University of Toronto Research Expertise

Sustainability

UNIVERSITY OF TORONTO

Mar 2023

U of T Global Rankings

#1 in Canada | #18 worldwide	#1 in Canada | #34 worldwide
THE World University Rankings (2021-2022)	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.

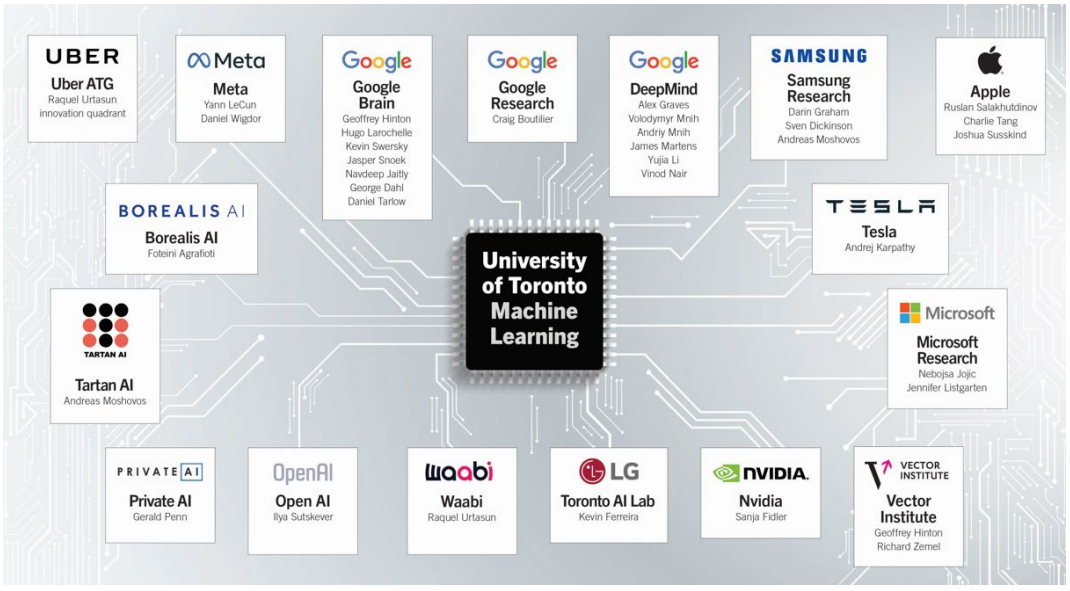
1000+ Patent Applications

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

[Bioinnovation partnership: U of T Engineering and Ford Canada introduce new, sustainable automotive material]

Jan 7, 2022

[Scientists find evidence of a warming planet high in the Earth's atmosphere]

Nov 23, 2021

[U of T experts work with U.S. startup to turn trains into giant carbon-capturing machines]

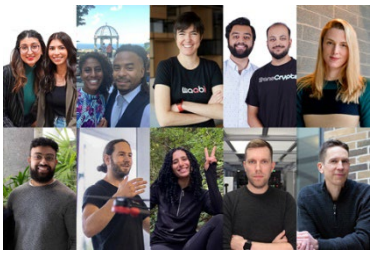
Jul 20, 2022

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

Nov 17, 2020

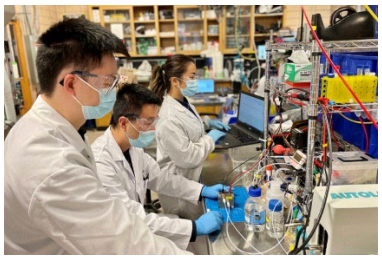
['An everybody problem': David Sinton on how U of T experts can help Canada – and the world – get to net-zero]

Dec 15, 2021



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

Mar 2, 2023



[U of T student team among 23 winners in Elon Musk's XPRIZE carbon removal competition]

Nov 10, 2021

Table of Contents

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.

Climate Positive Energy

https://cpe.utoronto.ca/

The Climate Positive Energy Initiative reflects the University of Toronto's response to Canada's formal commitment to achieving Net-Zero Greenhouse Gas emissions by 2050. It currently includes more than 100 faculty members from a wide range of fields, from anthropology to electrical engineering to public policy, developing clean-energy solutions that are mindful of political, human, and societal considerations.

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.

University of Toronto Electrification Hub

https://electrification.utoronto.ca

The University of Toronto Electrification Hub brings 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. The Electrification Hub is also closely aligned with UTEV (described above).

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 CleanTech, please see the companion **CleanTech sector summary** document, which highlights complementary research. (Note: some researchers appear in both documents).

TARGET AREA: URBAN ISSUES

Baher Abdulhai

University Affiliations:
Civil Engineering
UTTRI
Intelligent Transportation Systems
CARTE

Website: Baher Abdulhai

Keywords:
Transportation Systems
Computer Communications
Urban Infrastructure
Smart Cities

Baher Abdulhai conducts leading-edge research aimed at reducing traffic congestion and enhancing safety. His achievements include the establishment and leadership of the **Intelligent Transportation Systems Centre** and the **iCity Centre for Automated and Transformative Transportation Systems**, and the invention of two traffic signal control systems which have been licensed by major technology firms. Professor Abdulhai was recently named to the **Canadian Academy of Engineers** (2020). His record of service includes the Board of the **Ontario Transit Authority** and the **Toronto Board of Trade Infrastructure Committee**. He is a **fellow** of the **Engineering Institute of Canada** and received the 2018 **Canadian Society for Civil Engineering Sandford Fleming Award**.

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.

Evan Bentz

University Affiliations:
Civil Engineering

Website: Evan Bentz

Keywords:
Structural Engineering
Urban Infrastructure
Environmental Resilience

Evan Bentz is an expert in the development of structural software, empowering engineers to use new approaches in design to better assess and repair structures before catastrophe strikes. Hypotheses on the mechanisms of building collapse are validated using the (UofT-designed) Shell Element Tester located in the Structural Testing Facility on campus: the only facility of its kind in Canada capable of testing full-scale shell elements subjected to all eight possible force components. Combined with structural analysis software "*Response*" (created by Bentz), researchers can predict the behaviour of structures in extreme circumstances. This software has helped revolutionize building codes across Canada, the United States and Europe. Advances in testing scope and precision made by collaborators help to make building assessment and maintenance faster and more efficient, enabling engineers to more accurately predict which structures are safe following seismic events, ultimately saving lives and reducing costs.

Professor Bentz is **Chair** of **ACI Committee 365 (Service Life Prediction)**, and a member of **Joint ACI-ASCE Committee 445, (Shear and Torsion)**.

Shauna Brail

University Affiliations:
Institute for Management & Innovation
School of Cities
Munk School of Global Affairs
UTTRI

Website: Shauna Brail

Keywords:
Smart Cities
Sustainability
Urban Infrastructure
Transportation

Shauna Brail conducts her research at the Institute for Management & Innovation, University of Toronto Mississauga. As an economic geographer and urban planner, her research focuses on the transformation of cities as a result of economic, social, and cultural change.

Professor Brail's current research examines the disruptions taking place in urban mobility, particularly focused on the emergence and shifting strategies of ride-hailing firms and associated impacts on cities.

Professor Brail is a Senior Associate at the Innovation Policy Lab in the Munk School of Global Affairs & Public Policy and a faculty affiliate at the University of Toronto Transportation Research Institute. She served as the Presidential Advisor on Urban Engagement.

Tamer El-Diraby

University Affiliations:
Civil Engineering
Centre for Information Systems in Infrastructure & Construction
UTTRI
CARTE

Website: Tamer El-Diraby

Keywords:
Building Information Modelling (BIM)
Sustainability
Smart Cities
Life Cycle Management

Tamer El-Diraby investigates knowledge and informatics systems in construction project management. The scope of his lab's work expands temporal and spatial concerns, incorporating the complete life-cycle of the building, its wider urban context, and the broader impacts of both on all stakeholders (including the general public). All of this data is used to inform AI/ML systems, leading in turn to.shaping sustainable, adaptively-responsive smart cities.

Professor El-Diraby runs the **Centre for Information Systems in Infrastructure & Construction**.

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**.

Richard Florida

University Affiliations:
Rotman Management
School of Cities
Creative Destruction Lab
UTTRI

Website: Richard Florida

Keywords:
Smart Cities
Sustainability
Urban Infrastructure

Richard Florida is best known for his research and theories on the "Creative Class" (technology workers, artists, sexual minorities) and its influence on urban life. He works at the Rotman School of Management and the School of Cities, and he also serves as Chief Urbanist in the Creative Destruction Lab.

A highly sought-after speaker, he is the author of more than ten books including *The Rise of the Creative Class* and more than one hundred books chapters and articles in peer-reviewed academic journals. He is a Senior Editor at *The Atlantic*, where he co-founded and serves as Editor-at Large for *CityLab*, the world's leading publication devoted to cities and urbanism.

His research provides unique, data-driven insight into the social, economic and demographic factors that drive the 21st century world economy.

Professor Florida holds the rank of **University Professor**, accorded only to the top scholars at UofT. He is also a **Distinguished Fellow** at **New York University**.

Mark S. Fox

University Affiliations:
Mechanical & Industrial Engineering
Computer Science
School of Cities
UTTRI
CARTE

Website: Mark S. Fox

Keywords:
Smart Cities
Sustainability
AI/ML
Urban Infrastructure

Mark Fox is Distinguished Professor of Urban Systems Engineering and Professor of Industrial Engineering and Computer Science. He is also the Founding Director of the Centre for Social Services Engineering and the U of T Enterprise Integration Laboratory. His current research applies artificial intelligence to smart cities, and he has developed ontologies for the representation of city information and knowledge which are being adopted by cities around the world. Professor Fox is currently leading the Connaught-funded Urban Genome Project, a multidisciplinary initiative focused on understanding urban growth.

Professor Fox has extensive experience in the private sector. In 1984 he co-founded Carnegie Group Inc., one of the first companies to apply artificial intelligence to solving engineering, manufacturing, and telecommunications problems.

Professor Fox is a **Fellow** of the **American Association for Artificial Intelligence (AAAI**) and the **Engineering Institute of Canada**.

David Hulchanski

University Affiliations:
Social Work
Geography & Planning
School of Cities

Website: David Hulchanski

Keywords:
Social Justice
Community Development
Sustainability
Smart Cities

David Hulchanski's research and teaching focus on housing need, neighbourhoods, community development, social and economic rights, and homelessness. He teaches courses on housing, homelessness, neighbourhood change, and community development. He is currently completing a decade-long study on neighbourhood change in seven Canadian cities with international comparisons.

Professor Hulchanski has served on a European Union research advisory board for a ten-nation project on immigrant settlement and inclusion (2013-2017). He currently serves on the international research advisory board of the **UK Collaborative Centre for Housing Evidence**.

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 Daniels 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.

Eric Miller

University Affiliations:
Civil Engineering
UTTRI
School of Cities
School of the Environment

Website: Eric Miller

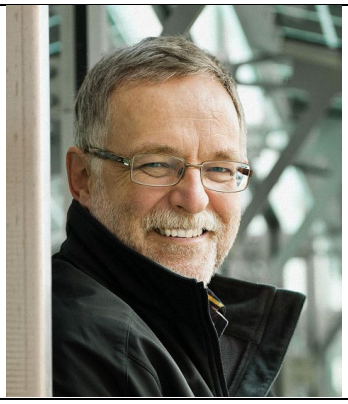
Keywords:
Transportation Systems
Urban Infrastructure
Smart Cities
Public Transit

Eric Miller focuses his research investigations within the area of transportation modelling and sustainable urban design. He is a pioneer in the development and application of agent-based microsimulation model systems in large urban contexts. His research is centred in the implementation of integrated transportation-land use models that permit the analysis of the two-way interaction between transportation systems and urban form. His work serves to improve urban transportation best practices and policy decision-making and, thereby improves the quality of life in urban settings.

Professor Miller is also **Research Director** of the **Data Management Group (DMG)**, providing data to government agencies, private sector partners working for government, and university researchers in support of a wide variety of travel behaviour analyses and modelling activities. He is also **Founding Research Director** of the **Travel Modelling Group (TMG)**, a research consortium that provides a forum and mechanism for inter-agency collaboration designed to improved travel modelling practice for all.

In 2018, Professor Miller received a **Lifetime Achievement Award** from the **International Association for Travel Behaviour Research (IATBR).**

John Robinson



University Affiliations:
Munk School of Global Affairs
School of the Environment
School of Cities

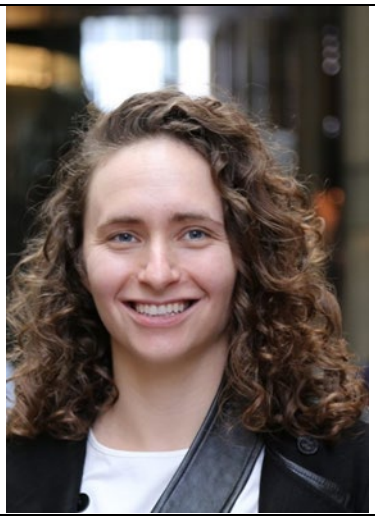
Website: John Robinson

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.

Shoshanna Saxe



University Affiliations:
Civil Engineering
School of Cities
School of the Environment
UTTRI
CARTE

Website: Shoshanna Saxe

Keywords:
Smart Cities
Sustainability
AI/ML
Urban Infrastructure

Shoshanna Saxe investigates the relationship between built infrastructure and society, identifying opportunities – and pathways – to better align infrastructure provision with sustainability. She is currently employing AI and Machine Learning to glean information from large urban datasets re travel/commuting patterns. Her research interests include sustainable urban infrastructure, Mega infrastructure, Transit infrastructure, and Urban material flow patterns.

Professor Saxe is a former **Action Canada Fellow**, sits on Waterfront Toronto's **Capital Peer Review Panel** and the board of the **International Society for Industrial Ecology**. She has been recognized by Clean 50 as

one of Canada's emerging environmental leaders and was awarded a 2019 Engineering Medal – Young Engineer. Professor Saxe holds the **Canada Research Chair in Sustainable Infrastructure**.

Her research and commentary have been featured in media outlets such as The New York Times, The BBC, The Toronto Star, The Financial Post, and Wired.

Matti Siemiatycki

University Affiliations:
Geography and Planning
School of Cities
UTTRI
Infrastructure Institute

Website: Matti Siemiatycki

Keywords:
Smart Cities
Sustainability
Urban Infrastructure

Matti Siemiatycki's research focuses on delivering large-scale infrastructure projects, public-private partnerships, and the effective integration of infrastructure into the fabric of cities. Professor Siemiatycki was a faculty leader of StudentMoveTO, a joint initiative between the University of Toronto, York, Ryerson and OCADU that successfully developed a model for inter-university research collaboration and mobilization on city-building issues. He is a highly engaged public scholar with a deep commitment to informing public discourse about city building, regularly providing advice to governments, civic institutions and industry; and is a frequent commentator in the media and public realm on urban issues, with a honed ability to communicate with various audiences.

Professor Siemiatycki held the **Canada Research Chair in Infrastructure Planning and Finance** until its expiry in 2021. He served as the **Interim Director** of the **School of Cities,**.and is currently the **Director** of the **Infrastructure Institute.**

Marianne Touchie

University Affiliations:
Civil Engineering
Mechanical and Industrial Engineering
School of Cities
School of the Environment
CARTE

Website: Marianne Touchie

Keywords:
Smart Cities
Sustainability
Urban Infrastructure

Marianne Touchie's research focuses on improving the energy performance and indoor environmental quality of existing buildings to make them more comfortable, healthy and sustainable through comprehensive retrofits. This work includes monitoring and characterizing building energy performance, environmental parameters and occupant perceptions to determine the influence of potential retrofit approaches, both active and passive. Much of her research has been in the multi-unit residential sector and particularly social housing buildings.

Professor Touchie is also **President** of the **Building Science Specialist Board of Canada** and **Chair** of **ASHRAE Technical Committee 2.1 Physiology and Human Environment**. . In 2020, she was awarded the **Rising Star Award** from the **Ontario Building Envelope Council**.

Michael Widener

University Affiliations:
Geography & Planning
School of Cities

Website: Michael Widener

Keywords:
Health
Nutrition,
Smart Cities
Urban Planning

Michael Widener is an expert in urban, health, and transportation geographies, with particular interest in understanding how people navigate cities to access nutritious food (e.g. supermarkets), healthy places (e.g. parks), and health care (e.g. pharmacies). His research uses spatial/temporal measures to explore how daily geography, transportation options, time pressures, and social and familial networks impact food purchasing, preparation, and consumption behaviours. Other work has examined the links between health outcomes and exposure to different urban forms and infrastructure. Professor Widener's tools include geographic information systems, GPS trajectory and activity sequence analysis, spatial optimization models, and advanced statistical methods.

Professor Widener holds the **Canada Research Chair in Transportation and Health** (Tier 2)), and serves as **Director of Health Studies** at University College.

Robert Wright

University Affiliations:
Architecture
Landscape Design
Mass Timber Institute
Knowledge Media Design Institute

Website: Robert Wright

Keywords:
Urban Design
Sustainablity
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 served as **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

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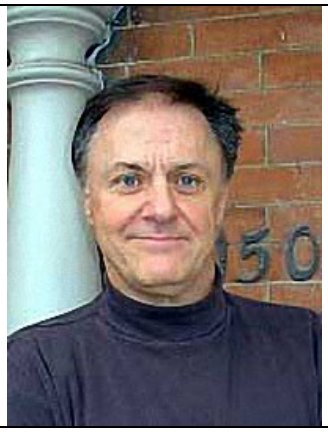
Adonis Yatchew



University Affiliations:
Economics

Website: Adonis Yatchew

Keywords:
Econometrics
Regulatory matters
Environment
Sustainability

Adonis Yatchew's research focuses on energy and regulatory economics, and econometrics. In addition to his university duties, he has advised public and private sector companies on energy, regulatory and other matters for over 30 years, and provided testimony in numerous regulatory and litigation procedures.

Professor Yatchew has served in various editorial capacities at **the Energy Journal** since 1995, and is currently the **Editor-in-Chief**. In 2018, he was recognized by the **International Association for Energy Economics** with the award **for Outstanding Contributions to the Profession**.

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**.

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.**

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).

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.**

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.

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 CO_2 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.

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 H_2-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**.**

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, CO_2 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 CO_2, 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 is the founding Academic Director of the Climate Positive Energy Initiative at U of T

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**.

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 Meda**l from the Meteorological Service of Canada, and the **Willet G. Miller Medal** from the Royal Society of Canada.

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.