques>

While algorithmic improvements will allow Deep Learning to evolve, much hinges on hardware's ability to keep delivering ever higher performance and data processing storage and processing capability.

This invention is a set of techniques that are valued-based methods for reducing the number of computations that need to be performed when executing Deep Learning Algorithms and do not require intervention from the Machine Learning expert.

By exploiting ineffectual computations, weight sparsity, precision variability, and bit content, the accelerator designs transparently reduce the amount of work that needs to be performed by neural networks. The methods lead to the design of performance-, energy-, and/or cost-optimized computing engines for various applications domains.

All work with out-of-the-box Deep Learning networks and rely on value properties exhibited by typical models such as value- and bit-sparsity and data type need variability, and reward model optimizations.

U of T ENTREPRENEURSHIP

The [U of T Entrepreneurship](#) community is Canada's leading engine for research-based startups and a global leader in transforming ideas into products and services that create jobs and impact the world. More than 500 research-based startups have been launched from U of T, outpacing every other Canadian university, and generating more than \$1.5 billion (CAD) in investment in the past 10 years.

The University of Toronto is also home to 11 [accelerator/incubator programs](#) that serve students, alumni, and faculty from all disciplines and levels of experience.

UTEST

<http://utest.to/>

The University Early Stage Technology (UTEST) is a startup development program for nascent companies supported in partnership by the University of Toronto Connaught Fund and MaRS Innovation. UTEST provides investments of up to \$100,000 per company in addition to intensive entrepreneurial education, advisory support, and dedicated incubation space.

[Click here](#) for a list of all UTEST companies.

RELEVANT UNIVERSITY OF TORONTO START-UPS:

ALT TEX

<https://thealttex.com/>

ALT TEX takes landfill-destined food waste and chemically regenerates it into a bioplastic used to create various textiles. Our waste-to-wardrobe technology creates textile solutions that are biodegradable and carbon neutral. They can be used for a suite of textile applications including polyester-like fabrics, jacket insulation and more.

CERT

<https://co2cert.com/>

CERT Systems Inc. is a carbontech company that converts CO₂ into chemical fuels and feedstocks using water and electricity. Our team has developed an electrochemical technology to convert CO₂ into conventional petrochemicals used by a wide range of industries.

CHAR Technologies

<http://www.chartechnologies.com/>

CHAR TECHNOLOGIES (TSX.V: YES) is decarbonizing for a circular economy through advanced design, technology and environmental services. CHAR is a cleantech development and services company, specializing in high temperature pyrolysis, converting woody materials and organic waste into renewable gases (renewable natural gas and green hydrogen) and biocarbon (activated charcoal “SulfaCHAR” and solid biofuel “CleanFyre”). Additional services include custom equipment for industrial water treatment, and providing services in environmental compliance, environmental management, site investigation and remediation, engineering and resource efficiency.

Erthos

<https://www.erthos.ca/>

Erthos is looking to tackle the global issue of single-use plastics by offering eco-friendly resin-based alternatives to plastic inputs. The company’s resins serve as alternatives to polypropylene, polyethylene and polystyrene – common non-biodegradable inputs in the single-use plastic manufacturing industry – and are compatible with existing plastic manufacturing technologies. Erthos is also working on solutions to help brands integrate compostable plastics into their existing supply chains, enabling the adoption of “Erthos-certified single-use products.”

Genecis

<https://genecis.co/>

Genecis is a biotechnology company that converts organic waste into high quality, PHA biodegradable plastics. We help waste management companies save on organic disposal costs and supply plastic manufacturers with cost-competitive PHAs produced from waste materials rather than food crops.

Phycus Biotechnologies

<https://www.phycusbio.com/>

Phycus Biotechnologies is a start-up focused on the manufacture of sustainable ingredients for the cosmetics and personal care industry. Our technology use a fermentation process to produce biobased chemicals that are today sourced from petroleum, but that could instead be derived from biomass feedstocks, like sugars.

QD Solar

<https://qdsolarinc.com>

Pricing of solar modules has continued to fall globally as module maker margins are being squeezed, while efficiency improvements and cost reductions have stagnated. QD Solar offers a solution and technical breakthrough: a low-cost, lightweight, and flexible high-power density solar sheet that combines two light-absorbing nanomaterials - perovskites and quantum dots - to take solar beyond efficiencies achievable using silicon.

Solistra

<http://www.solistra.ca/>

Solistra is commercializing a solar-activated nanomaterial that is able to convert the two most abundant greenhouse gases - carbon dioxide and methane gas - into green chemicals like hydrogen, methanol, and ammonia, providing a low-carbon alternative to conventional petrochemicals. Solistra has just finished its first demonstration unit with Natural Resources Canada and the Canadian Gas Association and will soon begin a field pilot to convert biogas from food waste into green hydrogen.