



## 2025 CAE Annual Conference Montreal, Quebec

# Engineering a Resilient Future for Canada

*Looking back in 2050, what will we wish we had started doing today?*

## Fellows' Showcase

1	2:00 - 2:10	Hany Moustapha	École de technologie supérieure	Advanced Air Mobility
2	2:10 - 2:20	Muthukumaran Packirisamy	Concordia University	Micro-Nano Integrated Lab on Chips (LOC): Energy Harvesting Using Algae to Very Early Cancer Diagnosis
3	2:20 - 2:30	Satinder Kaur Brar	York University	Sustainable Technologies for Environmental Remediation (STER)
4	2:30 - 2:40	Caijun Shi	Hunan University	Carbon Mineralization of Carbon-negative Construction Materials and Products
5	2:40 - 2:50	Ming Hou	Department of National Defence	Interaction-Centred Design for Responsible Human-AI Symbiosis: The Next Stage of Evolution
6	2:50 - 3:00	Catherine Mulligan	Concordia University	Sustainable remediation of soil, water, wastes and sediments
7	3:00 - 3:10	Doris Hiam-Galvez	Hatch	Designing Sustainable Prosperity: Canada's Moment to Lead the Future
	3:10 - 3:20	<b>Break</b>		
8	3:20 - 3:30	Vincent Wong	The University of British Columbia	AI for 6G Wireless Networks
9	3:30 - 3:40	Shuhui Sun	Institut National de la Recherche Scientifique (INRS)	Toward a Net-Zero Future: Transformative Battery and Hydrogen Technologies
10	3:40 - 3:50	Sankar Dasgupta	Electrovaya	Lithium Ion Batteries with Highest Longevity & Safety
11	3:50 - 4:00	Bruce Taylor	Enviro-Stewards Inc	Credible Affordable Sustainability
12	4:00 - 4:10	Andreas Athienitis	Centre for Zero Energy Building Studies, Concordia University	Integrated design and control of decarbonized and resilient buildings
13	4:10 - 4:20	Ted Stathopoulos	Concordia University	Wind Resilience: Proceeding from Wind Codes and Standards of Building Design Practice

## 1 - Advanced Air Mobility

Hany Moustapha

*École de technologie supérieure*

Electric Air Mobility EAM (regional and urban) is an emerging sector of air transport resulting from the major advances in electric propulsion (engines, batteries, fuel cells, electronic controllers, etc.) and the growing need for improved people's services. The EAM ecosystem includes urban and regional, low, and high altitude and piloted and autonomous. Electric Vertical Take-Off and Landing (eVTOL) aircraft are the most recent examples of technology in this sector. The 600+ prototypes, 350 companies involved and \$20 billion invested in the aircrafts side of EAM are a vote of confidence. This presentation will cover the landscape of this emerging sector including the various eVTOL in development, the required infrastructures such as vertiports, vertipads and vertistops, and the technologies needed such as digital twinning, AI, cyber security, batteries and Hybrid Electric Propulsion System (HEPS). In addition, the presentation will highlight progress made in Can

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## 2 - Micro-Nano Integrated Lab on Chips (LOC): Energy Harvesting Using Algae to Very Early Cancer Diagnosis

Muthukumaran Packirisamy

*Concordia University*

The necessity for increased level of integration with Lab-On-a-Chip (LOC) devices have been growing for enhancing performance, functionalities, and packaging. As the fully integrated devices favour portability and disposability they would be useful for in-situ biomedical diagnosis, Point-of-Care testing and energy harvesting applications. This work will present the integration of some novel technologies such as the microphotonics, microfluidics, nano elements with microsystems for various applications in energy harvesting from photosynthesis of algae, medical and health sciences. In this work, a microfluidic Lab-on-a-Chip device on silicon platform hybrid and monolithically integrated with Echelle grating based Spectrometer-on-Chip will be presented along with results. The poster will also cover many examples on micro-nano integration along with case studies in energy harvesting from photosynthesis of algae, biosensing, tactile sensing, endoscopy grasper, laparoscopy tools, early cancer diagnosis, cancer cellular studies, studies on various types of cancers, microvesicles enrichment, intra cellular plasmonics and pollen tube studies. The poster will cover the limits and range of applications of micro and nano technologies.

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### 3 - Sustainable Technologies for Environmental Remediation (STER)

Satinder Kaur Brar

*York University*

Canada's path toward a resilient and sustainable future hinge on innovative engineering solutions that address pressing environmental and societal challenges. My group's research is at the forefront of transformative research in environmental biotechnology and circular economy approaches. Her work focuses on converting waste streams into high-value bioproducts, such as biopesticides, biofertilizers, and bioplastics, while advancing technologies for the detection and removal of emerging contaminants from water, soil, and air. The interdisciplinary initiatives address critical concerns related to climate change adaptation, water security, pollution mitigation, and sustainable agriculture. Through bioremediation and green chemistry, her team designs sustainable, low-energy, and cost-effective solutions that not only reduce environmental burdens but also promote regenerative systems. By partnering with municipalities, industry stakeholders, and remote communities, our research ensures that engineered solutions are context-sensitive, equitable, and scalable. By turning environmental challenges into opportunities for innovation and regeneration, our research group is contributing to playing a pivotal role as engineers in shaping a resilient, inclusive, and environmentally secure future for Canada.

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### 4 - Carbon Mineralization of Carbon-negative Construction Materials and Products

Caijun Shi

*Hunan University*

The carbon mineralization in cement-based materials has been widely recognized as one of the most promising technologies for CO<sub>2</sub> utilization and storage. The invention of pre-conditioning technology made the commercial carbonation of concrete products possible. The technology has also been used for the performance enhancement of recycled concrete aggregates, conversion of recycled concrete powder into active pozzolanic materials and surface treatment of concrete products. Thermodynamic models and calculation point out that the polymorph control of calcium carbonate can produce carbonated concrete products consisting of aragonite and give flexural strength more than 50% higher than conventional carbonated concrete products. The commercial production of carbonated concrete products demonstrated very obvious lower production costs and environment benefits with a significant amount of CO<sub>2</sub> consumption.

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## 5 - Interaction-Centred Design for Responsible Human-AI Symbiosis: The Next Stage of Evolution

Ming Hou, PhD

*Department of National Defence*

The rapid advancement of AI technology and its applications are shaping both the present and future. This convergence of human intelligence and artificial intelligence raises critical questions about their coexistence. The increasing autonomy of AI in decision-making—such as self-driving cars, home care robotics, and drone operations—introduces challenges related to risk, responsibility, and trust in public safety. The effective AI integration into organizations, systems, and socio-technical applications is challenged by the lack of understanding of human-AI interaction issues and appropriate design methodologies for safety-critical systems. Stringent AI system requirements are not just a technical challenge but a design imperative. Building a human-AI symbiotic partnership that adapts dynamically and interacts intelligently is crucial to achieving responsible human-AI teaming. To address these challenges, a systematic and structured methodology for design, develop, verify, validate, and regulate these disruptive technologies is critical to the entire life cycle of AI systems. This talk will provide insights into the evolution of design strategy of intelligent systems, presents the state-of-the-art design methodologies to address the interaction challenges for developing and deploying responsible AI technologies and thus responsible human-AI partnership. A technological solution of trustworthy, collaborative, effective, and responsible human-AI teaming for decision-making in weapon engagement following international laws and rules of engagement provides a best practice example for all stakeholders in industry, academic, and government who are interested in building and using 21st century human-AI symbiosis technologies. The solution is instrumental to related international standards for designing AI systems while fostering trust, legal, and ethical considerations.

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## 6 - Sustainable remediation of soil, water, wastes and sediments

Catherine Mulligan, FRSC, FCAE, FEIC, FCSCE

*Concordia University*

Dr. Catherine Mulligan is an internationally recognized expert in the decontamination of water, soils, and sediments, and a pioneer of green remediation technologies. Her fundamental and applied contributions to research and her service to the engineering profession have been recognized with prestigious awards, including the Royal Society of Canada's Miroslaw Romanowski Medal for environmental contributions, the John B. Stirling Medal from the Engineering Institute of Canada and fellowships from the RSC, CAE, EIC and CSCE. She is the founding Director of the Concordia Institute of Water, Energy and Sustainable Systems (CIWESS) which is working on technologies and solutions for water, energy and resource conservation, laying the groundwork for respected sustainable engineering research. Various elements in the water sector (treatment, production and distribution) exert a heavy energy footprint (4% of global electricity consumption is for the water sector). In 2015, the United Nations (UN) adopted the Sustainable Development Goals (SDGs) focused on clean water and sanitation, affordable and clean energy, climate resiliency, good health and well-being, and industry, innovation and infrastructure. Key challenges to sustainable development include: (i) reliable potable water supply, (ii) efficient use of resources, (iii) environmental protection, and (iv) inclusion of local knowledge into the decision-making process. The unveiling impacts of climate change add to all these challenges. Efforts on reducing the impact of climate change on water systems, and enhancing the sustainability of water systems and energy production from water will be discussed.

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## 7 - Designing Sustainable Prosperity: Canada's Moment to Lead the Future

Dr. Doris Hiam-Galvez

*Hatch*

Canada has a pivotal opportunity to lead the global transition to a sustainable, resilient future. With abundant natural resources and strong innovation potential, the country is well-positioned, but only if we shift how we think about development. Dr. Doris' pioneering Designing Sustainable Prosperity (DSP) method transforms the traditional role of mining into a catalyst for long-term regional well-being. By broadening the focus from the mine site to the entire region, DSP aligns resource extraction with environmental preservation, social cohesion, and economic diversification. DSP provides a practical blueprint to elevate resource-rich regions like Sudbury and Saskatoon, BC and other regions into innovation-driven, knowledge-based economies. It integrates sectors—including mining, agriculture, water, energy, and health sciences into future-ready supply chains that serve both local communities and global needs. This approach addresses persistent challenges such as infrastructure gaps, talent shortages, and community conflict, while building trust, lasting value, and shared prosperity. In an era of trade wars, climate pressures, and shifting geopolitical alliances, Canada's moment to lead is now, and DSP is the systems-based pathway to do so.

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## 8 - AI for 6G Wireless Networks

Vincent Wong, FCAE

*The University of British Columbia*

The current fifth-generation (5G) wireless networks support different use cases, including enhanced mobile broadband (eMBB), ultra-reliable low-latency communications (URLLC), and massive machine-type communications (mMTC). These use cases exploit technologies such as network slicing, millimeter wave, massive multiple-input multiple-output (MIMO), and mobile edge computing. As the successor of 5G, the sixth-generation (6G) wireless networks aim to be a platform for connected intelligence and serve as a bridge between the physical world and the cyber world. 6G wireless networks will utilize the sub-6 GHz frequency band as well as the terahertz (THz) frequency band. 6G networks can provide global coverage by integrating terrestrial and non-terrestrial communications systems (e.g., high-altitude platform stations (HAPSs), very low earth orbit satellites). 6G networks will connect a massive number of heterogeneous wireless/mobile devices with sensing capabilities. 6G networks will have the capability to support joint sensing and communications by using the millimeter wave and THz frequency bands and utilizing the base stations as wideband networked sensors. 6G networks will support applications such as augmented reality, virtual reality, extended reality, and vehicle-to-everything (V2X). In this presentation, we will give an overview of 6G network architecture design to support different use cases and artificial intelligences (AI) applications. We will also introduce some AI algorithms for control, monitoring, and network resource allocation in wireless networks.

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## 9 - Toward a Net-Zero Future: Transformative Battery and Hydrogen Technologies

Shuhui Sun

*Institut National de la Recherche Scientifique (INRS)*

The development of high-performance, cost-effective clean energy technologies is crucial for achieving a carbon-neutral future. Hydrogen fuel cells and green hydrogen production are key pillars of sustainable energy systems. However, their widespread commercialization is hindered by challenges such as the reliance on expensive precious metal-based catalysts. Simultaneously, the advancement of safe, high-energy-density, and long-lasting batteries is essential to meet the growing demands of electric vehicles and smart grids, and. Among emerging energy storage technologies, lithium metal and aqueous zinc batteries show great promise. Yet, these technologies still face significant technical and practical barriers to large-scale deployment. In this talk, I will present the our recent progress in the following key areas: 1) High-Performance Electrodes and Electrolytes for Next-Generation Batteries: We have developed novel electrode materials and advanced electrolytes for high-energy-density, long-life lithium metal and aqueous Zn-ion batteries. In particular, our patented electrolyte additive strategy effectively suppresses dendrite formation on the battery anode, significantly enhancing battery safety and lifespan. (2) Low-Pt and Pt-Free Catalysts for Hydrogen Fuel Cells: To address cost barriers, we have designed low-platinum and platinum-free catalysts. Notably, our iron-based catalyst exhibits catalytic activity comparable to that of state-of-the-art commercial Pt catalysts, marking a significant step toward practical, affordable fuel cells. (3) Single-Atom and Non-Precious Metal Catalysts for Green Hydrogen Production: We have explored single-atom catalysts (SACs) and non-precious metal catalysts for efficient hydrogen production via water electrolysis. Our patented catalysts enable high-efficiency freshwater and seawater splitting, achieving industrially relevant current densities under real-world conditions.

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## 10 - Lithium Ion Batteries with Highest Longevity & Safety

Sankar Dasgupta

*Electrovaya*

Electrovaya invented much of the presently used Lithium Ion battery with hundreds of patents. Its present technology includes longevity of some 3 million miles (using electric vehicle terminology) and outstanding safety (never had a fire and UL safety tests are outstanding). Electrovaya high performance batteries are predominantly used by "mission critical applications" in electric vehicles and other sectors who needs superior longevity and safety. Over 95% of its revenue is from exports to US, Japan, Singapore and other places. Only North American producer exporting to Japan for mission critical applications. This year revenues are expected to be around C\$100 million and profitable.

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## 11 - Credible Affordable Sustainability

Bruce Taylor

*Enviro-Stewards Inc*

In April 2025, CRC Press (Taylor & Francis) published "Sustainable Business: Insights from the Field of Sustainability Engineering." This textbook (and CAE presentation) provide tools for engineering & business criteria that help organizations become more sustainable while saving money. The 25 case studies include NASA's space shuttle, Unilever, as well as Maple Leaf Foods, who became the World's First Carbon Neutral Major Food company (in 2019), while saving \$17 million thus far.

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## **12 - Integrated design and control of decarbonized and resilient buildings**

Andreas Athienitis

*Centre for Zero Energy Building Studies, Concordia University*

Decarbonization and energy resilience of buildings can be achieved through optimal integration of solar systems, passive solar design, energy storage and model predictive control. This talk will focus first on the example of the Varennes library net-zero energy building, its interaction with a smart grid, data driven model predictive control implementation and the annual energy balance. Examples of energy flexibility provision to a smart grid will also be given for a school building. The integration of thermal, structural, electrical and architectural design of net-zero buildings will also be addressed as an important need for cost effective designs. Integration of electric vehicles (EVs) will be discussed for multidirectional energy flows with buildings and the grid. Finally, an electrified solar community example will be overviewed from London, Ontario. The importance of early-stage major design decisions will be discussed and representative results will be presented.

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## **13 - Wind Resilience: Proceeding from Wind Codes and Standards of Building Design Practice**

Dr. Ted Stathopoulos, P.Eng, ing, F.CAE, F.ASCE, F.SEI, F.ICE

*Concordia University*

The presentation shows the state-of-the-art on wind resilience from the structural and environmental engineering viewpoint. It reviews the current status of the wind standards and building codes of practice and describes the need for further development in consideration of climate change.

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