

The Future Is Electric



Toronto
Metropolitan
University

Centre for Urban Energy
Faculty of Engineering
& Architectural Science

2023 Annual Report

Welcome Message

Located in the heart of downtown at Toronto Metropolitan University, the Centre for Urban Energy (CUE) is an innovative and collaborative clean energy research centre driving academic excellence for the implementation of industry solutions that advance Canada's energy transition.



Roberta Iannacito-Provenzano



John MacRitchie

Since its establishment in 2010, CUE has successfully secured \$36.7 million in funding, supporting 87 research projects, training over 1,074 highly qualified personnel and affirming its status as a world-class research centre.

Comprising a diverse group of researchers, connectors, collaborators, enablers and co-innovators, the CUE team actively fosters collaborations with a wide array of energy stakeholders. Partners include universities, electric utilities, government entities and private sector organizations, both within Canada and globally.

Advancing the energy transition requires an approach recognizing the full journey from research to training to application of results and their impact on policy and regulations, the economy and society. CUE covers this full spectrum with initiatives such as the annual Clean Energy Expo, the newly introduced Energy Transition Initiative, the Clean Energy Zone (CEZ) Power Up Program, continued work on NSERC Alliance and Mitacs Accelerate funded projects with Hydro One and Toronto Hydro,

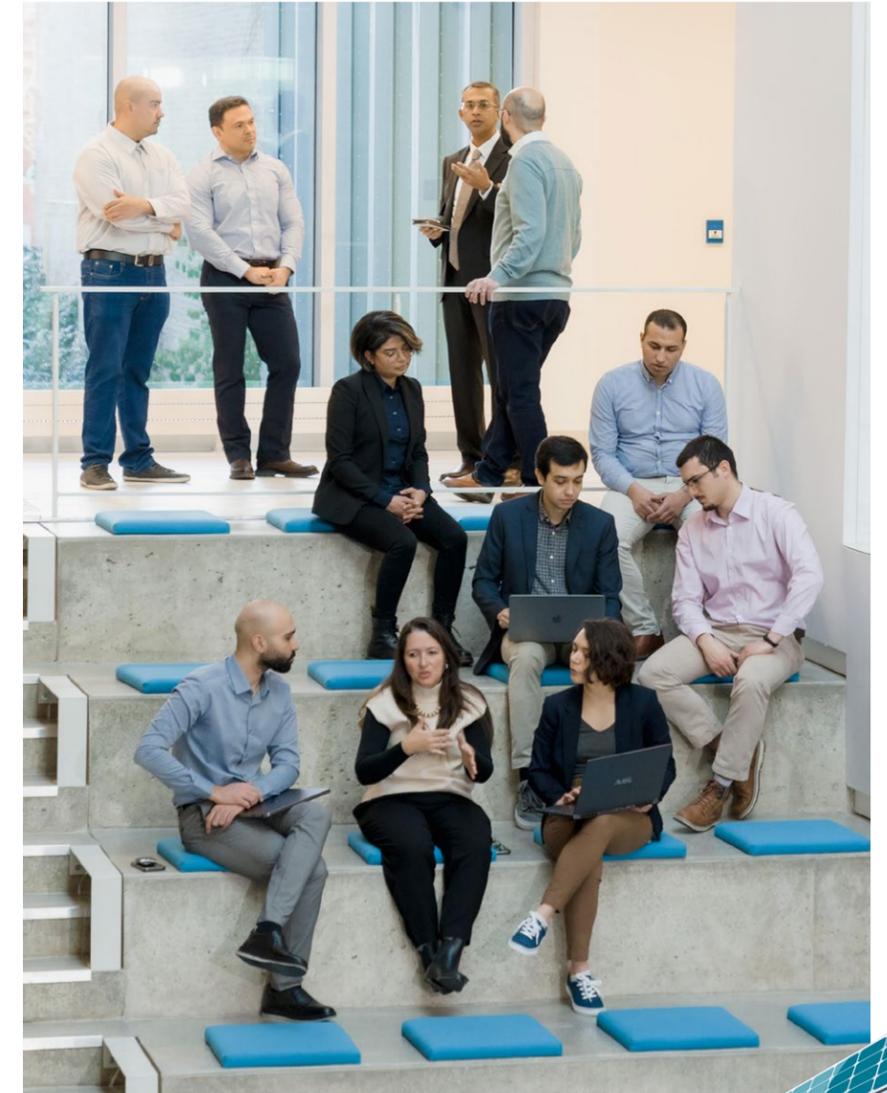
new collaborations with Tata Power and Toronto Community Housing (TCHC), and ongoing support of new clean energy ventures in CEZ.

As we navigate this transforming energy landscape, CUE achieves significant strides by forging impactful connections and delivering novel solutions for the energy sector. The consistent delivery of cutting-edge products, from state-of-the-art software solutions to innovative new hardware for utilities and industry, as well as our workshops and training programs, underscores CUE's commitment to the innovation that transforms our energy systems to usher in a more sustainable future.

The 2023 annual report reflects CUE's ongoing dedication to excellence, innovation and sustainable energy solutions.

Roberta Iannacito-Provenzano
Provost and Vice-President, Academic

John MacRitchie
Assistant Vice-President, Zone Learning & Strategic Initiatives



Vision

CUE aspires to be a world-class research and innovation centre dedicated to solving our most pressing urban energy challenges.

Mission

- Build academic, public and private sector partnerships
- Conduct research, development and demonstration, leading to commercialization
- Create the next generation of energy entrepreneurs
- Encourage multidisciplinary and collaborative approaches
- Provide scholarship and learning opportunities



Activities

Research, Testing and Consulting

Sponsored projects and reports are executed in collaboration with government, industry and academic partners.

Testing of products or prototypes is completed at world-class, state-of-the-art laboratories.

Consulting projects draw on our capacity for multidisciplinary collaborations between industry professionals and academic researchers, as well as access to our unique laboratories.

Education

Professional development is offered through a formalized curriculum and an executive education seminar series.

Innovation

As part of TMU's Zone Learning ecosystem and housed in CUE, CEZ is a startup incubator focused on fostering innovative ideas and businesses in the clean and sustainable energy sector.



Acknowledgements

Founding Sponsors



2023 Partners and Sponsors

Celestica
City of Toronto

Halton Hills Hydro
Hydro One

Mitacs
NSERC

Peak Power
Tata Power

TCHC
Toronto Hydro

2023 Advisory Board

Thomas Duever
Dean, Faculty of Engineering
and Architectural Science,
Toronto Metropolitan University (Chair)

Shitiz Agarwal
Vice-President, Power Systems,
Sales and Operations, Schneider Electric

Tom Chapman
Principal, The Brattle Group

Martin Huang
Vice-President, System Operations,
Hydro One

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

Elias Lyberogiannis
Executive Vice-President, Planning and
Chief Engineering and Modernization
Officer, Toronto Hydro

Neetika Sathe
Vice-President, Green Energy and
Technology (GRE&T) Centre, Alectra

Katherine Sparkes
Director, Innovation, Research and
Development, Independent Electricity
System Operator (IESO)

Thomas Timmins
Leader, Energy Sector Group,
Gowling WLG

Bala Venkatesh
Academic Director,
Centre for Urban Energy

Focus Areas

CUE's focus areas are climate change, microgrids, demand management, efficiency, electricity planning, hydrogen, conservation, electric vehicles, net zero buildings, policy and regulation, renewables, smart grids, storage, transmission and distribution, and transactive energy.

Expertise

CUE combines the perspectives of engineering, science, environmental studies, business, social sciences, public policy, law and infrastructure management.

Advantages

- World-class urban energy researchers, technologies and facilities
- Multidisciplinary collaborations under one roof
- Integration of research and commercialization
- Research and cost-effective testing for real-world applications
- Objective, academically driven innovation
- Evidence-driven approach to big-picture issues
- Sustained commitment to supporting incubation and entrepreneurship

Addressing Your Needs

You have a pressing energy problem to solve

- Have a pressing energy problem to solve
- Need access to pioneering research and innovative development
- Have a grid-scale prototype or project to test under real-world conditions
- Want customized energy education for professional development
- Would like to sponsor research, mentor a student or support awards



The collaborative efforts between Tata Power and Toronto Metropolitan University's Centre for Urban Energy are paving the way for innovative edge-of-the-grid solutions that will help deliver clean, green and reliable electricity to the consumers in Canada and India.

Praveer Sinha,
Chief Executive Officer and Managing Director, Tata Power



Applying Our Model to Different Stakeholders



Utilities benefit from access to cost-effective research, testing and innovation.



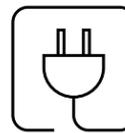
Governments benefit from policy and technical implementation, white papers, reports and a vision for whole energy systems.



Industries benefit from a pool of highly qualified personnel.



Students benefit from working and/or training directly with industry partners.



Society benefits from efficient, accessible electricity and a cleaner environment.



TCHC has been working collaboratively with TMU's CUE on an electrical research study that is exploring opportunities for electrical metering, aggregation and building heating system electrification within TCHC's large portfolio of over 2,000 buildings. This study presents an exciting opportunity to reduce our overall electricity bills and to reduce carbon emissions associated with heating systems. We're looking forward to the results of this study and how it can inform how we operate our portfolio moving forward.

Vuk Skulic, Design Program Manager, Electrical, TCHC





Our Resources

People

Administration

4
employees



7
interns



Researchers

5
research fellows



3
honorary fellows



11
visiting researchers



11
investigators



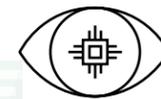
Facilities



736 m²
(7,922 ft²)



6 labs,
including the Schneider Electric Smart Grid Lab



TEDS showcase



Achievements and Impact

CUE is actively delivering innovative solutions for the energy sector, encompassing workshops and cutting-edge software offerings.



Highly Qualified Personnel

10
undergraduate students



11
MASC students



22
PhD students



10
research assistants



1,074
alumni



Events

5
CUE in-person events

9
CUE visits

115
CUE project meetings

23
CEZ events

Partnerships

Global Collaborations

3 Brazil 1 India 1 USA
 2 England 1 Scotland
 1 Germany 1 Singapore

Visiting Researchers

In 2023, CUE welcomed two scholars and nine students from four institutions. These international collaborations continue to yield valuable cross-cultural insights and foster innovative solutions to complex challenges within the energy sector.

Partners

7
industry

2
government

Projects

87
total

79
completed

8
in progress



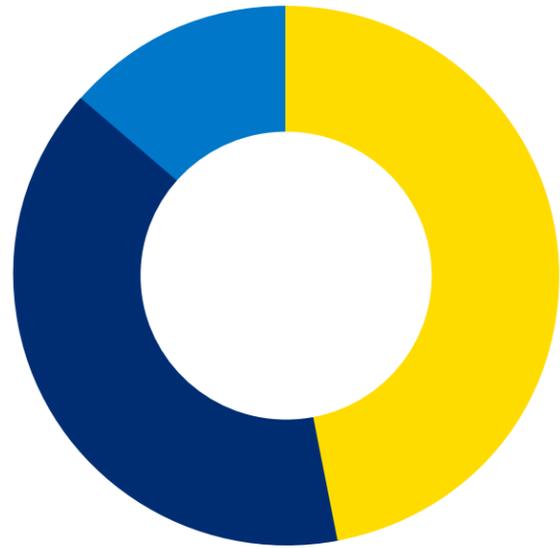
Funding

\$36.72M total funding from 2010

2023 funding **\$1.10M**

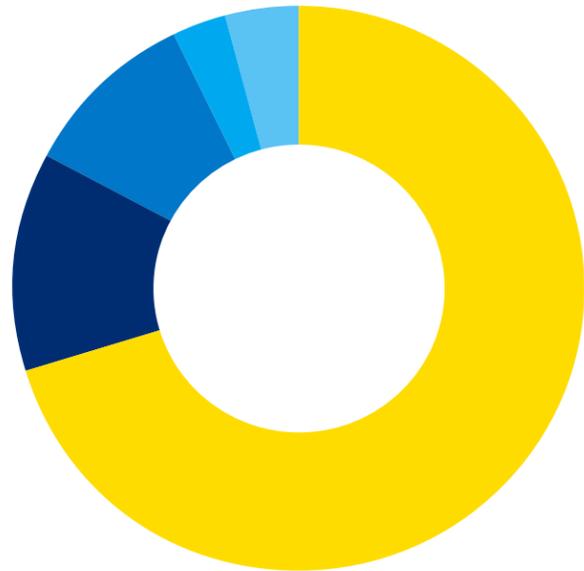


Sources



- 47.2% industry
- 39.2% government
- 13.6% university

Distribution



- 70.4% research
- 12.6% operations
- 9.9% research fellows
- 3.1% student awards
- 4.0% Clean Energy Zone

Impact

Journal publications



42 | **304**
in 2023 | since 2015

Technical reports



14 | **99**
in 2023 | since 2015

Conference publications



48 | **195**
in 2023 | since 2015

Patents



9



Featured Projects



DER Modelling – Hydro One, NSERC and Mitacs

Presently, electric distribution systems accommodate a limited number of distributed energy resources (DERs), a number that is anticipated to surge dramatically in the next 25 years for a net-zero carbon emissions 2050 future. Within this framework, predicting and modelling numerous, small-scale, and intermittently operating DERs will pose a considerable challenge. Modelling of DERs includes solar, wind and hydroelectric generation as well as supplied loads.

CUE developed a tool to forecast the integration of tens of thousands of DERs onto the Hydro One system. Work is

progressing on the development of aggregate models to represent DERs at the distribution feeder level in the steady state and during transients. This will enhance the reliability and resiliency of the electric grid.

The project is supported by funds from the joint NSERC Alliance and Mitacs Accelerate grant and Hydro One.

2023 team 2 postdoctoral fellows, 6 PhD students

Timeline 2022-2027

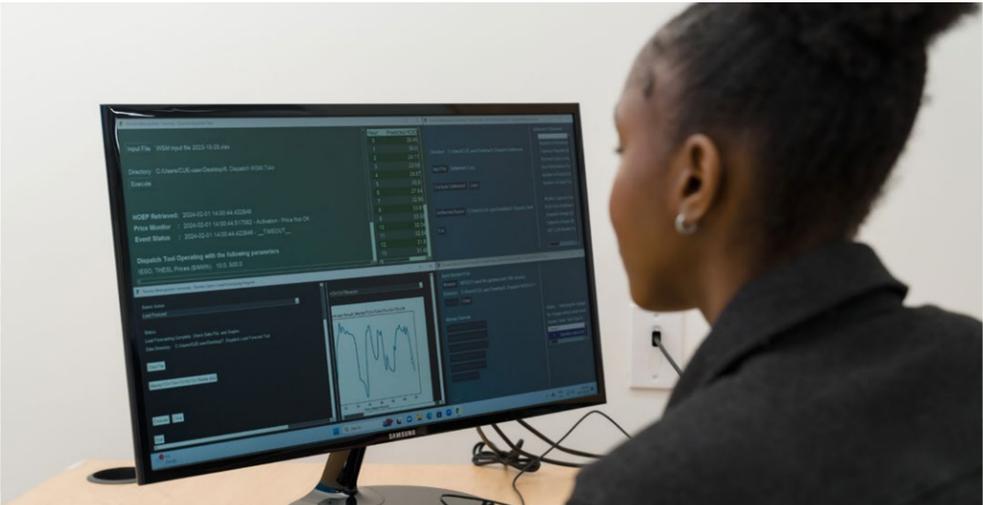


Dual Participation of Local Demand Response Resources – Independent Electricity System Operator (IESO), Toronto Hydro and Power Advisory LLC

CUE collaborated with Toronto Hydro and Power Advisory LLC, with support from the IESO Grid Innovation Fund and the Ontario Energy Board’s Innovation Sandbox, to identify solutions that will enable the utility to use the same demand response resources simultaneously to meet the capacity needs of both local and provincial grids. The overall goal of this program is to build resilient infrastructure, promote sustainability and foster innovation.

Team 1 postdoctoral fellow, 1 research associate, 1 undergraduate intern

Timeline 2023-2024





Dynamic Reconfiguration and Feeder Power Management – Tata Power-DDL and Mitacs

Climate change concerns will drive the transition to deep electrification, leading to increased electric loads. This project develops methods and strategies for dynamic reconfiguration and feeder power management to address operational challenges that utilities such as Tata Power-DDL may encounter.

The project is supported by funds from the Mitacs Accelerate grant and Tata Power-DDL.

Team 2 research associates
Timeline 2023-2024



Study of Metering and Aggregation, and Electrification of Buildings – Toronto Community Housing (TCHC)

Committed to reducing energy consumption within their buildings, TCHC is partnered with CUE on a study to explore opportunities for metering, aggregation and electrification of TCHC’s heating systems across its portfolio of buildings.

Team 2 postdoctoral fellows
Timeline 2023-2024



2023 CUE Clean Energy Expo

The 2023 CUE Clean Energy Expo was held in February with an attendance of 70 guests. The event included presentations by Harneet Panesar, Chief Operating Officer of the Ontario Energy Board, Katherine Sparkes, Director of Innovation, Research and Development at IESO, and Cedric Tai, Staff Solutions Architect at GE Digital for DERMs. In addition, a ceremony was held for the Toronto Hydro student award recipients, and posters were presented by researchers and CEZ startup companies.

Attendees	70
Student awards	4
Research posters	6
CEZ startup posters	10

Energy Transition Workshops

CUE hosted an energy transition workshop series to build a large international consortium of academic and energy sector specialists. The objective is to foster collaboration on innovative solutions for the future energy system.

Workshops	3
Participants	86
Academic participants	51
Industry participants	35
Countries	5

Recently Completed Projects

Energy Storage Software Development – Toronto Hydro

Amid the rapid evolution of the energy landscape, CUE developed methods to determine the optimum size of energy storage, improving scheduling, dispatching and utilization of energy resources. Together, these initiatives contribute to achieving sustainable growth.

Team 2 postdoctoral fellows

Timeline 2020-2023

“We’re proud to work with CUE as we prepare the grid for rising electricity demand. Our dynamic city continues to grow, and new technology is increasingly relying on electricity. CUE’s research helps us develop the practical solutions needed to meet Toronto’s power needs.”

Elias Lyberogiannis,
Executive Vice-President,
Planning and Chief Engineering and
Modernization Officer, Toronto Hydro

Professional Master’s Diploma in Energy and Innovation

The Professional Master’s Diploma in Energy and Innovation (part-time) program is designed to equip participants with the knowledge and skills required to function competently as operators, officers, administrators, managers, technicians, analysts, policy advisors and other key occupations in the fast-growing, rapidly evolving, dynamic Canadian energy sector.



CLEAN ENERGY zone

The **Clean Energy Zone (CEZ)** is an industry-leading, campus-based incubator located at CUE. Since its inception, 62 startups have passed through CEZ, including million-dollar companies such as Peak Power and SWTCH.

22

number of current startups

7

new startups in 2023

2

startups graduated in 2023

\$1.741M

revenue generated by startups in 2023

\$514K

capital raised by startups in 2023

23

events in 2023 (12 in-person, 11 virtual)

Power Up Program

The CEZ's newest initiative, the Power Up Program, aims to tackle energy poverty and energy entrepreneurship poverty concurrently by providing financial support to high-potential student entrepreneurs with promising clean energy-based ideas

in the form of full-time, four-month internships. The Power Up Program provides student entrepreneurs with the tools necessary to build scalable enterprises and bring their clean energy ventures to life.



Featured Companies

Innovia GEO

Innovia GEO is focused on decarbonizing the heating and cooling of our buildings and homes by developing innovative technologies that make clean and efficient geothermal heating and cooling systems more affordable.

2023 achievements

- Top 5 finalist at the Pivot2023 Global Geothermal Startup Competition
- Named to the Cleantech Group's 2023 Cleantech 50 to Watch List
- Winner of the 2023 City of Burlington Economic Development Award for Excellence in Innovation & Technology
- Named a Deep Tech Pioneer by the Hello Tomorrow Global Challenge

Alphacor

Alphacor, a startup involved in energy and carbon reduction technologies, stands at the forefront of innovation with a clear mission: to dominate the energy and carbon management market by 2040. Alphacor's flagship product, ecotapp, is a cloud-based web and mobile application for residential buildings that provides a simple, automated and engaging platform that incentivizes technical and non-technical users to participate in energy management and carbon reduction. It represents a holistic approach, seamlessly integrating technology to provide comprehensive carbon reduction and energy efficiency solutions.

2023 achievements

- Winner of the Norman Esch Stage 2 Award
- Recipient of Mitacs research funding to research, develop and deploy machine learning models in ecotapp



Have an idea for an urban energy startup?

Visit torontomu.ca/cue/cez today to find out how you can join the Clean Energy Zone.

Electric Autonomy

Electric Autonomy Canada is an independent media and events company reporting on Canada's transition to electric vehicles (EVs), autonomous transportation and new mobility services. Its content showcases original journalism along with opinions and comments from industry leaders. It highlights Canadian innovation and facilitates knowledge sharing and best practices across diverse industry sectors and all levels of government.

2023 achievements

- Launch of their first EV & Charging Expo over two days in May at the Enercare Centre in Toronto. Targeted at fleet operators and building owners who are investing in EVs and charging infrastructure, the event attracted over 1,500 attendees, over 60 exhibitors and 70 speakers across three stages, and 30 conference sessions. This event will now take place annually.
- Launch of the inaugural EV Innovation & Technology Conference in February in Toronto. Targeted at professionals developing advanced EV manufacturing technologies and EV supply chain innovations, the event attracted an attendance of over 220 people. It will now take place annually.
- Launch of the five-part EV Charging Webinar Series, which explored the issues and opportunities around the public EV charging experience in Canada.
- Development of a new “Jobs in Motion” job board to facilitate Canadians in finding EV-related jobs.



Connect with Us

Have an urban energy problem
or possibility worth exploring?

Contact our Academic Director,
Bala Venkatesh, at bala@torontomu.ca.

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