IEEE Canadian Review
La revue canadienne de l'IEEE
Summer / L'été 2025 — No. 99

Honoring Impact

IEEE Canada Awards

Battery Energy and Microgrids

Data Compliance and AI

IEEE Canada

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IEEE Canada

39th Annual Canadian Conference on Electrical and Computer Engineering (CCECE 2026)

May 18-20, 2026,
Le Westin, Montreal, Quebec, Canada

The 39th IEEE Canadian Conference on Electrical and Computer Engineering (CCECE 2026) will be held in Montreal, Quebec, Canada from May 18 to 20, 2026. CCECE provides a forum for the presentation of electrical and computer engineering research and development from Canada and around the world. Papers are invited, in French or English, for the following symposia.

- **Circuits, Devices, Photonics and Systems**
  Chair: Dr. Marzieh Amini, Carleton University
  Co-Chair: Dr. Montasir Qasymeh, Abu Dhabi University
- **Control Systems and Robotics**
  Chair: Dr. Jun Liu, University of Waterloo
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  Co-Chair: Dr. Concettina Buccella, University of L'Aquila
- **Signal and Multimedia Processing**
  Chair: Dr. Telex M. N. Ngatched, McMaster University
  Co-Chair: Himal A. Suraweera, University of Peradeniya
- **Biomedical and Health Informatics**
  Chair: Dr. Arezoo Emadi, University of Windsor
  Co-Chair: Dr. Zehor Belkhatir, University of Southampton
- **Machine Learning, Data Analytics and Artificial Intelligence**
  Chair: Dr. Apurva Narayan, Western University
  Co-Chair: Dr. Carmen Del Vecchio, Università degli Studi del Sannio
- **Clean and Intelligent Transportation**
  Chair: Dr. Qiang Ye, University of Calgary
  Co-Chair: Dr. Shaohua Wan, University of Electronic Science and Technology of China
- **Marine Systems and Technology**
  Chair: Dr. Oscar De Silva, Memorial University
  Co-Chair: Dr. Ning Wang, Dalian Maritime University
- **Space Systems**
  Chair: Dr. Robin Chhabra, Toronto Metropolitan University
  Co-Chair: Dr. Raghvendra Cowlagi, Worcester Polytechnic Institute
- **History of Technology**
  Chair: Dr. David Michelson, University of British Columbia
  Co-Chair: Dr. Scott Campbell, University of Waterloo

NOTE: *Selected papers accepted in this conference will be proposed for publication in the IEEE Canadian Journal of Electrical and Computer Engineering, after another round of review. This would require a substantial extension to the conference version.*

Questions or Comments

For any questions or comments, please contact the Conference General Chair: Amir G. Aghdam. Tel: (514) 848-2424 Ext. 4137, Email: amir.aghdam@concordia.ca

Tom Murad
P.Eng., Ph.D., F.E.C., F.EIC, SMIEEE

2024–2025 IEEE Canada President and Region 7 Director
2024–2025 Président de l'IEEE Canada Directeur de la Région 7

Dear fellow IEEE Canada members, I am delighted, once again, to connect with all of you through this periodical article. As I am communicating with you at the end of my two-year term as president of IEEE Canada and director of IEEE Region 7 (R7), after having the privilege to work with many of you during 2024 and 2025, and enjoying our collective successful experience of growth and learning.

In the previous editions of *IEEE Canadian Review*, during my term, I focused mainly on "the positive change," then I focused more on those individuals who can make that positive change happen: IEEE Canada's volunteers. Although, in the previous spring edition, I mainly focused on our experience and achievements with positive tangible results after a unique "culture change" journey, or at least the beginning steps of it. I also shared my perspective on the "leadership" factor's influence on the change of our unique professional engineering organization's culture.

Today, I would like to focus on a very important topic while we are progressing through our journey of culture change, that is, "celebrating positive cultural change," which is often overlooked. However, it is essential to reinforce new values, sustain momentum, and inspire ongoing engagement across our organization.

To celebrate positive cultural change in a professional organization such as IEEE Canada, where most of the contributors are practically volunteers, we should start by recognizing what's changed by clearly identifying and communicating what cultural shift has occurred, including, the following:

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Chers membres de l'IEEE Canada, Je suis une fois de plus heureux de pouvoir établir ce lien avec vous à travers cet article périodique. Alors que je m'adresse à vous à la fin de mon mandat de deux ans en tant que président de l'IEEE Canada et directeur de la Région 7 (R7), après avoir eu le privilège de collaborer avec nombre d'entre vous durant les années 2024 et 2025, je tiens à souligner le succès collectif que nous avons partagé, marqué par la croissance et l'apprentissage.

Dans les précédentes éditions de *la revue canadienne de l'IEEE,* au cours de mon mandat, j'ai principalement mis l'accent sur le « changement positif », puis davantage sur les personnes capables de concrétiser ce changement : les bénévoles de l'IEEE Canada. Dans l'édition du printemps dernier, j'ai surtout insisté sur notre expérience et nos réalisations, avec des résultats tangibles et positifs, à la suite d'un parcours unique de « changement culturel », ou du moins de ses premières étapes. J'ai également partagé mon point de vue sur l'influence du facteur « leadership » dans l'évolution de la culture de notre organisation professionnelle d'ingénierie.

Aujourd'hui, je souhaite mettre l'accent sur un sujet très important alors que nous poursuivons notre parcours de transformation culturelle : la célébration du changement culturel positif, un aspect trop souvent négligé. Pourtant, cette célébration est essentielle pour consolider les nouvelles valeurs, maintenir l'élan et encourager un engagement durable au sein de notre organisation.

Pour célébrer le changement culturel positif au sein d'une organisation professionnelle telle que l'IEEE Canada, où la majorité des contributeurs sont essentiellement des bénévoles, il

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- Improved collaboration between various teams, committees, and groups
- Greater inclusion and diversity awareness.
- Stronger accountability and/or respect in our day-to-day activities and communications.
- Adoption of new communication or leadership habits.

Public appreciation reinforces desired behaviors and motivates others to follow. We know that people drive culture. Therefore, it is certain that recognizing individuals, teams, or committees who embodied the new behaviors or championed the change by repeatedly announcing this recognition in organizational/operational committees' meetings, newsletters, or internal platforms and/or creating a "culture champion" award (like our IEEE Canada's President Award, which I have been keen to present in the last two years to our champions), or spotlighting and also sharing success stories through internal communications will have a great impact on the organization's members and create a positive platform to attract more contributing volunteers and membership. It is also very important that these celebrations are hosted collectively by bringing as many volunteers and members together as possible to reflect on and enjoy the progress of our efforts. This can be done through the formal Regional and Sectional annual or seasonal general meetings, or innovatively by a "Culture Celebration Day" or other informal events such as team lunches, recognition ceremonies, or cultural fairs as well as virtual celebrations for remote or hybrid teams (with digital shout-outs or fun activities). The main issue is to keep the events meaningful and tie the event directly to the values that changed, not just a general party. One thing that we made sure of at the IEEE Canada leadership in the past few years is to have organization leaders present at all these events to show appreciation for these changes and achievements. I found that having senior leaders present to thank teams personally, through speeches, videos, or handwritten notes, is an impactful practice, especially for younger volunteers and affinity groups such as our student branches, Young Professionals (YPs), and Women in Engineering. When leaders model gratitude, it signals that the change is strategic and lasting, not just symbolic. When leadership contributes to such events, they will be able to link celebration to continuous growth and share progress metrics (e.g., engagement scores, turnover rates, and inclusion survey results) to show tangible impact in a way that frames celebration not as an endpoint but as a milestone in an ongoing journey as well as reflect on lessons learned and what worked well and integrate feedback into future cultural initiatives to conclude with the most obvious questions to ask the team: "*What's next?*" "*How can we sustain this momentum?*"

When leaders model gratitude, it signals that the change is strategic and lasting, not just symbolic.

Moving forward is a different kind of energy than just "keeping going," which is about endurance, while moving

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convient de commencer par reconnaître ce qui a évolué, en identifiant et en communiquant clairement les transformations culturelles qui se sont produites, notamment :

- Une collaboration accrue entre les différentes équipes, comités et groupes.
- Une sensibilisation renforcée à l'inclusion et à la diversité.
- Une responsabilité et/ou un respect plus affirmé dans nos activités et communications quotidiennes.
- L'adoption de nouvelles habitudes de communication ou de leadership.

La reconnaissance publique renforce les comportements souhaités et motive les autres à les adopter. Nous savons que ce sont les personnes qui façonnent la culture. Il est donc certain que le fait de reconnaître les individus, les équipes ou les comités qui ont incarné les nouveaux comportements ou qui ont porté le changement, en annonçant régulièrement cette reconnaissance lors des réunions des comités organisationnels ou opérationnels, dans les bulletins ou sur les plateformes internes, ou encore en créant un prix de « champion de la culture » (comme le Prix du président de l'IEEE Canada, que j'ai eu le plaisir de remettre au cours des deux dernières années à nos champions), ou en mettant en lumière et en partageant des histoires de réussite par le biais des communications internes, aura un impact considérable sur les membres de l'organisation et créera une plateforme positive pour attirer davantage de bénévoles et de nouveaux membres.

Il est également très important que ces célébrations soient organisées collectivement, en réunissant autant de bénévoles et de membres que possible afin de réfléchir aux progrès accomplis et d'en profiter ensemble. Cela peut se faire lors des assemblées générales régionales et sectionnelles annuelles ou saisonnières, ou de manière innovante par une « Journée de célébration de la culture » ou d'autres événements informels tels que des déjeuners d'équipe, des cérémonies de reconnaissance ou des foires culturelles, ainsi que des célébrations virtuelles pour les équipes à distance ou hybrides (avec des messages numériques de félicitations ou des activités conviviales).

La principale exigence est de donner un sens à ces événements et de les relier directement aux valeurs qui ont évolué, plutôt que d'en faire de simples festivités. Au sein de la direction de l'IEEE Canada, nous avons veillé ces dernières années à ce que les dirigeants de l'organisation soient présents à toutes ces occasions afin de témoigner leur reconnaissance pour les changements et les réalisations accomplis. J'ai constaté que la présence de dirigeants expérimentés, exprimant leur gratitude directement aux équipes par des discours, des vidéos ou des notes manuscrites, constitue une pratique particulièrement marquante, notamment pour les jeunes bénévoles et les groupes d'affinité tels que nos branches étudiantes, les Jeunes Professionnels (IPs) et les Femmes en ingénierie. Lorsque les dirigeants incarnent la gratitude, cela démontre que le changement est stratégique et durable, et non simplement symbolique. Leur participation à ces événements permet de relier la célébration à une croissance continue et de partager des indicateurs de progrès (par exemple, les scores d'engagement, les taux de rotation ou les résultats des enquêtes sur l'inclusion), afin de montrer un impact tangible. Cela permet de présenter la célébration non comme une finalité, mais comme une étape dans un parcours en constante évolution, tout en réfléchissant aux leçons apprises et aux pratiques efficaces, et en intégrant les retours dans les futures initiatives culturelles. Cela

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forward is about direction—choosing growth, even after loss or uncertainty. We don't have to sprint. Even one step, if it's in the right direction, counts as progress. Momentum builds naturally when you choose purpose over pace. As we all know, our main direction is the path for growth. There isn't one single formula that explains the path for growth, but there is a rhythm—the natural process that all real growth tends to follow. It's less about perfection and more about alignment and honesty with ourselves. Awareness is the soil; nothing grows without it. Growth begins the moment we stop pretending and start noticing our patterns, fears, and longings. i.e., when we begin asking, "What's working?" "What's hurting?" "What needs to change?" This should be an iterative process that we exercise more frequently.

With that, 2025 continues to show all the signs of success and growth, with our dedicated and hard-working team of volunteers and contributors, and our conducting various exciting events. In 2025, we fulfilled our promise to our members about the Region conferences frontier as we successfully conducted the IEEE Canadian Conference on Electrical and Computer Engineering in May 2025 in Vancouver, BC; followed by the IEEE International Symposium on Antenna Technology and Applied Electromagnetics in July 2025 in St. John's, NF; then the IEEE International Humanitarian Technology Conference, an interdisciplinary conference series organized by IEEE R7 (Canada), IEEE R8 (Europe, Africa, and the Middle East), and IEEE R9 (Latin America and Caribbean) in August 2025 in Edmonton, AL. Finally, we

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conduit naturellement à poser les questions essentielles à l'équipe : *« Quelle est la prochaine étape ? »* et *« Comment maintenir cet élan ? »*

Aller de l'avant représente une énergie différente de celle qui consiste simplement à « continuer », laquelle relève de l'endurance. Aller de l'avant, c'est choisir une direction : celle de la croissance, même après une perte ou une période d'incertitude. Il n'est pas nécessaire de courir ; un seul pas, s'il est orienté dans la bonne direction, constitue déjà un progrès. L'élan se construit naturellement lorsque l'on privilégie le sens plutôt que la vitesse. Comme nous le savons tous, notre principale orientation est celle de la croissance. Il n'existe pas de formule unique qui en explique le cheminement, mais plutôt un rythme — le processus naturel que toute véritable croissance tend à suivre. Il s'agit moins de perfection que d'alignement et d'honnêteté envers nous-mêmes. La conscience est le terreau : rien ne pousse sans elle. La croissance commence au moment où nous cessons de prétendre et où nous commençons à observer nos habitudes, nos peurs et nos aspirations. Autrement dit, lorsque nous nous posons les questions : « Qu'est-ce qui fonctionne ? », « Qu'est-ce qui fait obstacle ? », « Que faut-il changer ? ». Ce processus doit être itératif et pratiqué plus fréquemment.

Ainsi, l'année 2025 continue de témoigner de signes évidents de succès et de croissance, grâce à notre équipe dévouée et travailleuse de bénévoles et de contributeurs, ainsi qu'à l'organisation de divers événements stimulants. En 2025, nous avons tenu notre promesse envers nos membres concernant le volet des conférences régionales, en organisant avec succès la Conférence canadienne de l'IEEE sur le génie

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IEEE Canadian Review

La revue canadienne de l'IEEE

IEEE Canadian Review is published three times per year: Spring, Summer, and Fall.

Its **principal objectives** are:

- To inform Canadian members of IEEE on issues related to the impacts of technology and its role in supporting economic development and societal benefits within Canada.
- To foster growth in the size and quality of Canada's pool of technology professionals to serve our increasingly knowledge-based economy.

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conducted the IEEE Canada Electrical Power and Energy Conference, focusing on a "Path to Net-Zero: Smart Technologies for Sustainable and Clean Energy Grids," in October 2025 at Waterloo University.

It is also beneficial to mention that Canada is very popular for hosting, in addition to the IEEE Canada flagship/Region conferences, a large number of other International IEEE conferences hosted by the IEEE Technical Activities Board Societies, such as the IEEE COMSOC ICC in June 2025 in Montréal, and lately, the WiSEE Conference, in October 2025 in Halifax, NS. All these conferences are organized and chaired by local Canadian IEEE experts and volunteers from academia and industry, another proven record of our IEEE Canada's leaders in action.

I would personally like to sincerely thank our IEEE Canada's CONAC Committee, all the conference chairs and contributing volunteers, and the supporting IEEE Canada staff for their extraordinary efforts and fabulous dedication. They have collectively built our confidence to continue the success and growth of our IEEE Canada conferences in 2026 and beyond.

I would also like to celebrate the extraordinary achievements of our student and YP teams in organizing the most attended Students and YP Congress (IEEE Canada CSYPC in September 2025 in Toronto) and congratulate and thank our Canadian students and YP leaders who contributed to this very successful event. This success provided the momentum for another related successful event organized by the IEEE Lakehead University Student Branch and Lakehead University's Barrie STEM Hub at Lakehead University – Barrie Campus in November 2025 titled "The IEEE Industry Academia Handshake Convention 2025," which convenes students, entrepreneurs, and industry professionals to bridge the gap between academic innovation and industrial implementation.

Finally, I would like to reemphasize that the IEEE Canada Board and I always encourage you all to continue being a part of this exciting journey and joining our fabulous team to enrich our experiences and achievements for further and better success and growth.

By the time you read this article, I will have most probably passed the torch to my colleague and successor, Dr. Wahab Almuhtadi, who I wish all the best in his new role contributing to the historic journey of IEEE Canada with his unique knowledge and long-term experience. I encourage you all to support him as you supported me and give him the opportunity to use his leadership touch in steering the ship on the right course. ■

Tom Murad, P.Eng., Ph.D., F.E.C., F.EIC, SMIEEE
2024–2025 IEEE Canada President
2024–2025 Region 7 Director

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électrique et informatique en mai 2025 à Vancouver (C.-B.), suivie du Symposium international de l'IEEE sur la technologie des antennes et l'électromagnétisme appliqué en juillet 2025 à St. John's (T.-N.), puis de la Conférence internationale de l'IEEE sur la technologie humanitaire, une série interdisciplinaire organisée conjointement par l'IEEE R7 (Canada), l'IEEE R8 (Europe, Afrique et Moyen-Orient) et l'IEEE R9 (Amérique latine et Caraïbes), en août 2025 à Edmonton (Alb.). Enfin, nous avons tenu la Conférence canadienne de l'IEEE sur l'énergie électrique et la puissance, axée sur « La voie vers la carboneutralité : technologies intelligentes pour des réseaux énergétiques durables et propres », en octobre 2025 à l'Université de Waterloo.

Il convient également de souligner que le Canada est reconnu pour accueillir, en plus des conférences phares et régionales de l'IEEE Canada, un grand nombre d'autres conférences internationales de l'IEEE organisées par les sociétés du IEEE Technical Activities Board. Parmi celles-ci, citons le IEEE COMSOC ICC en juin 2025 à Montréal, ainsi que la conférence WiSEE en octobre 2025 à Halifax (N.-É.). Toutes ces conférences sont organisées et présidées par des experts et bénévoles canadiens de l'IEEE issus du milieu universitaire et industriel, ce qui constitue une nouvelle preuve tangible du dynamisme et du leadership de l'IEEE Canada.

Je tiens à exprimer ma sincère gratitude au comité **CONAC de l'IEEE Canada**, à l'ensemble des présidents de conférence et des bénévoles contributeurs, ainsi qu'au personnel de soutien de l'IEEE Canada, pour leurs efforts remarquables et leur dévouement exemplaire. Collectivement, ils ont renforcé notre confiance dans la poursuite du succès et de la croissance des conférences de l'IEEE Canada en 2026 et au-delà.

Je souhaite également célébrer les réalisations extraordinaires de nos équipes étudiantes et de Jeunes Professionnels (JP) pour l'organisation du *Congrès des étudiants et des Jeunes Professionnels* le plus fréquenté (IEEE Canada CSYPC, en septembre 2025 à Toronto), et féliciter ainsi que remercier nos étudiants et leaders JP canadiens qui ont contribué à la réussite remarquable de cet événement. Ce succès a donné l'élan nécessaire à un autre événement connexe, organisé par la branche étudiante IEEE de l'Université Lakehead et le Barrie STEM Hub de l'Université Lakehead – campus de Barrie, en novembre 2025, intitulé *« The IEEE Industry Academia Handshake Convention 2025 »*. Cette rencontre a réuni étudiants, entrepreneurs et professionnels de l'industrie afin de combler le fossé entre l'innovation académique et sa mise en œuvre industrielle.

Enfin, je souhaite réitérer que le conseil d'administration de l'IEEE Canada et moi-même vous encourageons vivement à continuer de faire partie de cette aventure stimulante et à rejoindre notre remarquable équipe afin d'enrichir nos expériences et nos réalisations, pour assurer un succès et une croissance toujours plus grands.

Au moment où vous lirez cet article, j'aurai très probablement passé le flambeau à mon collègue et successeur, Dr Wahab Almuhtadi, à qui je souhaite le meilleur succès dans ses nouvelles fonctions, contribuant au parcours historique de l'IEEE Canada grâce à ses connaissances uniques et à sa vaste expérience. Je vous encourage tous à lui apporter le même soutien que celui que vous m'avez témoigné et à lui donner l'occasion d'exercer son leadership pour maintenir le cap dans la bonne direction. ■

Tom Murad, ing., Ph.D., F.E.C., F.EIC, SMIEEE
Président de l'IEEE Canada 2024–2025
Directeur de la Région 7 2024–2025

Jahangir Khan, Ph.D., P.Eng., SMIEEE
mjakhan@ieee.org

As 2025 nears an end, I recognize the professional and personal challenges that have impacted many of us due to the U.S.–Canada trade tension as well as the unsettling trends in global geopolitics. I believe that the "one IEEE" philosophy will rise above these uncertainties and keep all IEEE Members united to a common and ultimate goal: advancing technology for humanity.

This edition of *IEEE Canadian Review* (*ICR*) features a holistic overview of battery energy storage systems, data compliance standards in artificial intelligence systems, and recognizes the

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Lors que l'année 2025 touche à sa fin, je souhaite reconnaître les défis, tant professionnels que personnels, auxquels beaucoup d'entre nous ont été confrontés, qu'il s'agisse des tensions commerciales entre les États-Unis et le Canada ou des incertitudes liées à la géopolitique mondiale. Je garde toutefois la conviction que la philosophie du " un seul IEEE " nous permettra de rester solidaires et de poursuivre ensemble notre objectif commun: mettre la technologie au service de l'humanité.

Dans cette édition de la revue canadienne de l'IEEE, vous découvrirez un panorama complet des systèmes de stockage

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(A Few Words From the Editor-in-Chief cont'd from p. 5)

IEEE Canada Major Award winners as well as IEEE Canadian Foundation donors. Several community news articles also provide a pulse check on IEEE Canada operation, which includes Guglielmo Marconi's 150 birthday [A1], Witold Kinsner's passing [A2], and Memorial University's contributions to dc microgrid development [A3].

As Dr. Tom Murad's term ends as the IEEE Canada president and Region 7 director, Dr. Wahab Almuhtadi's begins, starting in January 2026. Congratulations to Dr. Ekram Hossain for being voted president-elect. As mentioned in Dr. Murad's message [A4] in this edition of *ICR*, leadership factors greatly influence how an organization like IEEE operates. A positive culture change is a vital recipe for success, and we look forward to the new leadership team to drive IEEE Canada to new heights.

The upcoming edition of *ICR* will be a landmark 100th edition. We are in the process of celebrating this edition with a number of articles on the history of this publication as well as on the future outlooks, especially looking at various cutting-edge tech-

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(Quelques mots du rédacteur en chef suite de p. 5)

d'énergie par batteries, des normes de conformité des données dans les systèmes d'intelligence artificielle, ainsi qu'un hommage aux lauréats des prix majeurs de l'IEEE Canada et aux généreux donateurs de la Fondation IEEE Canada. Plusieurs

Un changement culturel positif est une clé essentielle, et nous avons hâte de voir la nouvelle équipe dirigeante porter l'IEEE Canada vers de nouveaux horizons.

articles communautaires viennent également illustrer la vitalité de nos activités, en évoquant notamment le 150e anniversaire de Guglielmo Marconi [A1], le décès de Witold Kinsner [A2], et les contributions de l'Université Memorial au développement des microréseaux en courant continu [A3].

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(A Few Words From the Editor-in-Chief cont'd from p. 6)

nologies that will shape our future. Please send your comments and feedback to icr@ieee.ca. ■

Appendix: Related Articles

[A1] J. Craig, O. De Silva, and L. Zedel, "Commemorating Marconi's 150th birthday on signal hill," *IEEE Canadian Rev.*, vol. 37, no. 2, p. 23, Summer/Été 2025, doi: 10.1109/MICR.2025.3612541.

[A2] W. Kinsner, "[In Memoriam]," *IEEE Canadian Rev.*, vol. 37, no. 2, pp. 24–25, Summer/Été 2025, doi: 10.1109/MICR.2025.3608994.

[A3] G. Atinkum, "From research labs to remote communities: MUN's global impact," *IEEE Canadian Rev.*, vol. 37, no. 2, pp. 45–47, Summer/Été 2025, doi: 10.1109/MICR.2025.3612540.

[A4] T. Murad, "[President's Message]," *IEEE Canadian Rev.*, vol. 37, no. 2, pp. 1–4, Summer/Été 2025, doi: 10.1109/MICR.2025.3627987.

(Quelques mots du rédacteur en chef suite de p. 6)

Le mandat du Dr Tom Murad s'achève en tant que président de l'IEEE Canada et directeur de la Région 7, et celui du Dr Wahab Almuhtadi débutera en janvier 2026. Nous adressons également nos félicitations au Dr Ekram Hossain, élu président désigné. Comme le rappelle le message du Dr Murad [A4] dans cette édition, le leadership joue un rôle déterminant dans le succès d'une organisation comme l'IEEE. Un changement culturel positif est une clé essentielle, et nous avons hâte de voir la nouvelle équipe dirigeante porter l'IEEE Canada vers de nouveaux horizons.

La prochaine édition de la revue canadienne de l'IEEE sera une étape historique : la 100e. Nous préparons une célébration spéciale, avec des articles retraçant l'histoire de cette publication et explorant les perspectives d'avenir, notamment les technologies de pointe qui façonneront notre monde. Nous serions ravis de recevoir vos commentaires et suggestions à icr@ieee.ca. ■

Control and Optimization Algorithms for Renewable Energy Sources With Battery Energy Storage Systems: A Review

by Md Tariqul Islam and Xiaodong Liang

Renewable energy sources, such as wind and solar, bring environmental benefits, but also cause uncertainties in power systems operation. Battery Energy Storage Systems (BESSs) can serve as a solution to improve the power grid's stability and reliability when combined with renewable energy sources. A BESS reduces the power variance, enables localized real and reactive power flow, improves the congestion management, and offers the power leveling. However, the high capital cost of BESSs necessitates effective control and optimization strategies to improve the performance, extend the battery lifetime, and minimize the overall expenditures. This paper presents a review of control and optimization algorithms developed for mitigating power fluctuations in PV and wind systems integrated with BESSs. The review emphasizes filter-based smoothing, rate-limiting, hybrid storage approaches, model predictive control, and artificial intelligence-driven optimization methods, with particular focus on their impact on power fluctuation reduction, system stability, and battery lifespan.

Introduction

The rising global population is driving a significant surge in the demand for electrical energy, which is difficult to meet by using conventional power generation methods. Conventional power generation plants rely primarily on fossil fuels, such as coal and diesel, which release approximately 34 billion tons of CO_2 per year, causing environmental degradation [1], [2]. This urgent situation has motivated a global transition toward renewable energy resources, particularly solar and wind power, which are cleaner and more sustainable alternatives.

In the last decade, government policies, incentives, and technologies have been a strong force behind the integration of renewable energy sources, and the costs of renewable energy sources have been greatly reduced from before. The levelized cost of onshore wind and solar photovoltaics (PVs) is expected to be reduced by 26% and 43%, respectively, by 2025 [3], [4]. These cost savings are likely to speed up the uptake of renewable energy across the entire globe, making it more viable as a sustainable energy source. Despite these advancements, a critical limitation of renewable energy systems lies in their inherent intermittency. Solar PV cells produce fluctuating voltages depending on sunlight, and sudden changes in sunlight can create voltage spikes [5], [6]. Wind power generation varies with wind speed and direction. One solution for the fluctuating power generated from wind and solar is to use high power rating devices with enhanced insulation, which increases the system cost [7].

A battery energy storage system (BESS) can play a vital role to address such challenges associated with renewable energy sources [6]. A BESS can store the excess energy produced during high renewable power generation and release it when the supply is insufficient or the demand spikes, which ensures a smoother power delivery and enhances overall system efficiency [8], [9]. In recent decades, the adoption of BESSs has increased due to their efficiency, substantial energy storage capacity, and adaptability [10]. Modern energy systems are more stable and reliable with BESSs by reducing the cost of the battery and continuously improving its performance and longevity [9], [11].

Although these benefits exist, the power variability of wind and solar power generation presents a most significant challenge in BESS-integrated renewable energy sources. The intermittency of solar radiation and wind speed creates random variations in

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the power generated, which may cause repetitions in charging and discharging of the BESS. This abnormal cycling not only increases the rate of battery degradation but also decreases the overall efficiency of the system [12]. The converter and inverter components connected to BESSs could be overstressed by voltage spikes caused by sudden changes in solar radiation or fast wind gusts, causing thermal stress, a shorter lifespan, and even unstable power distribution [13], [14]. Thus, the reliability, longevity, and financial sustainability of BESSs in renewable energy sources depend heavily on the effective management of power variations.

Different methods of filtration are used in BESSs to reduce the voltage swings generated by renewable energy sources. Some filter-based approaches, such as low-pass, high-pass, moving average, and moving medium filters, have been proposed in the literature to solve the power fluctuation problem [15], [16], [17]. Some control and optimization mechanisms, such as the rated ramp limiting (RRL) and maximum power point tracking (MPPT) approaches, are developed in [18] to mitigate the power fluctuations of renewable energy sources, optimize battery scheduling, and increase efficiency. The RRL method controls the rate of change in the power output, which can't increase the predetermined threshold; the MPPT method keeps the wind power within the operating limit. Recently, artificial intelligence (AI)-based control algorithms have been proposed to optimize battery scheduling in an efficient manner by considering ramp-down, peak-shaving, and load leveling. This ensures a stable power supply from a battery system, also increases the battery life, and decreases operational and maintenance costs [19], [20], [21], [22], [23].

This article provides a review of the challenges associated with power fluctuations due to renewable energy sources, and the advanced control and optimization strategies that are used to enhance the BESS's performance in renewable energy systems. The article reviews the following:

- The major challenges caused by integration of renewable energy sources in power grids, particularly PV and wind power systems, including intermittency, unpredictability, ramp-rate, voltage fluctuations, and their adverse impacts on the grid stability.
- Different connection configurations of battery-integrated PV and wind power systems (ac link, dc link, and hybrid converter-based structures) and their role in improving energy storage, power control, and system reliability.
- Control and optimization strategies to mitigate power fluctuations in renewable energy systems with BESSs, covering filter-based methods, rate-limiting

techniques, model predictive control, hybrid storage approaches, and AI-based algorithms.

The article is organized as follows. The "Major Challenges of Renewable Energy Integration and the Role of BESSs" section presents major challenges of renewable energy sources integration. The "System Configurations for Wind and PV Power Generation With BESSs" section details connection diagrams of battery-based energy conversion systems. The "Control and Optimization Strategies to Mitigate Power Fluctuations in Renewable Energy Systems With BESSs" section discusses control and optimization strategies to mitigate power fluctuations in renewable energy systems with BESSs. The "Conclusion and Future Work" section discusses future work and concludes the article.

Major Challenges of Renewable Energy Integration and the Role of BESSs

PVs and wind power are the most important clean energy sources. With an additional 320 TWh (a 25% increase) to reach more than 1,600 TWh globally in 2023, solar PVs experienced the greatest growth among renewables [24]. Onshore wind turbine capabilities have jumped to more than 2 MW and offshore ones to 3–5 MW, from 0.05 and 3.8 MW, respectively [25]. However, both wind and solar power generation is highly weather dependent, leading to fluctuating and unpredictable power generation concerns. The output from PV systems depends on sunlight—full sun, shaded sun, and no sun [5]—which can cause sudden voltage changes. These fluctuations can seriously damage component insulation and cause instability within the electrical grid [7]. Wind power generation is highly unpredictable and inconsistent because it depends on wind speed and direction [26], which pose challenges to maintaining a steady and consistent power supply [27]. The ramp rate of wind power, which refers to how quickly its output changes, makes it difficult to maintain a controlled and steady generation profile. Due to its low dispatchability, wind energy cannot easily respond to changing electricity demand, making it challenging to effectively balance supply and demand [28]. In addition, frequency control, voltage flickers, and transmission congestion can all be caused by rapid changes in wind speed, which in turn leads to lost efficiency and expenditure [17].

To solve these problems, BESSs can play a vital role in providing a continuous power supply to the grid without creating disturbances [6]. During the peak of wind and solar power generation, the BESS is charged to its rated capacity [29]. After a grid failure occurs, the BESS seamlessly transitions to the backup operation by providing immediate power injection or absorption to stabilize the system, thereby enhancing grid reliability and resilience [30].

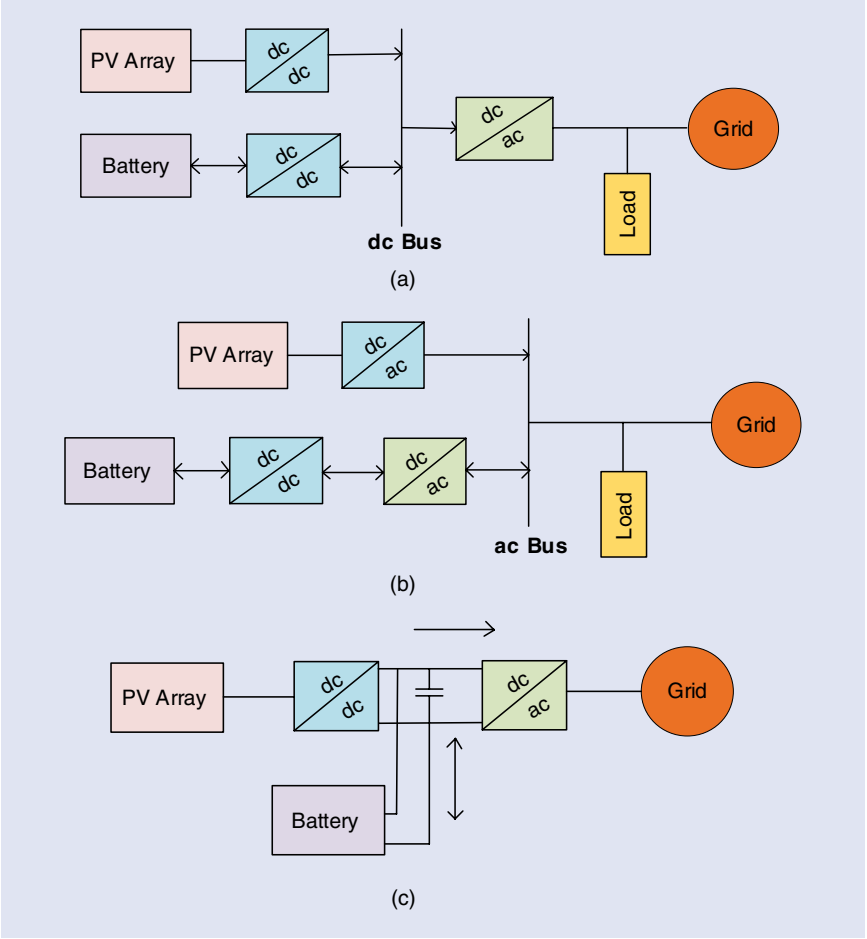

Figure 1: Three circuit configurations of a battery-integrated PV system [31], [32].

System Configurations for Wind and PV Power Generation With BESSs

In the literature, there are various system configurations for wind and PV power generation with BESSs. For PV systems, there are three types of feasible connections, as shown in Figure 1, either dc- or ac-based connections with batteries (with or without a bidirectional dc–dc converter) [31], [32]. In wind energy conversion systems, batteries may be connected via an ac bus with a converter, through a converter–chopper setup, or at a dc bus after converting wind power to dc, as shown in Figure 2. These configurations improve energy storage, power control, and grid stability [31], [32].

Control and Optimization Strategies to Mitigate Power Fluctuations in Renewable Energy Systems With BESSs

The substantial initial investment in BESSs makes effective control and optimization measures more important to lower operational costs, increasing battery life and preserving grid stability. Numerous methods have been proposed in the literature to address power fluctuations, including filter-based smoothing, rate-limiting and hybrid storage, predictive control, and AI-based approaches. Some filter-based approaches, such as low-pass filters, high-pass filters, moving average filters, moving medium filters, discrete Kalman filters (DKFs), and Hodrick–Prescott (HP) decomposition filters, are also proposed in the literature to smooth PV and wind power generation [34], [35], [36], [37], [38], [39]. In [15], the authors demonstrate a comparative analysis among the simple moving window, single window, and half-moving average algorithms for smoothing solar power output. It is found that the simple moving window average technique increases the battery size; while the techniques employing

a single-window or a half-moving average reduce both latency and battery size [15]. A moving median (MM) filter is proposed for mitigating power latency and solar power fluctuations. The main advantages of the MM filter are that it minimizes expectancy, smooths performance, and uses less battery power compared to conventional low-pass and moving medium filters [34]. Lamsal et al. [39] introduces a DKF for leveling the output of wind power and PV system fluctuations. By using the weighted average of the most and least stable power values for every period, the DKF generates the intended output power from wind and PV generation, thereby greatly decreasing variations. The HP decomposition filter is proposed in [38] to smooth the power of wind turbines as well as enhance power tracking and control the state of charge (SoC) of the battery.

Several rate-limiting and hybrid energy storage approaches have been proposed to minimize power fluctuations in renewable energy systems, particularly wind and solar generation. Another optimum solution for wind power fluctuation is to integrate the supercapacitor with BESSs, as shown in Figure 3 [40]. These integrated solutions extend the lifespan of lead-acid batteries by mitigating the power fluctuations caused by load switching and variations in wind speed [40]. An iterative algorithm and a sensitivity-based optimization technique are utilized in [41] to investigate the potential for a grid-connected microgrid that incorporates wind power and a BESS to effectively manage the unpredictable and variable characteristics of renewable energy sources. Alam et al. [14] introduces a control method that employs an energy buffer system to reduce the fast voltage and power fluctuations from solar or wind power generation. Every discharging or charging operation of the energy storage system is controlled through available energy storage buffers to maintain the desired power rate changes, while keeping voltage variations at an acceptable level.

A model predictive controller (MPC) was developed in [42] to mitigate the fluctuation of wind power. The MPC algorithm tracks a predefined power reference point and utilizes real wind power forecasting data for the enhanced accuracy. By minimizing tracking errors, the battery's performance and operational health were optimized. The event-based optimization (EBO) algorithm is a developed method that smooths ramp events in a BESS integrated with wind power generation systems [43]. The proposed technique optimizes system performance using energy-based events with Q (quality) factors as it optimizes the long-term operation instead of focusing on immediate responses. Through continuous optimization of power transitions, EBO generates mappings between events and actions, which lower power output ramping.

Some AI-based optimization approaches have been also proposed. A scheduling algorithm for managing the power fluctuations caused by varying

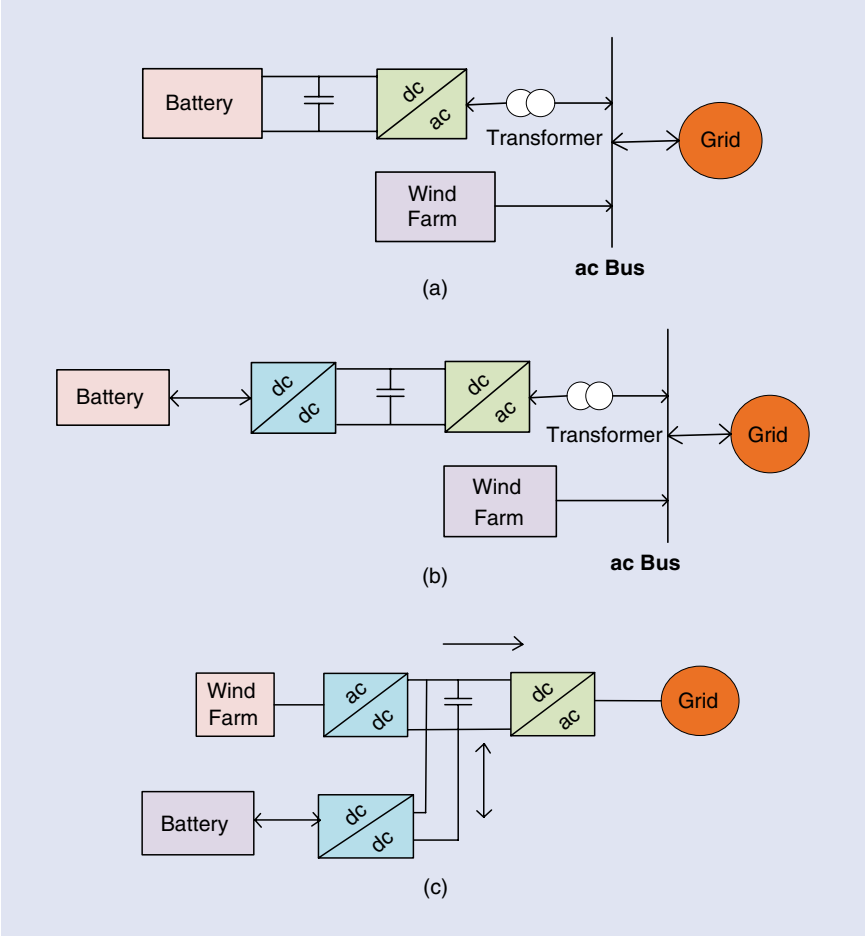

Figure 2: Three circuit configurations of a battery-integrated wind farm [32], [33].

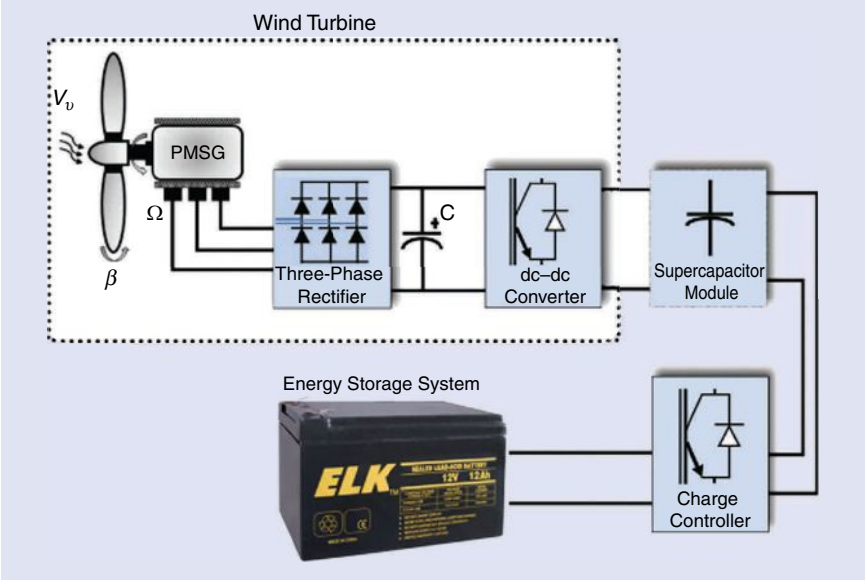

Figure 3: The system configuration with supercapacitors for a battery-integrated wind energy conversion system [40].

demand was developed in [19] for BESSs with a grid-connected solar PV system. The emperor penguin optimization algorithm is used to optimize battery scheduling in an efficient manner by considering ramp-down, peak-shaving, load leveling, and so on. The battle royale optimization function is applied to optimal battery sizing for the lowest capital and maintenance costs, while still meeting load demand, where the Nashik Wani substation dataset is used. The performance of the proposed topology is compared to that of the particle swarm optimization and demand response algorithms. The analysis shows that 67.19% and 67.7% costs were reduced for investment cost and operational and maintenance costs, respectively. To improve the PV-generated power, the active power ramp rate control algorithm is proposed in [20] by combining a Gaussian confidence estimator and deep neural network (NN) predictor. The results indicate that the proposed algorithm effectively regulates the power ramp rate and enhances efficiency.

In [21], the African vultures optimization algorithm (AVOA) and self-attention generative adversarial networks (SAGANs) are used to minimize the power oscillations coming from PV cells. Bootstrapping the battery cycle with AVOA combined with SAGANs enables a better energy storage system control through precise solar power forecasting. The integration results in reduced solar power fluctuation, along with a faster system response time; improved grid stability; and minimal error rates. The NN predictive control (NNPC) algorithm is developed in [22] to mitigate power output oscillations in PV systems. The proposed model employs an NN to predict net energy output as expected from inputs, such as solar irradiance and load demand. To achieve power stability, an exponential moving average filter is integrated into the system, achieving a smoother reference signal for BESSs via the NNPC controller. The performance analysis indicates that the approach minimizes power fluctuations and voltage flickers effectively and maintains stable-battery SoC by controlling power peak.

An intelligent MPC (IMPC) that integrates an NN with a quasi-Newton optimizer is developed in [23] to control solar–wind power together with the battery's SoC through a hydrogen electrolyzer fuel cell unit. This NN model with 10 hidden BRMAP layers predicts the regulated power output from the battery's SoC, while the optimizer ensures stable control within system constraints. The developed IMPC demonstrates better capabilities to protect batteries from deep draining and overcharging events compared to fuzzy logic controllers.

Conclusion and Future Work

This article reviewed control and optimization techniques to reduce the power variations in PV and wind power systems that are coupled with BESSs to facilitate the delivery of power, improve reliability, and increase battery life. The discussion covered a wide range of methodologies, such as filter-based smoothing, rate-limiting, hybrid storage setups, MPC, and AI-based optimization. Among them, AI-based solutions and hybrid energy storage systems show significant potential in increasing system efficiency and lowering the cost of operations. The recommended future research includes

- creating lightweight and real-time optimization algorithms that can be implemented in large-scale renewable energy systems without introducing heavy computational demands
- developing hybrid designs that combine supercapacitors, hydrogen storage, and new BESS designs to enhance energy buffering and battery life
- improving AI-based techniques, which show great promise but need better generalization, performance in uncertain weather, and less training complexity to become feasible for realistic power grid applications
- advancing predictive control by using sophisticated forecasting models that integrate physical parameters with deep learning. ■

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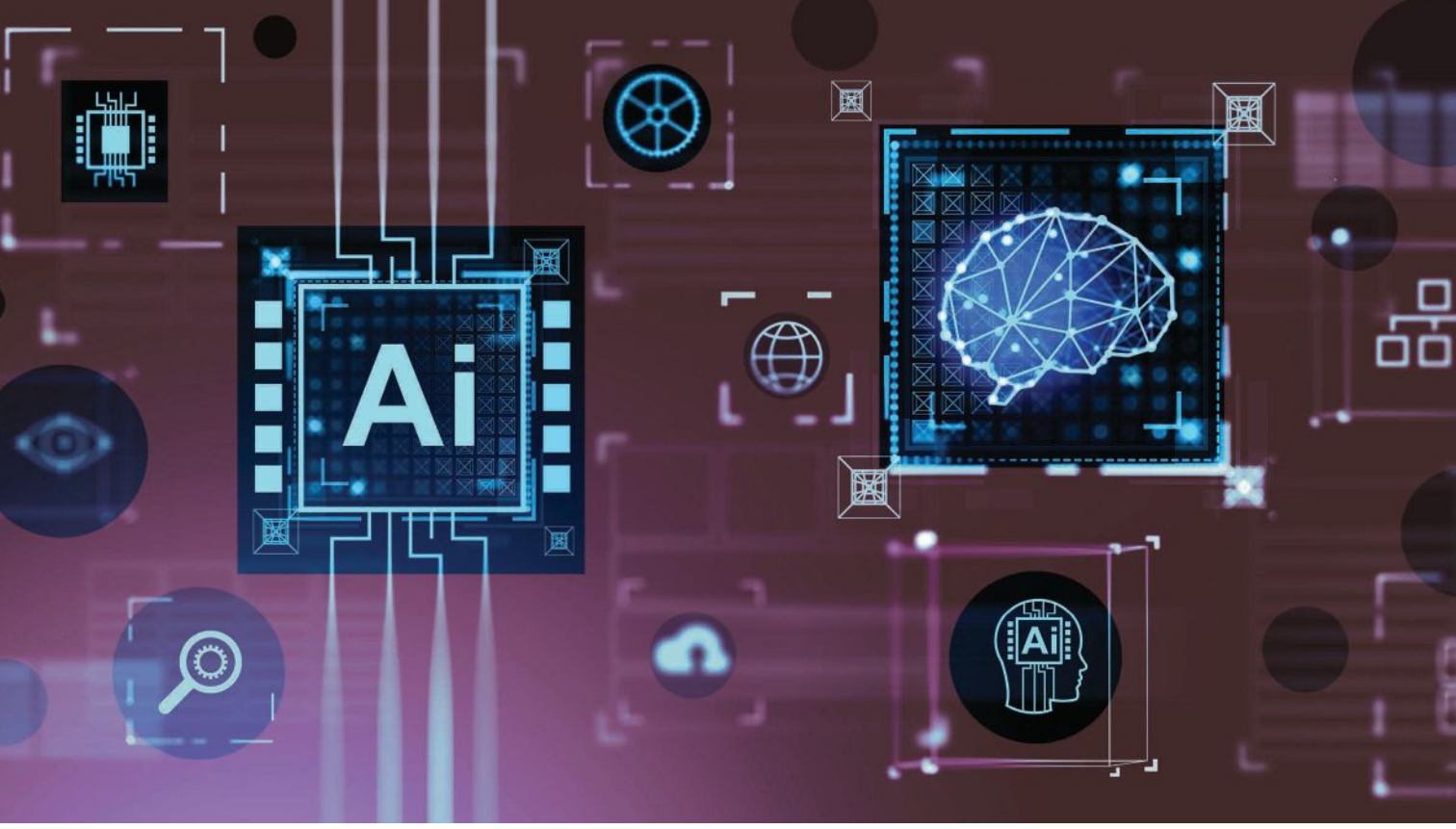

Data Compliance Standards in Artificial Intelligence Systems

by Hamed Taherdoost

Artificial intelligence (AI) is transforming critical sectors such as healthcare, finance, and government, but its rapid adoption raises pressing concerns about data security, privacy, ethics, and compliance. While global frameworks like the EU's General Data Protection Regulation (GDPR) set rigorous benchmarks, Canada's evolving landscape, anchored by the Personal Information Protection and Electronic Documents Act (PIPEDA) and the forthcoming AI and Data Act (AIDA), remains less harmonized and technically prescriptive. This review examines and compares Canadian AI data compliance standards with prominent global frameworks to identify strengths, gaps, and opportunities for harmonization. The study employs a comparative literature review, analyzing legal provisions, governance structures, and technical compliance measures across multiple jurisdictions, particularly emphasizing engineering, architecture, and operational mechanisms underpinning AI lifecycle compliance. Canada follows international best practices in transparency, accountability, and stakeholder involvement, but differs in enforcement intensity, scope, and sectoral integration. Consent management systems, privacy-enhancing technology, and reproducibility guidelines are emerging in Canada, but they lag behind EU counterparts. Provincial diversity, overlapping jurisdictions, and patchwork cybersecurity regulation hamper national harmonization. However, Canada's flexible, principle-based strategy supports AI risk adaptation and worldwide interoperability. Legal, technical, and ethical approaches must be integrated into governance ecosystems to meet Canadian and global AI compliance criteria. Canada can become a global leader while protecting rights and supporting innovation by strengthening enforcement, streamlining provincial-federal coordination, and investing in privacy-preserving AI research.

Introduction

Health care, banking, and governments are among the industries quickly changing due to artificial intelligence (AI) [1], [2], [3]. However, AI's widespread use raises significant concerns over data security, privacy, and ethics. The economic adoption of AI now depends not only on technical innovation but also system reliability and governance [4].

AI systems rely on massive datasets containing sensitive personal information. Every stage of the AI lifecycle, from data collection to model deployment, introduces privacy risks, demanding robust compliance, bias mitigation, and explainability measures [5], [6]. Comparative literature reviews are essential to address governance gaps and identify best practices across jurisdictions [7], [8], [9].

Different regions adopt divergent data protection approaches. The European Union's (EU's) General Data Protection Regulation (GDPR) provides strict privacy protections, while the United States follows fragmented, sector-specific rules [10]. In Canada, the forthcoming AI and Data Act (AIDA) remains vague regarding enforcement and lags behind the EU's AI Act (AIA), which sets clear requirements for risk management, transparency, and human oversight. Scholars call for aligning AIDA with international best practices to protect rights, enhance accountability, and support cross-border data flows [11], [12].

This review compares global and Canadian AI compliance systems, analyzing technical foundations such as engineering, architecture, and operations. It highlights areas of convergence and divergence, evaluates AI and traditional compliance methods, and proposes action plans to strengthen transparency, accountability, and risk management. The goal is to harmonize compliance measures worldwide and ensure that AI systems are trustworthy, rights-protective, and innovation-friendly.

Background of Data Compliance in the Age of AI

The distinguishing features of AI, i.e., adaptive learning, data dependency, and black-box behavior, impose unprecedented technical compliance challenges (Figure 1). This section discusses these challenges with help from the respective literature to grasp them properly.

Adaptive Learning

Adaptive learning enables AI systems to modify their behavior based on new data, which is valuable in rapidly changing environments but complicates compliance efforts. Such systems risk learning biases or making decisions beyond predefined rules, requiring safeguards to ensure alignment with human values and legal standards. Zhang et al. [16] emphasize that AI's lack of explicit knowledge hinders decision-making transparency, accountability, and traceability. Moreover, the flexibility of AI can produce unpredictable outcomes, and traditional quality assurance methods are insufficient. Luettig et al. [13] argue that new standards tailored to machine learning are necessary to address these verification challenges.

Data Dependency

AI systems depend on large datasets for training and operation, making data quality, privacy, and security critical compliance concerns. Model performance is tied to the representativeness of training data; missing or biased data can produce skewed and legally problematic outcomes, such as discriminatory treatment in medicine [14]. Integrating AI with existing architectures must align with data protection regulations like the GDPR, but the black-box nature of most models complicates compliance. Ezzeddine [15] calls for explainable AI to improve transparency and address privacy risks.

Black-Box Behavior

The black-box problem refers to the opacity of AI systems, where decision-making processes are not interpretable to users or developers. This lack of transparency undermines trust and hinders adoption in high-stakes sectors such as finance and medicine. Zhang et al. [16] note that opaque algorithms are difficult to validate for clinical use, while Luettig et al. [17] highlight the need for new certification standards that address AI-specific failure modes and ensure regulatory compliance.

Global Data Compliance Standards for AI Systems

The rapid adoption of AI across industries has heightened the need for robust compliance standards to address ethical, data protection, and security risks. The GDPR serves as a global benchmark for data privacy, emphasizing transparency, accountability, and strong rights for data subjects, influencing legislation worldwide [18], [19]. The EU's AIA represents a comprehensive regulatory framework that classifies AI systems by risk level, imposing stringent requirements on high-risk applications in sectors like health care and transportation [20], [21]. It mandates transparency by requiring organizations to disclose AI capabilities and limitations, fostering stakeholder trust. The National Institute of Standards and Technology developed the AI Risk Management Framework to guide organizations in identifying, measuring, and mitigating AI-related risks, ensuring that systems are secure, efficient, and trustworthy [22], [23], [24], [25]. The International Organization for Standardization (ISO) has issued AI standards that promote algorithmic transparency, data quality, ethics, and interoperability. Notably, ISO/IEC 42001:2023 defines AI management system requirements to ensure accountability and alignment with international best practices (Figure 2) [26].

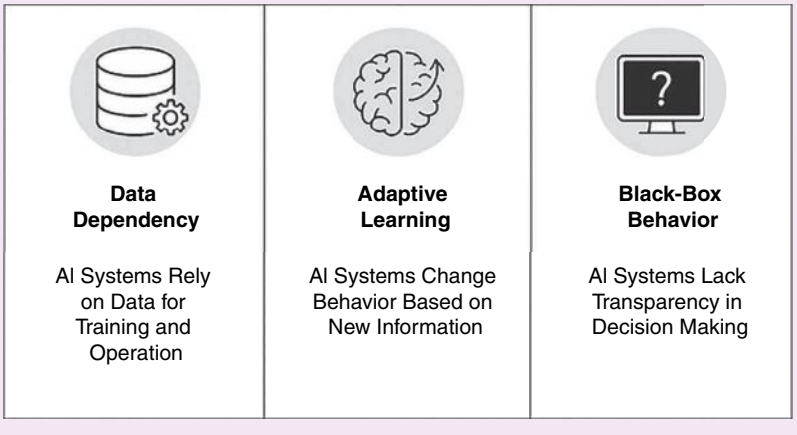

Figure 1: Foundations of data compliance in AI systems.

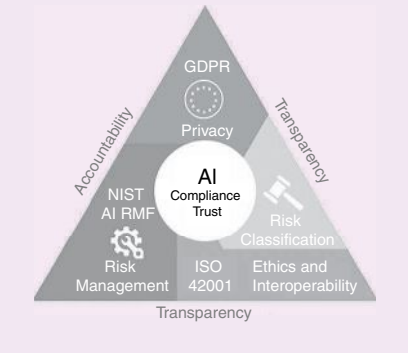

Figure 2: Global AI data compliance standards. NIST: National Institutes of Standards and Technology; AI RMF: AI Risk Management Framework.

EU: GDPR

The GDPR, implemented in May 2018, has reshaped the EU's data protection framework and poses unique challenges for AI systems. Its principle of data minimization, requiring organizations to collect only necessary data, conflicts with AI's reliance on large datasets [27].

The GDPR also imposes strict consent requirements; consent must be informed, voluntary, and withdrawable, creating difficulties for AI systems that operate on aggregated data from multiple sources. Politou et al. [28] emphasize the need for robust consent management mechanisms to handle withdrawal requests and maintain compliance.

The GDPR mandates explainability in automated decision making, yet sophisticated AI models often function as "black boxes." Hamon et al. [29] highlight the difficulty of providing understandable explanations for high-risk AI applications, such as in medicine, while ensuring legal compliance and trust.

Additionally, the GDPR grants individuals rights to access, correct, and erase their data, including the "right to be forgotten," which impacts AI systems trained on historical datasets. These restrictions may hinder cybersecurity efforts by limiting access to personal data that are critical for combating cybercrime [30].

United States: California Consumer Privacy Act and Other Frameworks

The California Consumer Privacy Act (CCPA) has intensified calls for comprehensive U.S. federal privacy legislation as the country lacks a unified approach comparable to the GDPR [31]. U.S. privacy protections are governed by sector-specific laws such as the Health Insurance Portability and Accountability Act for health data and COPPA for children's data, resulting in a fragmented regulatory landscape that leads to inconsistent safeguards depending on context. Unlike the GDPR, which prioritizes individual rights like data portability and the right to be forgotten, the United States relies heavily on industry self-regulation, which is criticized as insufficient for protecting consumer privacy. This divergence reflects cultural differences, with the United States prioritizing economic interests and the EU emphasizing personal privacy rights [32].

For AI developers, varying state laws such as the CCPA complicate compliance by imposing different requirements on data collection, use, and transparency [33]. The absence of a federal privacy strategy risks slowing AI innovation as companies navigate conflicting regulations and increased legal exposure [34].

Canadian Data Compliance Standards

Canadian Data Compliance Standards combine federal laws like the Personal Information Protection and Electronic Documents Act (PIPEDA) and AIDA, diverse provincial frameworks such as Québec's Law 25 and Ontario's Digital Charter, and institutional guidance from the Office of the Privacy Commissioner (OPC), Digital Advertising Alliance of Canada (DAAC), and ISO. Together, they form a multilayered but fragmented system that balances privacy protection with technological innovation (Figure 3).

Federal Level

In Canada, data compliance is currently governed by PIPEDA and will soon include AIDA. PIPEDA, enacted in 2000, regulates how organizations collect, use, and disclose personal information in commercial contexts, emphasizing accountability, consent, and transparency, and even applies to foreign organizations with a "real and substantial connection" to Canada [35].

Although PIPEDA requires breach reporting and security safeguards, it is largely reactive and lacks strong enforcement provisions, prompting calls for reform [36]. AIDA, part of the Digital Charter Implementation Act, introduces a proactive compliance framework tailored to AI technologies. It classifies "high-impact" AI systems, requiring risk assessments, audits, and stringent oversight to address bias, accountability, and transparency [37], [38]. AIDA mandates explainability of AI decisions and shifts compliance from reactive to anticipatory,

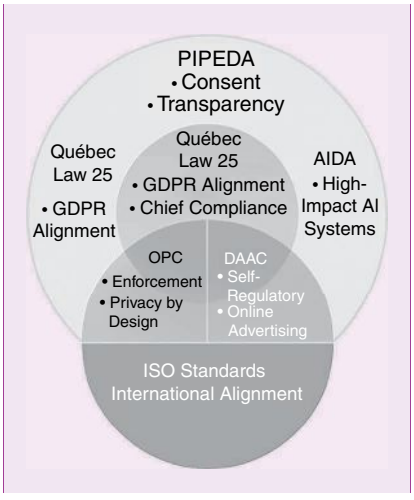

Figure 3: Canadian data compliance standards.

aligning with the dynamic pace of technological advancement [39], [40], [41].

However, AIDA's implementation poses technical and jurisdictional challenges, particularly for global organizations navigating PIPEDA and AIDA requirements [51], [52]. Clear guidelines, facilitation frameworks, and cooperation among government, industry, and civil society will be critical to ensure that compliance remains consistent with technological progress and societal values [40], [42].

Provincial Landscape

Federal and provincial laws shape Canada's data compliance landscape, creating complexity and inconsistency. Québec's Law 25 strengthens individual data rights, imposes stricter organizational requirements, and aligns with the GDPR's principles of transparency, consent, and accountability. It also formalizes the role of a chief compliance officer to oversee governance [43].

In contrast, Ontario's Digital Charter adopts a more flexible framework that balances innovation, economic growth, and privacy protection [44].

The division of jurisdiction between federal and provincial governments has resulted in a patchwork of standards. Although Québec enforces rigorous compliance, other provinces apply less-stringent rules, complicating data protection efforts [45].

Constitutional principles safeguard provincial autonomy, limiting federal authority to override provincial privacy laws, a conflict acknowledged by the Supreme Court of Canada [46].

This fragmented regulatory environment presents organizational operational challenges, increases costs, and complicates compliance. However, it also allows companies to integrate best practices from multiple jurisdictions, potentially leading to stronger data protection measures [47]. Moving forward, debates over federal–provincial harmonization will shape Canada's data privacy framework, with efforts to establish more uniform standards for consumers and businesses [48].

Canadian Institutions and Guidance

Canada's data compliance framework combines federal and provincial legislation, with PIPEDA as the foundation for regulating how private sector organizations collect, use, and disclose personal information. The DAAC supports consumer control over online behavioral advertising through self-regulatory programs [49], [50], [51].

The OPC enforces PIPEDA, offering guidance on best practices, transparency, and consumer data control. It also promotes privacy through design principles, embeds privacy into technological development, and encourages organizations to align with international standards, such as ISO guidelines, to strengthen data protection and ethical AI practices [52], [53]. As emerging technologies evolve, there is a growing call for more integrated regulation harmonized with global standards while accommodating Canada's unique regulatory environment. This requires continuous collaboration among government, industry, and civil society to keep compliance frameworks current and effective [54].

Discussion and Comparison

Canada has gone so far as to establish a solid legal framework in data protection, such as PIPEDA. However, Canada must adapt its policies to align with best practices worldwide as international standards evolve. The challenge lies in striking the correct balance between mandating innovation and data sharing and the need to preserve individuals' privacy rights. Over the last few years, the propagation of AI across industries has compelled the creation of technical architectures that integrate compliance by design. These types of architectures combine data governance, consent management, logging, auditing, traceability, and privacy-enhancing technologies (PETs) into the lifecycle of AI development to address international standards (e.g., the OECD AI Principles and the AIA) as well as Canada's principle-based regulatory framework (Table 1).

Lifecycle and Infrastructure Tools

The regulatory framework for AI systems is based on robust technical processes that enable transparency, accountability, and auditability throughout the model lifecycle. Reproducibility frameworks, strict model versioning, and scalable infrastructure are some of the most important elements. Reproducibility is the basis for trustworthy AI, where third-party auditing of model behavior and safety claims is possible. Regions cannot guarantee compliance or audit events without clear protocols for logging code, data preprocessing steps, hyperparameters, and runtime environments. Gundersen and Kjensmo [62] point to standardized experiment logging and environment encapsulation for addressing "research drift" in AI research. Pineau et al. [63] also recommend explicit "reproducibility checklists" for data versions, random seeds, and hardware configurations to help ensure consistency within the community. Using these practices in development pipelines makes regulatory submissions more solid and internal validation loops even quicker.

Model versioning aids reproducibility by providing high-fidelity traceability across successive refinements. Sculley et al. [64] employed "hidden technical debt" to characterize underestimated artifacts such as transformation scripts and feature stores that accrue when model lineage is not adequately tracked. ModelDB provides centralized registries for tracking model metadata, training code, and performance metrics, allowing audit teams to reproduce any deployed variant retrospectively. Subsequent platforms, such as MLflow, embed data, code, and environment dependency version control; automatically capture lineage and support rollbacks via compliance investigation.

AI infrastructure's compliance needs involve computation requirements and controls for governance across CI/CD pipelines, container orchestration, and secure logging. Containerization platforms (e.g., Docker and Kubernetes) offer deterministic environments under which the models run, and pipeline platforms enforce policy checks before deployment. In their case study, Amershi et al. [65] demonstrate how built-in testing suites and feature-flagged rollouts detect policy violations early on, reducing the chances of noncompliant AI reaching production. Tamper-evident audit trails and fine-grained access controls, mandated in most data protection regimes, must be baked into infrastructure layers to provide end-to-end visibility.

Canadian–global harmonization necessitates technical lifecycles to satisfy global standards and Canada's independent regulatory framework. Canada's AIDA also requires recordkeeping for high-impact systems, which requires demonstrating provable evidence of risk, validation results, and change logs before commercialization. Businesses with operations in both jurisdictions can tap into a single lifecycle platform to automate multi-regime compliance artifact generation, avoiding duplication while maintaining jurisdictional context. Table 2 summarizes the core concepts, tools, and Canadian applications related to reproducibility, model versioning, and compliance-focused infrastructure in AI.

Comparative Analysis

Canada's regulatory frameworks generally align with global models in intent but differ in scope and stringency. The federal privacy law, PIPEDA, is recognized as "adequate" under the GDPR, and allows cross-border personal data flows; however, Canada's laws are sectoral and fragmented, unlike the GDPR's unified omnibus structure. Scholars note that Canadian privacy law lacks national

Table 1: Technical measures for compliance in AI systems.

Technical Measure	Key Technologies/Approaches	Compliance Relevance	References
Data Governance	Policies and procedures, blockchain for transparency, and decentralized frameworks	Ensures adherence to legal/regulatory requirements (e.g., health care and finance) and improves accountability	[55]
Consent Management Systems	GDPR/CCPA-compliant platforms and adaptive governance models	Balances data sharing with privacy rights, which is essential for privacy law compliance	[56]
Logging and Auditing	Security information and event management and centralized log analysis	Creates audit trails, supports incident detection, and meets regulatory reporting requirements	[57], [58], [59]
Traceability	Distributed Ledger Technology and blockchain-based identity systems	Meets legal/industry standards (e.g., supply chain and identity verification) and enhances trust	[60]
PETs	Soft PETs: access control, differential privacy; hard PETs: onion routing and virtual private networks	Embeds Privacy by Design principles into systems and reduces reliance on trusted third parties	[61]

harmonization and updated emergency guidance, prompting proposals to align more closely with European standards [70], [71]. Procedural requirements, such as breach reporting and consent, may differ from EU practices, and traditionally softer enforcement could be strengthened through recent amendments that impose higher fines.

Although PIPEDA was historically equivalent to the EU standard, weaker individual rights and enforcement in Canada create divergence, risking future misalignment despite the adequacy status. Companies that handle EU data benefit from this adequacy but must monitor reforms like the proposed CPPA law to remain aligned with global norms (Table 3).

Canada's cybersecurity legislation is evolving. Bill C-26, the Critical Cyber Systems Protection Act (CCSPA), would impose duties on owners of "critical systems" such as telecom and energy, yet scholars describe it as a "patchwork approach" with weak penalties and limited oversight [72]. By contrast, the EU's NIS directives mandate extensive reporting, risk management, and enforcement across all critical sectors. Consequently, Canadian compliance obligations may be less rigorous than Europe's unified standards, requiring domestic entities to map CCSPA rules against international norms, including the EU's directives and upcoming Cyber Resilience Act, to ensure transnational compliance.

Strengths and Gaps in the Canadian Framework

The Canadian government has recognized the necessity of promoting innovation while ensuring that ethical values take precedence in formulating AI. This dual focus is evident through various initiatives to promote transparency, accountability, and equity in AI system development. For instance, working toward framing guidelines to guarantee ethics in AI suggests

Table 2: Key components of AI reproducibility and compliance infrastructure.

Aspect	Concept	Key Tools/Frameworks	Canadian Context	References
Reproducibility in AI	Ability to replicate AI model results for validation and reliability	JupyterLab, with a docker-based infrastructure, and standardized model formats	Adoption of reproducibility-focused infrastructures can improve trust in AI research and applications	[66]
AI Model Passport	Structured framework for traceability and transparency in AI models	Automated metadata collection and proper versioning systems	Can strengthen Canadian AI governance by ensuring model traceability	[67]
Infrastructure for AI Compliance	Technological and organizational resources are needed to ensure that AI meets standards	Flexible IT architectures and cloud-based infrastructures	Aligns with the Canadian trend toward robust, scalable cloud solutions	[68]
Cloud-based AI Frameworks	End-to-end lifecycle management platforms hosted on the cloud	Cloud frameworks (Hummer et al.) and compliance-focused cloud tools	Facilitates adherence to industry standards in Canadian AI initiatives	[69]

Table 3: A comparative analysis of Canadian and global regulatory frameworks.

Area/ Framework	Canada	Global Counterpart	Key Alignment Versus Divergence
Privacy/Data Protection	PIPEDA (federal and sectoral; "adequacy" with the EU)	EU GDPR	Canada is recognized as adequate (alignment) but has weaker individual rights and enforcement. Laws are sector specific versus the GDPR's uniform scope. Efforts are underway to harmonize.
Health Data	Sectoral health privacy laws; open science policies	EU GDPR plus national health data rules	Canada permits broad genomic data sharing under existing laws. EU/WHO guidelines offer more prescriptive protections, especially in emergencies. Canada's framework is less harmonized, potentially complicating cross-border research compliance.
Mobile Health (mHealth)	No dedicated app framework; general device rules only	U.S. FDA Pre-Cert program; EU medical device regulations	Canada lacks specific mHealth standards (divergence). The United States has a robust Pre-Cert program, and Europe applies risk-based device rules. Canadian developers have less regulatory clarity, so compliance steps differ markedly.
AI	Federal ADM Directive (applies only to the federal public sector)	EU AIA (all sectors, and risk-based rules)	The directive is narrow; the AIA is broad and stringent. Canada's approach focuses on fairness/legal principles in government use, while the EU imposes detailed obligations (transparency, risk management, and audits). There is a major divergence in scope and compliance requirements.
Cybersecurity	Proposed CCSPA	EU NIS1/NIS2 Directives	Canada's CCSPA targets critical systems but is critiqued as "patchwork," with weaker penalties. The EU's NIS rules enforce comprehensive security standards and incident reporting. Canadian rules will need harmonization to meet comparable compliance obligations.

WHO: World Health Organization; FDA: U.S. Food and Drug Administration.

Canada's focus on ensuring that AI technologies do not perpetuate biases or transgress human rights [73], [74]. Canada's regulatory design is constructed considering the flexibility to adapt as technology changes. Such flexibility is required in a field as dynamic as AI, where challenges and opportunities always crop up. The emphasis on stakeholder participation in the regulation process also makes the framework resilient because it accommodates a broad spectrum of views in decision making [54].

Critical gaps persist in the Canadian regulatory landscape. For instance, although Canada has advanced in the regulation of AI, the absence of a national vaccine injury compensation plan unearths a larger gap in health-related policies, conflicting with the proactive approach witnessed in AI regulation [75]. The gap also raises concerns regarding Canada's regulatory framework's comprehensiveness and ability to address emerging sector challenges. Canada's policy environment for AI continues to be under construction, and there are issues of simplicity and accessibility of the conditions for AI technologies to align, particularly concerning health applications. There has been an argument that there is a need for a simpler and better-accessible regulatory framework that can keep pace with the rapid development of AI technology and ensure public safety and ethics standards [54]. Table 4 summarizes Canada's key strengths and shortcomings in AI governance (Figure 3).

Challenges and Future Directions

Despite the emergence of AI governance regimes, a significant gap remains between transnational and national data compliance standards, causing uncertainty for developers and regulators. Although the EU's GDPR is considered an international benchmark, Canada's PIPEDA does not fully meet stringent requirements such as binary consent and the right to be forgotten, increasing legal fragmentation and complicating multinational AI system adjustments.

Operational challenges further hinder compliance. PETs, including federated learning, secure multiparty computation, and homomorphic encryption, face computational burdens and scalability issues. Multijurisdictional cloud infrastructures exacerbate real-time auditing, traceability, and accountability difficulties, which must comply with domestic and cross-border privacy standards.

Rapid AI development, especially in autonomous decision making and generative models, outpaces regulatory and compliance tools, increasing risks of unmonitored data processing, bias amplification, and opaque algorithmic decisions. Canadian reforms, such as the upcoming AIDA, aim to address these issues, but enforcement mechanisms and international interoperability remain nascent. Compliance alone cannot address social concerns; public trust depends on transparency, accountability, and ethical governance, particularly when explainability conflicts with confidentiality or trade secrets.

Future AI data governance will likely rely on integrating technical, legal, and ethical solutions into cohesive systems. This includes enhancing interoperability between Canadian and international frameworks through standardized application programming interfaces (APIs), mutual certification schemes, and cross-border audits. Research in privacy-preserving machine learning, adaptive legislation, and multistakeholder collaboration, including policymakers, technologists, ethicists, and civil society, will be essential for effective and socially acceptable compliance frameworks.

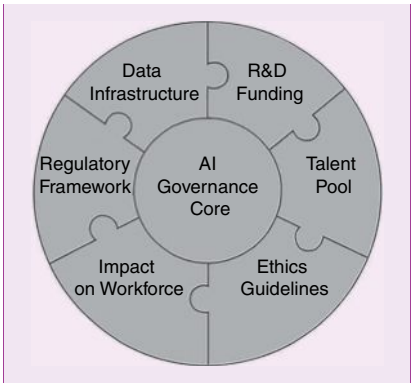

Figure 4: Canada's AI strengths and gaps.

Conclusion

This review demonstrated that Canada has made considerable progress in developing a legal and technical architecture for AI data compliance, spearheaded by PIPEDA and the imminent AIDA. A comparative reference demonstrated that Canadian accountability, transparency, and stakeholder participation principles contradict international best practices, particularly those reflected in the GDPR and the OECD AI Principles. Still, the Canadian model remains largely principle based and sectoral, leading to varying compliance expectations across industries and jurisdictions. This contrasts with the

Table 4: Strengths and gaps in Canada's AI regulatory framework.

Theme	Key Point	Strength/Gap	Details	Reference
Global Alignment	Adoption of principles aligned with global best practices	Strength	Positions Canada as a responsible player internationally, boosts credibility, and enables collaboration on AI initiatives	[76]
Public Engagement and Transparency	Inclusive stakeholder input in policy shaping	Strength	Government involves industry, academia, and civil society, fostering trust and ensuring that policies reflect citizens' values	[77], [78]
Ethical Commitment	Focus on fairness, accountability, and transparency	Strength	Meets global ethical AI demands and sets a positive international example	[79]
National Strategy	Lack of a cohesive AI implementation plan	Gap	AIDA is a good foundation, but integration across sectors like health care, finance, and transportation is missing	[54]
Adaptability to Change	Need for responsive regulation to tech advancements	Gap	Regulations risk is becoming outdated; ongoing evaluation and adaptation are required	[80]
Accountability Measures	Absence of specific roles and responsibilities for AI actors	Gap	Ethical focus exists, but a lack of enforceable accountability for developers and users weakens compliance	[81]

EU's more prescriptive, monistic model, which is more uniform in regulatory certainty and enforcement capacity.

Mechanisms such as consent management systems, PETs, reproducibility frameworks, and model versioning are technically becoming essential tools in Canadian and international environments. Such mechanisms incorporate compliance into the AI lifecycle to enable traceability, explainability, and accountability. Canada's adoption of such measures reflects an understanding of its critical role in ensuring trustworthy AI, yet the extent of implementation varies, and alignment with more mature international systems is a work in progress.

The provincial–federal divide in Canada adds further complexity, with provinces like Québec and Ontario each having strategies that sometimes complement and diverge from federal objectives. Although such plurality stimulates localized adaptation and innovation, it also creates a patchwork compliance environment that may render harmonization more challenging and impose additional operational burdens on organizations that function across provinces or internationally. The lack of a fully integrated cybersecurity regime, like that proposed in the recommended CCSPA, further underscores the need for greater national cohesion.

In an increasingly interdependent AI ecosystem, bridging technical AI development and emerging data compliance standards, is no longer an option but an imperative. The pace of AI development, particularly in generative and autonomous systems, tends to outstrip the development of legal and regulatory frameworks, increasing the likelihood of noncompliance, amplifying bias, and eroding public trust. To mitigate this, Canada must commit itself to continuous regulatory adaptation, informed by international benchmarks, technological advancement, and ethical imperatives.

A composite governance ecosystem, integrating technical controls, legal imperatives, and ethical guardrails, will be key to sustainable AI adoption. This means rationalizing legislation like AIDA to include more targeted enforcement levers and interoperability requirements and investing in the technical architecture that will facilitate cross-border compliance. Standard audit protocols, compliance APIs, and mutual recognition of certification could reduce fragmentation while enhancing trust among domestic and international stakeholders.

Canada's credibility as a trustworthy AI leader will depend on its ability to balance international alignment and domestic diversity so that innovation is not gained at the expense of fundamental rights. By expanding on its existing strengths, adaptability based on principles, ethical commitments, and inclusivity in policymaking, and addressing gaps in enforcement and technical readiness, Canada can join the forefront of global AI governance, innovation, and the highest possible data security and accountability standards. ■

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Commemorating Marconi's 150th Birthday on Signal Hill

by Joe Craig, Oscar De Silva, and Len Zedel
Memorial University of Newfoundland, St. John's, NL

The year 2024 marked the 150th anniversary of Guglielmo Marconi's birth, a series of events to commemorate his legacy, and the transatlantic experiment in particular. For the past several years, IEEE, Memorial University's Engineering and Science faculties, the Poldhu Amateur Radio Club, and the Marconi Radio Club of Newfoundland have united to commemorate Marconi's achievements. Other participants have included colleagues at Villa Griffone in Italy, Glace Bay in Nova Scotia, and Cape Cod in the United States.

For the 25 April birthday activities, a high-frequency transceiver and amplifier manufactured by the Marconi Company were used to complete contacts with sites of significance in the Marconi legacy, in particular highlighted by the usual camaraderie with Poldhu, operated by Callum Macleod at the site of the famous transatlantic transmitter.

On 12 December, we were delighted to be welcomed back to Signal Hill for the traditional reenactment at the Johnson Geo Centre by Andrea Van Nostrand and Kim Shipp. Prof. Len Zedel gave a captivating talk to teacher Natasha Hart's class of schoolchildren, including a demonstration of mechanical resonance, while Joe Craig listened on the radio, translating Morse code for the pupils. After their many questions, the students prepared to build their crystal radio sets using breadboards provided by David Green with kind support from IEEE. It was gratifying to see the children's astonishment as they listened to their radios when an aerial was connected. They were amazed that their creations, powered only by radio waves, functioned without needing batteries, computers, or mobile telephones.

Just before 12:30 p.m. local time, generally agreed to be the first moment when Marconi claimed with certainty to have heard the transatlantic signals in 1901, greetings were exchanged with collaborators in Villa Griffone with whom

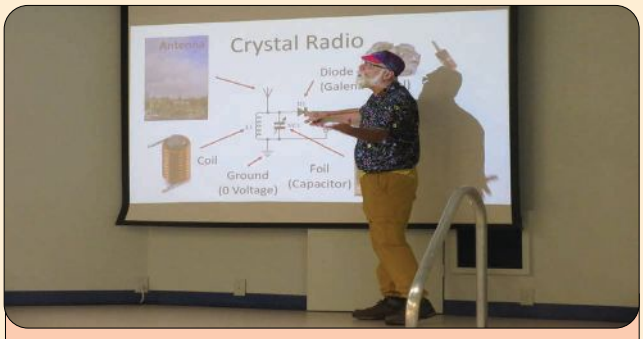


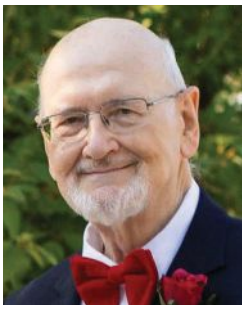
Figure 1: Prof. Len Zedel explains the workings of a crystal radio to the students.

Dr. Oscar De Silva sent greetings on behalf of IEEE, Cape Cod, and Glace Bay. We then listened for Poldhu. The signals were very weak, so we tried Morse code (CW). Fortunately, David Barlow's CW was perfectly readable. We were delighted to receive the letter "S" at 12:30. Conditions improved and we were able to resume voice (SSB) communications. Marconi often arranged wireless communications between dignitaries, and in keeping with this tradition, Dr. Zhang sent greetings to Poldhu on behalf of Dean Octavia Dobre of the Faculty of Engineering and Dr. De Silva on behalf of IEEE. We were pleased to receive greetings from Cliff Malcolm, secretary, and Carolyn Rule, chairperson of PARC, and to discuss commemorating forthcoming milestones in the Marconi legacy. This will include the 125th transatlantic anniversary in 2026.

Figure 2: Students and Marconi Group members at the Geo Centre on 12 December 2024. (Left to right): Natasha Hart (teacher), Joe Craig, VO1NA, students, Dr. Zhang (Faculty of Engineering and Applied Science), and Dr. Oscar De Silva (IEEE NL). Missing from photo are Michelle Craig, VO1RL, Frank Davis, VO1HP, Prof. Eric Gill, Andrea Van Nostrand, Geo Centre, Kim Shipp, Geo Centre, Dr. Siu O'Young, and Prof. Len Zedel.

Dr. Witold Kinsner

Dr. Witold Kinsner, Life Senior Member of IEEE, passed away peacefully on 28 April 2025, in Winnipeg, Manitoba, at the age of 80. He was a distinguished educator, visionary researcher, and a devoted contributor to the Canadian engineering community. His legacy spans more than five decades of academic excellence, professional leadership, and tireless advocacy for inclusive education.



Witold Kinsner

Born on 21 January 1945, in Edinburgh, Scotland, Witold spent his formative years in Poland before immigrating to Canada in 1970 to pursue graduate studies. He earned his Ph.D. degree in electrical engineering from McMaster University in 1974 and held academic appointments at McMaster and McGill before joining the University of Manitoba (UM). There, he helped establish the Computer Engineering program and served for more than 15 years as associate head of the department. He retired in June 2023 and was named professor emeritus.

Dr. Kinsner's research spanned cognitive informatics, computational intelligence, machine learning, cyber-physical security, and multiscale signal processing. His work found applications in biomedical devices, industrial monitoring, aerospace systems, and satellite technologies. He authored more than 500 publications, including nearly 300 conference papers, and held nine patents. He mentored nearly 80 graduate students and hundreds of undergraduates, leaving a lasting impact on the next generation of engineers.

He mentored nearly 80 graduate students and hundreds of undergraduates, leaving a lasting impact on the next generation of engineers.

His commitment to IEEE was profound. More than 30 years of service included roles as Winnipeg Section chair, Computer Chapter chair, co-editor of the *Canadian Journal of Electrical and Computer Engineering*, and organizer of numerous conferences. He served as IEEE Canada president (2016–2017), Region 7 director, and IEEE Vice-President for Educational Activities in 2018. He was a Life Senior Member of IEEE and a fellow of the Engineering Institute of Canada, Engineers Canada, and the Canadian Academy of Engineering.

Dr. Kinsner was deeply committed to outreach and education. He championed science, technology, mathematics, and engineering/science, technology, art, mathematics, and engineering initiatives; founded UM's team for the Canadian Satellite Design Challenge; and mentored Indigenous students through the Verna J. Kirkness Foundation and the ENGAP program. His contributions were recognized with multiple outreach awards, including the 2013 UM Dr. and Mrs. Ralph Campbell Outreach Award and 2021 Excellence in Engineering Education Award.

Even in his final months, Dr. Kinsner remained active in the IEEE community. As the keynote speaker at the 2024 IEEE Can-

Dr. Witold Kinsner

Dr Witold Kinsner, membre émérite à vie de l'IEEE, s'est éteint paisiblement le 28 avril 2025 à Winnipeg, Manitoba, à l'âge de 80 ans. Il fut un enseignant remarquable, un chercheur visionnaire, et un contributeur engagé au sein de la communauté canadienne du génie. Son héritage s'étend sur plus de cinquante années d'excellence académique, de leadership professionnel, et de militantisme infatigable en faveur d'une éducation inclusive.

Né le 21 janvier 1945 à Édimbourg, en Écosse, le Dr Witold a passé ses années de formation en Pologne avant d'immigrer au Canada en 1970 pour y poursuivre des études supérieures. Il a obtenu son doctorat en génie électrique à l'Université McMaster en 1974, puis a occupé des postes académiques à McMaster et à McGill avant de rejoindre l'Université du Manitoba (UM). À UM, il a contribué à la création du programme de génie informatique et a exercé les fonctions de directeur adjoint du département pendant plus de 15 ans. Il a pris sa retraite en juin 2023 et a été nommé professeur émérite.

Dr Kinsner a mené des recherches de pointe dans des domaines tels que l'informatique cognitive, l'intelligence computationnelle, l'apprentissage automatique, la cybersécurité des systèmes physiques et le traitement du signal à échelle multiple. Ses travaux ont trouvé des applications dans les dispositifs biomédicaux, la surveillance industrielle, les systèmes aérospatiaux et les technologies satellitaires. Il est l'auteur de plus de 500 publications, dont près de 300 communications scientifiques, et détenteur de neuf brevets. Il a encadré près de 80 étudiants aux cycles supérieurs et des centaines d'étudiants de premier cycle, laissant une empreinte durable sur plusieurs générations d'ingénieurs.

Son engagement envers l'IEEE fut remarquable. Pendant plus de 30 ans, il a occupé des rôles clés : président de la section de Winnipeg, président du chapitre informatique, coéditeur de la *Revue canadienne de génie électrique et informatique*, et organisateur de nombreuses conférences. Il a également été président d'IEEE Canada (2016–2017), directeur de la Région 7, et vice-président de l'IEEE pour les activités éducatives en 2018. Il était membre émérite à vie de l'IEEE et fellow de l'Institut canadien du génie, d'Ingénieurs Canada et de l'Académie canadienne du génie.

Le Dr Kinsner s'est profondément investi dans la sensibilisation et l'éducation. Il a défendu les initiatives STIM (sciences, technologie, ingénierie et mathématiques) ainsi que STIAM (sciences, technologie, ingénierie, arts et mathématiques). Il a fondé l'équipe de l'Université du Manitoba pour le Canadian Satellite Design Challenge et a encadré des étudiants autochtones par l'intermédiaire de la Fondation Verna J. Kirkness et du programme ENGAP. Ses contributions ont été reconnues par de nombreux prix de rayonnement, notamment le Prix de rayonnement *Dr et Mme Ralph Campbell de l'UM* (2013) et le *Prix d'excellence en enseignement du génie* (2021).

Même dans ses derniers mois, il est resté actif au sein de la communauté IEEE. En tant que conférencier principal au *IEEE Canada Students Congress 2024* à Winnipeg, il a su inspirer les jeunes ingénieurs par son énergie, sa sagesse et son optimisme inébranlable. Sa présence illuminait la salle, reflet de son esprit indomptable et de son dévouement.

ada Students Congress in Winnipeg, he inspired young engineers with his energy, wisdom, and unwavering optimism. His presence lit up the room, a testament to his enduring spirit and dedication.

Witold is survived by his wife Jean, children Michael (Jasmine) and Kathleen (William), grandchildren Winston and Tilly, step-granddaughter Allura, and extended family. The family extends heartfelt thanks to CancerCare Manitoba, the Palliative Care Program, and Riverview Health Centre for their compassionate support.

Dr. Kinsner will be remembered not only for his scholarly achievements but for his humanity, mentorship, and unwavering belief in education as a force for good. His legacy lives on in the students he inspired, the institutions he shaped, and the future he helped build. ■

Witold laisse dans le deuil son épouse Jean, ses enfants Michael (Jasmine) et Kathleen (William), ses petits-enfants Winston et Tilly, sa belle-petite-fille Allura, ainsi que sa famille élargie. La famille exprime sa profonde gratitude à *CancerCare Manitoba*, au *Programme de soins palliatifs* et au *Riverview Health Centre* pour leur soutien empreint de compassion.

Le Dr Kinsner restera dans les mémoires non seulement pour ses réalisations scientifiques, mais aussi pour son humanité, son mentorat et sa foi indéfectible en l'éducation comme vecteur de progrès. Son héritage perdure à travers les étudiants qu'il a inspirés, les institutions qu'il a façonnées et l'avenir qu'il a contribué à bâtir. ■

Witold Kinsner in memory.

IMPORTANT UPDATES

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IEEE CANADA ACHIEVEMENTS AWARDS

A.G.L. MCNAUGHTON AWARD
for exemplary contributions to the engineering profession

R.A. FESSENDEN AWARD
for important contributions to the field of telecommunications engineering

P.D. ZIOGAS ELECTRIC POWER AWARD
for important contributions to the field of electric power engineering

C.C. GOTLIEB COMPUTER AWARD
for important contributions to the field of computer engineering and science

OUTSTANDING ENGINEER AWARD
for outstanding contributions to electrical and electronics engineering

J.M. HAM OUTSTANDING ENGINEERING EDUCATOR AWARD
for outstanding contributions to engineering education

ROBERT H. TANNER INDUSTRY LEADERSHIP AWARD
for important leadership contributions in Canadian industry where there is significant activity in areas of interest to IEEE

IEEE CANADA SERVICE AWARDS

E.F. GLASS WESTERN CANADA MERIT AWARD
for meritorious service in western Canada at the local IEEE Section and Area level

M.B. BROUGHTON CENTRAL CANADA MERIT AWARD
for meriterious service in central Canada at the local IEEE Section and Area level

J.J. ARCHAMBAULT EASTERN CANADA MERIT AWARD
for meriterious service in eastern Canada at the local IEEE Section and Area level

W.S. READ OUTSTANDING SERVICE AWARD
for outstanding and sustained service to IEEE Canada and the Institute

Programme des Prix

Prix de l'IEEE Canada

IEEE CANADA ACHIEVEMENTS AWARDS

PRIX A.G.L. MCNAUGHTON
pour les contributions exceptionnelles aux circuits, aux systèmes et au traitement du signal, ainsi que pour son leadership dans l'enseignement du génie

PRIX R.A. FESSENDEN
pour les contributions à l'analyse de la capacité et aux techniques d'optimisation pour les communications multi-utilisateurs et la planification d'accès aléatoire massif

PRIX P.D. ZIOGAS D'ÉNERGIE ÉLECTRIQUE
pour les contributions aux systèmes de conversion électronique de puissance pour les applications en énergies renouvelables

PRIX C.C. GOTLIEB D'INFORMATIQUE
pour les contributions à l'interaction homme-machine et au suivi de la qualité de l'expérience utilisateur

PRIX D'INGÉNIEUR EXCEPTIONNEL
pour les contributions à la photonique intégrée sub-longueur d'onde, appliquée au multiplexage en longueur d'onde, à la spectrométrie et à la détection

PRIX J.M. HAM D'ÉDUCATEUR EXCEPTIONNEL EN GÉNIE
pour les contributions exceptionnelles à la formation de la relève en ingénierie dans les domaines des systèmes numériques et des logiciels

PRIX ROBERT H. TANNER DU LEADERSHIP DANS L'INDUSTRIE
pour le leadership dans la modernisation des systèmes de distribution d'électricité et leur résilience, efficacité et sécurité

IEEE CANADA SERVICE AWARDS

PRIX DE MÉRITE E.F. GLASS DE L'OUEST DU CANADA
pour le leadership et ses contributions à la section IEEE de la Saskatchewan Sud, à la région Ouest d'IEEE Canada et à IEEE Canada

PRIX DE MÉRITE M.B. BROUGHTON DU CENTRE DU CANADA
pour le leadership et ses contributions à la section IEEE de London, à la région centrale d'IEEE Canada et à IEEE Canada

PRIX DE MÉRITE J.J. ARCHAMBAULT DE L'EST DU CANADA
pour le leadership et les contributions à la section IEEE d'Ottawa, à la région de l'Est d'IEEE Canada et à IEEE Canada

PRIX W.S. READ POUR SERVICE EXCEPTIONNEL
pour le leadership et ses contributions à la section IEEE d'Ottawa et à IEEE Canada, ainsi que pour son engagement envers IEEE Women in Engineering

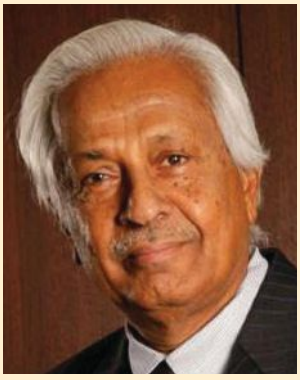
A.G.L. MCNAUGHTON AWARD
PRIX A.G.L. MCNAUGHTON

For important contributions to the Engineering Profession.
Pour ses contributions exceptionnelles aux circuits, aux systèmes et au traitement du signal, ainsi que pour son leadership dans l'enseignement du génie.

Srikanta M. N. Swamy

Dr. M.N. Srikanta Swamy (Fellow, IEEE) is a Concordia trailblazer who helped shape Gina Cody School of Engineering and Computer Science during his career of advancing research and supporting generations of students for over 60 years. Currently, he is a Research Professor and an Honorary Concordia Research Chair. Swamy served as the founding chair of Department of Electrical Engineering from 1970 to 1977, and dean of the Faculty of Engineering and Computer Science from 1977 to 1993. During his tenure as Dean, Swamy helped establish new undergraduate programs, such as Canada's only Building Engineering program and the first Computer Engineering program in Quebec.

He has published more than 350 journal articles in high quality journals in circuits, systems and signal processing, a large number of papers at conferences, holds five patents and has co-authored nine books. Swamy has supervised more than 50 PhD theses and mentored over 70 PDFs and research associates, more than 10 of whom have



been elected as IEEE Fellows, a tribute to the quality of his mentorship.

He is a Fellow of many professional societies, including IEEE, CAE, EIC and AAAS. Swamy has served as the Editor-in-chief of the Circuits, Systems and Signal Processing (CSSP) journal since 1999. He has served IEEE CAS society in many roles including being the Editor-in Chief of IEEE Transactions on Circuits and Systems (1999–2001) and President (2004).

He is a recipient of many IEEE CAS Society awards, including the Education Award, Golden Jubilee Medal and its highest honor, the Mac Van Valkenburg Award. He is also the recipient of IEEE Millenium Medal and IEEE Montreal Section Gold Medal. ■

Le Dr. M.N. Srikanta Swamy (Fellow, IEEE) est un pionnier de l'Université Concordia, où il a joué un rôle clé dans le développement de l'École d'ingénierie et d'informatique Gina-Cody.

Il a consacré plus de 60 ans à la recherche et à la formation d'étudiants.

Actuellement professeur de recherche et titulaire d'une chaire honoraire, il a été président fondateur du département de génie électrique (1970–1977) et doyen de la Faculté de génie et d'informatique (1977–1993). Durant son mandat, il a lancé des programmes innovants, dont le premier programme de génie du bâtiment au Canada et le premier programme de génie informatique au Québec.

Auteur de plus de 350 articles scientifiques et titulaire de cinq brevets, il a supervisé plus de 50 thèses de doctorat et formé plus de 70 chercheurs postdoctoraux.

Durant son mandat, il a lancé des programmes innovants, dont le premier programme de génie du bâtiment au Canada et le premier programme de génie informatique au Québec.

Le Dr. Swamy est Fellow de l'IEEE, de l'Académie canadienne du génie et de plusieurs autres sociétés prestigieuses. Il est rédacteur en chef de Circuits, Systems and Signal Processing depuis 1999 et a occupé des postes de leadership au sein de l'IEEE. Il a reçu de nombreuses distinctions, dont le Mac Van Valkenburg Award et la médaille du millénaire de l'IEEE. ■

R.A. FESSENDEN AWARD
PRIX R.A. FESSENDEN

For important contributions to the field of Telecommunications Engineering.
Pour ses contributions à l'analyse de la capacité et aux techniques d'optimisation pour les communications multi-utilisateurs et la planification d'accès aléatoire massif.

Wei Yu

Wei Yu (Fellow, IEEE) is a Professor and Canada Research Chair in Information Theory and Wireless Communications in the Electrical and Computer Engineering Department at the University of Toronto. He received the B.A.Sc. degree in computer engineering and mathematics from the University of Waterloo, and M.S. and Ph.D. degrees in electrical engineering from Stanford University.

Professor Wei Yu made fundamental contributions to the information theoretical capacity analysis of multiuser communication systems and to the development of optimization techniques for the wireless cellular communications and broadband access networks.

Prof. Wei Yu received numerous awards for his research, including the IEEE Communications 0Theory Society Joint Paper Award in 2024, the IEEE Communications Society Award for Advances in Communication in 2019, the IEEE Marconi Prize Paper Award in Wireless Communications in 2019, the IEEE Communications Society Best Tutorial Paper Award in 2015, and the IEEE Signal Processing Society Best Paper Award in 2021, 2017 and 2008.

Prof. Wei Yu served as the President of the IEEE Information Theory Society in 2021. He was a recipient of a Steacie Memorial Fellowship and has been recognized as a Highly Cited Researcher. He is a Fellow of IEEE and a Fellow of the Canadian Academy of Engineering. ■

Wei Yu (Fellow, IEEE) est professeur et titulaire d'une Chaire de recherche du Canada en théorie de l'information et en communications sans fil au sein du département de génie électrique et informatique de l'Université de Toronto. Il est diplômé en génie informatique et mathématiques de l'Université de Waterloo, et détient une maîtrise (M.S.) ainsi qu'un doctorat (Ph.D.) en génie électrique de l'Université Stanford.

Prof. Wei Yu a apporté des contributions fondamentales à l'analyse théorique de la capacité en théorie de l'information pour les systèmes de communication multi-utilisateurs, ainsi qu'au développement de techniques d'optimisation pour les réseaux cellulaires sans fil et les réseaux d'accès à haut débit. Le professeur Yu a reçu de nombreux prix prestigieux pour ses travaux de recherche, notamment le prix conjoint IEEE Communications Society and Information Theory Society Joint Paper Award en 2024, le IEEE Communications Society Award for Advances in Communication en 2019, le IEEE Marconi Prize Paper Award in Wireless Communications en 2019, le IEEE Communications Society Best Tutorial Paper Award en 2015 ainsi que le IEEE Signal Processing Society Best Paper Award en 2021, 2017 et 2008.

En 2021, il a assumé la présidence de l'IEEE Information Theory Society.

Il a également été récipiendaire de la Bourse commémorative Steacie et figure parmi les chercheurs les plus cités dans son domaine. Il est Fellow de l'IEEE et membre de l'Académie canadienne du génie. ■

P.D. ZIOGAS ELECTRIC POWER AWARD
PRIX P.D. ZIOGAS D'ÉNERGIE ÉLECTRIQUE

For important contributions to the field of Electric Power Engineering.
Pour ses contributions aux systèmes de conversion électronique de puissance pour les applications en énergies renouvelables.

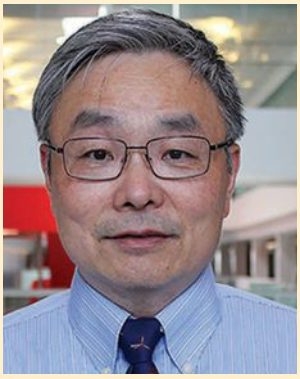
Yan-Fei Liu

Dr. Yan-Fei Liu (IEEE Fellow, 2013; CAE Fellow, 2018) received his bachelor's and master's degrees from Zhejiang University, China, in 1984 and 1987, and his Ph.D. from Queen's University, Canada, in 1994. He was a Technical Advisor at Nortel Networks in Ottawa from 1994 to 1999. Since 1999, he has been with the Dept. of ECE at Queen's University, where he is a full professor.

Dr. Liu's research interests include the modeling, control, and topology of power electronics systems, and the applications in electric vehicle (EV) power systems, data center power, renewable energy systems, and consumer electronics.

Among his recognitions are the IEEE PELS Modeling and Control Achievement Award (2017) and the Queen's Prize for Excellence in Research (2020).

His research has been disseminated in more than 300 IEEE journal and conference papers. He is also



the inventor of 75 issued U.S. patents and the author of one book. Among his recognitions are the IEEE PELS Modeling and Control Achievement Award (2017) and the Queen's Prize for Excellence in Research (2020).

Dr. Liu's major service to IEEE includes serving as a Member-at-Large of the IEEE Awards Policy and Portfolio Review Committee, Chair of the IEEE Medal in Power Engineering Selection Committee, General Chair of the 2019 IEEE Energy Conversion Congress and Exposition (ECCE), Vice President of Technical Operations for the IEEE Power Electronics Society (PELS), and Founding Editor of the IEEE Journal of Emerging and Selected Topics in Power Electronics (JESTPE). ■

Le Dr Yan-Fei Liu, Fellow de l'IEEE (2013) et Fellow de l'ACE (2018), est professeur titulaire au département de génie électrique et informatique de l'Université Queen's, où il travaille depuis 1999. Titulaire d'un baccalauréat et d'une maîtrise de l'Université Zhejiang (Chine), ainsi que d'un doctorat de l'Université Queen's (Canada), il a été conseiller technique dans la division des systèmes d'alimentation avancés chez Nortel Networks de 1994 à 1999.

Ses recherches portent sur la modélisation, le contrôle et les topologies des systèmes électroniques de puissance, avec des applications dans les véhicules électriques, les centres de données, les énergies renouvelables et l'électronique grand public. Il a publié plus de 300 articles dans des revues et conférences IEEE et est l'inventeur de 75 brevets américains. Il est également l'auteur d'un livre.

Le Dr Liu a reçu plusieurs distinctions, dont le prix IEEE PELS Modeling and Control Achievement Award (2017) et le prix d'excellence en recherche de l'Université Queen's (2020). Il a occupé des rôles de leadership au sein de l'IEEE, y compris comme rédacteur en chef fondateur de IEEE Journal of Emerging and Selected Topics in Power Electronics et président général de la conférence IEEE ECCE 2019. ■

C.C. GOTLIEB COMPUTER AWARD
PRIX C.C. GOTLIEB D'INFORMATIQUE

For important contributions to the field of Computer Engineering and Science.
Pour ses contributions à l'interaction homme-machine et au suivi de la qualité de l'expérience utilisateur.

Tiago Henrique Falk

Tiago H. Falk (Fellow, IEEE) is a Full Professor at the Institut national de la recherche scientifique (INRS), University of Quebec, where he directs the Multisensory Signal Analysis and Enhancement Laboratory. He is also co-director of the new INRS-UQO Joint Research Unit on Cybersecurity and Digital Trust. Prof. Falk's research interests are on the development of secure and sustainable multimodal human-machine interfaces, with applications in real and virtual environments.

Prof. Falk's work has resulted in numerous awards, including the 2024 NSERC Synergy Award for Innovation, the Sigma Xi Research Society Young Innovator Award, the Canadian Medical and Biological Engineering Society Young Investigator Award, nine Best Paper awards at leading international conferences and journals, and was listed in the Quebec

Science Magazine's list of Top-10 Quebec Technologies in 2023.

Prof. Falk is a Fellow of the IEEE and of the AAIA, is a member-at-large of the Board of Governors of the IEEE Systems, Man, and Cybernetics (SMC) Society, co-chair of the IEEE Future Directions Initiative on Telepresence, and co-chair of the IEEE SMC Technical Committee on Brain-Machine Interface Systems. He is Editor-in-Chief of the SMC eNewsletter and an Associate Editor for IEEE TRANSACTIONS ON HUMAN-MACHINE SYSTEMS. ■

Tiago H. Falk (Fellow, IEEE) est professeur titulaire à l'Institut national de la recherche scientifique (INRS), Université du Québec, où il dirige le Laboratoire d'analyse et d'amélioration des signaux multisensoriels. Il est également codirecteur de l'unité mixte de recherche INRS-UQO sur la cybersécurité et la confiance numérique. Les recherches du professeur Falk portent sur le développement d'interfaces humain-machine multimodales sûres et durables, avec des applications dans des environnements réels et virtuels.

Les travaux du professeur Falk ont été récompensés par de nombreux prix, notamment le Prix Synergie pour l'innovation du CRSNG en 2024, le Prix « Young Innovator Award » du Sigma Xi Research Society, le Prix « Young Investigator Award » de la Société canadienne de génie biomédical, neuf prix du meilleur article décernés lors de conférences et de revues internationales, et ont figuré dans la liste des 10 meilleures technologies québécoises en 2023 établie par le Québec Science Magazine.

Le professeur Falk est Fellow de l'IEEE et de l'AIAA, membre du conseil des gouverneurs de l'IEEE Systems, Man, and Cybernetics Society (SMCS), coprésident de l' IEEE Future Directions Initiative sur la téléprésence et coprésident du comité technique de l'IEEE SMCS sur les systèmes d'interface cerveau-machine.

Il est rédacteur en chef de la lettre électronique de la SMCS et rédacteur en chef adjoint de L'IEEE TRANSACTIONS ON HUMAN-MACHINE SYSTEMS. ■

OUTSTANDING ENGINEER AWARD
PRIX D'INGÉNIEUR EXCEPTIONNEL

For important contributions to Electrical and Electronics Engineering.
Pour ses contributions à la photonique intégrée sub-longueur d'onde, appliquée au multiplexage en longueur d'onde, à la spectrométrie et à la détection.

Pavel Cheben

Dr. Pavel Cheben (Fellow, IEEE) is a Principal Research Officer at the National Research Council (NRC) of Canada. He is also an Honorary Professor at the University of Malaga and an Adjunct Professor at the University of Ottawa, Carleton University, McMaster University, and the University of Zilina.

Dr. Cheben is best known for his work in subwavelength silicon photonics, pioneering a new field of research that merges metamaterial technology with integrated photonics. He has co-authored more than 830 publications, 44 patent applications, and over 350 invited presentations.

Dr. Cheben is an International Fellow of the Royal Academy of Engineering (UK) and a Fellow of the IEEE, Royal Society of Canada, SPIE, Optica, American Physical Society, European Optical Society, Institute of Physics, Engineering Institute of Canada, and Canadian Academy of Engineering.

He is also the recipient of the Order of the Slovak Republic, the IEEE Photonics Society Engineering Achievement Award, the SPIE Maria Goeppert Mayer Award, the International Prize of the Slovak Academy of Sciences, the Government of Canada's Public Service Excellence Award, the NRC Research Excellence Award, and the NRC Industrial Achievement Award.

Dr. Cheben is the most published scientist at NRC Canada for the past 18 years. ■

Le Dr. Pavel Cheben (Fellow, IEEE) est chercheur principal au Conseil national de recherches du Canada (CNRC). Il est également professeur honoraire à l'Université de Malaga, ainsi que professeur associé aux universités d'Ottawa, Carleton, McMaster et Zilina.

Le Dr Cheben est surtout reconnu pour ses travaux pionniers en photonique de silicium à sous-longueur d'onde, qui ont permis l'émergence d'un nouveau domaine de recherche combinant les métamatériaux à la photonique intégrée. Il est coauteur de plus de 830 publications, a déposé 44 demandes de brevet et a donné plus de 350 conférences invitées.

Il est membre international de la Royal Academy of Engineering (Royaume-Uni), ainsi que Fellow de l'IEEE, de la Société royale du Canada, du SPIE, d'Optica, de l'American Physical Society, de l'European Optical Society, de l'Institute of Physics, de l'Engineering Institute of Canada et de l'Académie canadienne du génie.

Le Dr Cheben est le chercheur le plus publié du CNRC Canada au cours des 18 dernières années.

Au cours de sa carrière, il a reçu de nombreuses distinctions prestigieuses, notamment l'Ordre de la République slovaque, le IEEE Photonics Society Engineering Achievement Award, le prix Maria Goeppert Mayer de la SPIE, le prix international de l'Académie slovaque des sciences, ainsi que le Prix d'excellence en service public, le Prix d'excellence en recherche et le Prix d'excellence industrielle du CNRC.

Le Dr Cheben est le chercheur le plus publié du CNRC Canada au cours des 18 dernières années. ■

J.M. HAM OUTSTANDING ENGINEERING EDUCATOR AWARD
PRIX J.M. HAM D'ÉDUCATEUR EXCEPTIONNEL EN GÉNIE

For outstanding contribution to Engineering Education.
Pour ses contributions exceptionnelles à la formation de la relève en ingénierie dans les domaines des systèmes numériques et des logiciels.

Jason Anderson

Dr. Jason Anderson is a Professor of Electrical and Computer Engineering (ECE) at the University of Toronto (UofT) and holds the Jeffrey Skoll Endowed Chair. Professor Anderson received the 2019 Faculty Teaching Award from the Faculty of Applied Science and Engineering, UofT, and has received seven ECE departmental awards for excellence in undergraduate teaching. He was founding Director of the minor program in Artificial Intelligence (AI) Engineering and a Faculty Affiliate of the Vector Institute for AI.

His research focusses on design methodologies, architectures and circuits for coarse-grained reconfigurable arrays (CGRAs) and field-programmable gate arrays (FPGAs).

He is an inventor on 30 U.S. patents and has co-authored over 100 peer-reviewed journal and conference articles. Dr. Anderson served as Associate Editor for IEEE Transactions on Circuits and Systems-II, and ACM Transactions on Design Automation of Electronic Systems.

He was Program Chair for the 2017 ACM International Symposium on FPGAs,

and General Chair for the 2015 IEEE International Conference on Application-Specific Systems, Architectures.

Professor Anderson spent 10 years at Xilinx, working on automated synthesis methods for FPGAs. More recently, Prof. Anderson co-founded LegUp Computing, a startup launched from his group's high-level synthesis research. LegUp was acquired by Microchip in 2020.

Prof. Anderson completed his graduate work (Ph.D. and M.A.Sc.) at UofT and received his undergraduate degree from the University of Manitoba. He is a Professional Engineer (P.Eng.), ACM Member and a Fellow of the IEEE. ■

Jason Anderson est professeur de génie électrique et informatique à l'Université de Toronto (UofT) et titulaire de la chaire Jeffrey Skoll. En 2019, il a reçu le Faculty Teaching Award de l'UofT et sept prix départementaux pour son excellence dans l'enseignement de premier cycle. Il a également fondé le programme mineur en génie de l'intelligence artificielle (AI Engineering) et est membre affilié du Vector Institute for AI.

Ses recherches portent sur la conception, les architectures et les circuits pour les coarse-grained reconfigurable arrays (CGRAs) et les field-programmable gate arrays (FPGAs). Inventeur de 30 brevets et coauteur de plus de 100 articles scientifiques, il a été rédacteur associé pour des revues de renom telles que IEEE Transactions on Circuits and Systems-II et

Il a également fondé le programme mineur en génie de l'intelligence artificielle (AI Engineering) et est membre affilié du Vector Institute for AI.

ACM Transactions on Design Automation of Electronic Systems.

Ancien employé de Xilinx, où il a développé des méthodes de synthèse automatisées pour les FPGAs, il a cofondé LegUp Computing, une start-up acquise par Microchip en 2020. Le professeur Anderson détient un M.A.Sc. et un Ph.D. de l'UofT et un baccalauréat de l'Université du Manitoba. Il est ingénieur professionnel (P.Eng.), membre de l'ACM et Fellow de l'IEEE. ■

ROBERT H. TANNER INDUSTRY LEADERSHIP AWARD
PRIX ROBERT H. TANNER DU LEADERSHIP DANS L'INDUSTRIE

For important leadership contributions in Canadian industry where there is significant activity in areas of interest to IEEE.
Pour son leadership dans la modernisation des systèmes de distribution d'électricité et leur résilience, efficacité et sécurité.

Vinay Sharma

Dr. Vinay Sharma is the former CEO of London Hydro Inc., where he worked for 26 years before retiring in September 2024. Prior to becoming CEO in July 2009, Vinay served as Vice President of Customer Services and Strategic Planning.

Under his leadership, London Hydro Inc. achieved significant milestones, including substantial growth in corporate value, capital investment, grid modernization, and leadership in technology and innovation. These accomplishments enhanced the reliability and resilience of the grid while reducing system losses. His thought leadership in technology and innovation earned London Hydro several national and international recognitions. Dr. Sharma's dedicated efforts led to the development of the first community net metering and a micro-grid in London.

These accomplishments enhanced the reliability and resilience of the grid while reducing system losses.

Before his tenure at London Hydro, Dr. Sharma worked at SaskPower from 1991 to 1998 in Distribution System Planning, Power Procurement, and Customer Services. He also taught in the Department of Electrical Engineering at the University of Saskatchewan.

Vinay earned his bachelor's degree in electrical engineering from Punjab Engineering College, Chandigarh, India. He holds an M.Sc. and Ph.D. in electrical engineering from the University of Saskatchewan, Saskatoon, and an MBA from the University of Regina. He is a Chartered Director, life member of PEO and APEGA, and a Fellow of the Canadian Academy of Engineering. ■

M. Vinay Sharma est l'ancien président-directeur général de London Hydro Inc., où il a œuvré pendant 26 ans avant de prendre sa retraite en septembre 2024. Avant sa nomination comme PDG en juillet 2009, il a occupé les fonctions de vice-président des services à la clientèle et de la planification stratégique. Sous sa direction, London Hydro a connu une croissance remarquable de sa valeur corporative, accompagné d'investissements majeurs en capital, d'une modernisation du réseau et d'un rôle de chef de file en matière de technologie et d'innovation. Ces avancées ont permis d'améliorer la fiabilité et la résilience du réseau électrique, tout en réduisant les pertes d'énergie. Son leadership visionnaire a valu à London Hydro de nombreuses distinctions nationales et internationales, notamment pour le développement du premier système communautaire de comptage net et d'un micro-réseau à Londres (Ontario).

Ces avancées ont permis d'améliorer la fiabilité et la résilience du réseau électrique, tout en réduisant les pertes d'énergie.

Avant son passage à London Hydro, M. Sharma a travaillé chez SaskPower de 1991 à 1998, au sein des équipes de planification des réseaux de distribution, d'approvisionnement énergétique et de services à la clientèle. Il a également enseigné au département de génie électrique de l'Université de la Saskatchewan.

M. Sharma est titulaire d'un baccalauréat en génie électrique du Punjab Engineering College à Chandigarh (Inde), d'une maîtrise et d'un doctorat en génie électrique de l'Université de la Saskatchewan, ainsi que d'un MBA de l'Université de Regina. Il est administrateur agréé, membre à vie des ordres professionnels PEO et APEGA, et Fellow de l'Académie canadienne du génie. ■

E.F. GLASS WESTERN CANADA MERIT AWARD
PRIX DE MÉRITE E.F. GLASS DE L'OUEST DU CANADA

For meritorious service in Western Canada at the local IEEE Section and Area level.
Pour son leadership et ses contributions à la section IEEE de la Saskatchewan Sud, à la région Ouest d'IEEE Canada et à IEEE Canada.

Kin-Choong Yow

Dr. Kin-Choong Yow obtained his B.Eng (Elect) with 1st Class Honours from the National University of Singapore in 1993, and his Ph.D. from the University of Cambridge, UK in 1998.

He joined the University of Regina in September 2018, where he is presently a Professor in the Faculty of Engineering and Applied Science. His research interest is in Artificial General Intelligence and Smart Environments, and he has published over 120 top quality international journal and conference papers and secured over $2 million in research grants.

Dr. Kin-Choong Yow joined the IEEE South Saskatchewan Section ExCom in 2020 as the Section Secretary. He then served as the Section Chair from 2022 to 2023, and while he was Section Chair, he led the section to win the IEEE MGA Outstanding Small Section Award 2023.

This is the first time since 2017 that any section from Region 7 won the IEEE MGA Outstanding Section Award. In addition, the value that he had added to the IEEE membership created a large interest in membership, leading to the Section being awarded the IEEE Outstanding Membership Retention and Recruitment Performance Award 2023, one of only four sections in IEEE Canada to be awarded both in that year. ■

Le Dr. Kin-Choong Yow a obtenu un baccalauréat en génie électrique avec mention 1re classe de l'Université nationale de Singapour en 1993, puis un doctorat de l'Université de Cambridge (Royaume-Uni) en 1998. Il a rejoint l'Université de Regina en septembre 2018, où il est actuellement professeur à la Faculté de génie et des sciences appliquées. Ses recherches portent sur l'intelligence artificielle générale et les environnements intelligents. Il est l'auteur de plus de 120 publications de haut niveau dans des revues et conférences internationales, et il a obtenu plus de 2 millions de dollars en subventions de recherche.

Le Dr Yow s'est joint en 2020 au comité exécutif de la section IEEE du Sud de la Saskatchewan à titre de secrétaire de section. Il a ensuite été élu président de section pour la période 2022–2023. Sous sa direction, la section a remporté le prestigieux IEEE MGA Outstanding Small Section Award 2023, une première pour une section de la Région 7 depuis 2017. Son leadership a également eu un impact important sur l'engagement des membres, ce qui a suscité un intérêt marqué pour l'adhésion à l'IEEE. Cette dynamique a conduit à l'obtention du IEEE Outstanding Membership Retention and Recruitment Performance Award 2023. La section du Sud de la Saskatchewan a ainsi été l'une des quatre seules sections de l'IEEE Canada à recevoir ces deux distinctions au cours de la même année. ■

M.B. BROUGHTON CENTRAL CANADA MERIT AWARD
PRIX DE MÉRITE M.B. BROUGHTON DU CENTRE DU CANADA

For meriterious service in Central Canada at the local IEEE Section and Area level.
Pour son leadership et ses contributions à la section IEEE de London, à la région centrale d'IEEE Canada et à IEEE Canada.

Ahmed Refaey Hussein

Ahmed Refaey Hussein, Ph.D., SMIEEE, is a Professor of Computer Engineering at the University of Guelph, Canada. He holds a B.Sc. and M.Sc. in Electrical Engineering from Alexandria University, Egypt, and a Ph.D. in Electrical and Computer Engineering from Laval University, Canada. Dr. Hussein has a diverse career spanning telecommunications and academia, having worked with industry leaders like Fujitsu, Vodafone, and Alcatel-Lucent. He also held senior positions at Mircom Technologies Ltd. and Manhattan University.

Dr. Hussein has authored over 100 peer-reviewed publications and filed four patents. A recognized expert in cybersecurity, he co-developed the SDP architecture and contributed to the development of risk frameworks for zero-trust cloud environments. He is an active IEEE leader, serving in key editorial roles and on the

technical committees of major conferences, including CCECE, GLOBECOM, and ICC.

A recipient of the IEEE ComSoc North American Exceptional Service Award, Dr. Hussein is also a prominent contributor to international research and secure design initiatives under the USA CHIPS Act. His work bridges the gap between AI-enabled systems and secure communication, and he continues to mentor the next generation of engineers globally. ■

Ahmed Refaey Hussein, Ph.D., SMIEEE, est professeur en génie informatique à l'Université de Guelph, après avoir obtenu ses diplômes de baccalauréat et de maîtrise en génie électrique de l'Université d'Alexandrie (Égypte) et un doctorat en génie électrique et informatique de l'Université Laval (Canada). Il a débuté sa carrière professionnelle dans le secteur des télécommunications, en travaillant pour Fujitsu, Vodafone et Alcatel-Lucent, avant de se tourner vers la recherche académique, d'abord au Laboratoire LRTS de l'Université Laval, puis à l'Université Western. Il a également occupé le poste d'architecte principal des systèmes chez Mircom Technologies Ltd.

Dr. Hussein est l'auteur de plus de 100 publications et détient quatre brevets. Il a reçu plusieurs distinctions, dont le prix du service exceptionnel de l'IEEE ComSoc pour l'Amérique du Nord. Il a contribué à

Il a contribué à des projets importants en cybersécurité et à la Cloud Security Alliance, co-développant l'architecture SDP et des outils d'analyse d'API.

des projets importants en cybersécurité et à la Cloud Security Alliance, co-développant l'architecture SDP et des outils d'analyse d'API.

Il siège au comité directeur de la feuille de route MAPT du Semiconductor Research Corporation et est actif au sein de l'IEEE, ayant occupé des rôles de leadership dans plusieurs conférences majeures. Son expertise contribue à la recherche sur les systèmes de communication sécurisés et l'intelligence artificielle, tout en encadrant la prochaine génération d'ingénieurs. ■

J.J. ARCHAMBAULT EASTERN CANADA MERIT AWARD
PRIX DE MÉRITE J.J. ARCHAMBAULT DE L'EST DU CANADA

For meriterious service in Eastern Canada at the local IEEE Section and Area level.
Pour son leadership et les contributions à la section IEEE d'Ottawa, à la région de l'Est d'IEEE Canada et à IEEE Canada.

Amir Andaliby Joghataie

Amir Andaliby is an IEEE Senior Member and committed volunteer based in Ottawa, Ontario. His work spans software development, network engineering, teaching, and service to the engineering profession—blending deep technical expertise with a strong commitment to community and collaboration.

As a Software Architect at Nokia, Amir has contributed to the design and testing of complex infrastructure systems, with a focus on automation, DevOps, and high-performance solutions. His emphasis on quality and innovation has consistently led to streamlined workflows and robust product delivery.

In parallel, his role as an Adjunct Professor at Algonquin College enables him to mentor and guide emerging engineers, creating engaging learning environments that support both academic and professional development.

Within IEEE, Amir has held key leadership roles advancing strategic planning, industry partnerships, and community outreach—driving initiatives that revitalized member engagement and strengthened IEEE's presence across academic and professional circles in Eastern Canada.

Beyond IEEE, Amir collaborates with universities, industry partners, and municipal organizations to create meaningful opportunities for students and professionals. As an honorary member of IEEE-HKN, he exemplifies the values of leadership, mentorship, and service that define the spirit of the J.J. Archambault Award. ■

Amir Andaliby est membre senior de l'IEEE et bénévole engagé, basé à Ottawa, en Ontario. Son parcours professionnel couvre le développement logiciel, l'ingénierie des réseaux, l'enseignement et l'engagement envers la profession d'ingénieur, alliant une expertise technique approfondie à un fort esprit de collaboration et de service communautaire.

À titre d'architecte logiciel chez Nokia, Amir a contribué à la conception et à la validation de systèmes d'infrastructure complexes, en mettant l'accent sur l'automatisation, les pratiques DevOps et les solutions à haute performance. Son souci constant de la qualité et de l'innovation a permis l'optimisation des flux de travail et la fiabilité de la livraison des produits.

Parallèlement, il agit comme professeur adjoint au Collège Algonquin, où il encadre la nouvelle génération d'ingénieurs dans un cadre d'apprentissage stimulant favorisant leur développement académique et professionnel.

Au sein de l'IEEE, Amir a occupé des postes de leadership clés, axés sur la planification stratégique, les partenariats industriels et les initiatives de mobilisation communautaire. Ses efforts ont permis de revitaliser l'engagement des membres et de renforcer la présence de l'IEEE dans les milieux universitaires et professionnels de l'Est canadien.

En dehors de l'IEEE, Amir collabore activement avec des universités, des entreprises technologiques et des organismes municipaux afin de créer des occasions concrètes pour les étudiants et les professionnels en génie. En tant que membre honoraire de l'IEEE-HKN, il incarne les valeurs de leadership, de mentorat et de service, qui sont au cœur de l'esprit du Prix J.J. Archambault. ■

W.S. READ OUTSTANDING SERVICE AWARD
PRIX W.S. READ POUR SERVICE EXCEPTIONNEL

For outstanding and sustained service to IEEE Canada and the Institute.
Pour son leadership et ses contributions à la section IEEE d'Ottawa et à IEEE Canada, ainsi que pour son engagement envers IEEE Women in Engineering.

Winnie Ye

Dr. Winnie Ye is a Fellow of Optica and the Engineering Institute of Canada, and a Full Professor at Carleton University. She was a Canada Research Chair (Tier II) in Nano-scale IC Design for Reliable Opto-Electronics and Sensors (2009–2021) and specializes in silicon photonics with applications in telecommunications, data communication, biophotonics, and renewable energy.

Dr. Ye earned her B.Eng. in Electrical Engineering from Carleton University, followed by an M.A.Sc. and Ph.D. in Electrical and Computer Engineering from the University of Toronto and Carleton. She was an NSERC postdoctoral fellow at MIT and Harvard University before joining Carleton as a faculty member in 2009.

Her contributions have been recognized with prestigious awards, including the 2025 Optica Robert E. Hopkins Leadership Award, 2021 IEEE MGA Leadership Award, 2020 Partners in Research

National Technology and Engineering Ambassador Award, and the 2018 IEEE Women in Engineering Inspiring Member Award. She has also received multiple teaching and research excellence awards.

Beyond research and teaching, Dr. Ye has held key leadership roles, including Chair of Optica's Photonics and Opto-Electronics Technical Division (2021–2023). She is currently the Chair of IEEE Women in Engineering (2025–2026) and an elected member of the IEEE Photonics Society Board of Governors. ■

La Dre Winnie N. Ye, Fellow d'Optica, de l'Institut canadien des ingénieurs (EIC) et Senior Member de l'IEEE, est professeure titulaire à l'Université Carleton, où elle dirige le Laboratoire de photonique micro/nano en silicium. Elle a été titulaire de la Chaire de recherche du Canada en conception de circuits intégrés à l'échelle nanométrique pour l'optoélectronique et les capteurs de 2009 à 2021. Ses recherches se concentrent sur la photonique sur silicium, avec des applications dans les télécommunications, la biophotonique et les énergies renouvelables.

Titulaire d'un baccalauréat en génie électrique de l'Université Carleton, d'une maîtrise et d'un doctorat en génie électrique et informatique de l'Université de Toronto et de Carleton, elle a également été boursière

La Dre Ye a reçu de nombreux prix, dont le Robert E. Hopkins Leadership Award (2025) et le IEEE MGA Leadership Award (2021).

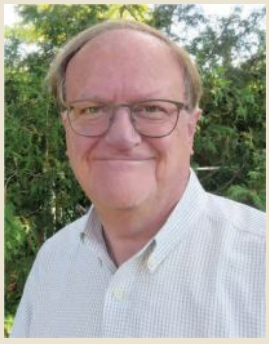
postdoctorale au MIT et à l'Université Harvard avant de rejoindre Carleton en 2009.

La Dre Ye a reçu de nombreux prix, dont le Robert E. Hopkins Leadership Award (2025) et le IEEE MGA Leadership Award (2021). Elle a occupé des fonctions de leadership dans plusieurs organisations professionnelles, dont la présidence de la division technique en photonique d'Optica (2021–2023). Elle est également la présidente mondiale de IEEE Women in Engineering (2025–2026). ■

IEEE Canadian Foundation
La Fondation Canadiene de L'IEEE

2024 YEAR IN REVIEW—We want to thank you again and recognize your support to the IEEE Canadian Foundation in 2024. Each gift has an impact on future generations and current practitioners, and is managed to meet the highest expectations of donor intentions.

Donations from individuals and organizations were $21,167 to General Fund programs, $42,850 to designated funds, and $15,000 to new enduring endowments. All programs continued for support of the IEEE Canada community, despite the disruptions to student, academic, industry and professional life.



Our Mission—Your gifts enhance the learning experience for electrical, electronics and computer engineering students across Canada with our programs of McNaughton Centres and Scholarships.

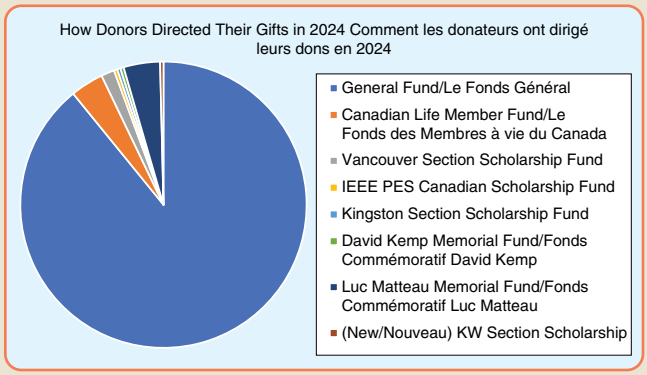
Students and other recipients also benefit through the cofunding of special projects that develop engineering enthusiasm and skills at all levels. Increasingly, these projects use technology for the benefit of humanity. "Success Stories" on our website, the monthly IEEE Canada newsletter, and in this magazine demonstrate the wide range of technical, professional, and development opportunities that your gifts support.

Our General Fund is crucial to our ability to operate each and every year, and your undirected donations allow us to keep our base strong.

Our Endowed Funds support a wide range of awards, prizes, and scholarships. Please consider a directed donation to endow a new IEEE Canada award of your choosing.

Donor Impact—Gifts may be designated to any one of the following funds of the IEEE Canadian Foundation.

- **General Fund**—supports IEEE McNaughton Learning Resource Centres across Canada, related scholarships, and special grants
- **Canadian Life Members Fund**—supports activities of interest to Life Members, potential engineers, and engineering students
- **Technology for Humanity Fund**—supports new and innovative projects that seek to apply technology for the benefit of humanity



BILAN DE L'ANNÉE 2024—Nous tenons à vous remercier encore une fois et à rcconnaître votre soutien à la Fondation canadienne de l'IEEE en 2024. Chaque don a un impact sur les générations futures et les praticiens actuels et aussi est géré pour rédpondre aux attentes les plus élévees des intentions des donateurs.

Les dons de particuliers et d'organismes ont été 21 167 $ aux programmes du Fonds général, 42 850 $ aux programmes désignés et 15 000 $ aux nouvelles dotations durables. Tous les programmes se sont poursuivis pour soutenir la communauté IEEE Canada.

Notre mission—Vos dons améliorent l'expérience d'apprentissage des étudiants en électricité, en électronique et en génie informatique à travers le Canada grâce à nos programmes de centres McNaughton et de bourses.

Les étudiants et les autres bénéficiaires bénéficient également du cofinancement de projets spéciaux qui développent l'enthousiasme et les compétences en ingénierie à tous les niveaux. De plus en plus, ces projets utilisent la technologie au profit de l'humanité. Les «histoires de réussite» sur notre site Web, le bulletin mensuel de l'IEEE Canada et dans ce magazine illustrent le large éventail d'opportunités techniques, professionnelles et de développement que vos dons soutiennent.

Notre fonds général est crucial pour notre capacité a fonctionner chaque année, et vos dons non dirigés nous permettent de maintenir notre base solide. Nos fonds de dotation soutiennent un large éventail de récompenses, prix et bourses. Veuillez considérer un don dirigé pour doter un nouveau prix de l'IEEE Canada prix de votre choix.

Impact des donateurs—Les dons peuvent être attribués à l'un des fonds suivants de la Fondation Canadienne de l'EEE:

- **Le Fonds général**—soutient les centres de ressources d'apprentissage McNaughton de l'IEEE à travers le Canada, les bourses d'études connexes et les subventions spéciales
- **Le Fonds des Membres à vie du Canada**—soutient les activités qui intéressent les membres à vie, les ingénieurs potentiels et les étudiants en génie
- **Fonds Technologie pour l'humanitê**—soutient des projets nouveaux et innovants qui cherchent à appliquer la technologie au profit de l'humanité
- **Vancouver Section Scholarship Fund**—soutient les bourses accordées par la section Vancouver de l'IEEE
- **La Fondation canadienne de l'IEEE Nick Cercone Graduate Scholarship in Computer Science Fund**—soutient une bourse en informatique, un domaine d'études intéressant l'IEEE
- **Le Fonds de bourses d'études de la section de Kingston**—soutient les bourses accordées par la section de Kingston de l'IEEE
- **La Bourse annuelle de premier cycle Raymond D. Findlay**—soutient une bourse nationale reconnaissant le leadership et le professionnalisme
- **Fonds commémoratif Dave Kemp**—perpétue la mémoire de Dave en soutenant les programmes de l'IEEE qui correspondent à ses passions - y compris les jeunes professionnels et les étudiants au Canada.

- **Vancouver Section Scholarship Fund**—supports scholarships awarded by the IEEE Vancouver Section
- **The IEEE Canadian Foundation Nick Cercone Graduate Scholarship in Computer Science Fund**—supports a scholarship in computer science, a field of studies of interest to IEEE
- **Kingston Section Scholarship Fund**—supports scholarships awarded by the IEEE Kingston Section
- **Raymond D. Findlay Annual Undergraduate Scholarship**—supports a national scholarship recognizing leadership and professionalism
- **Dave Kemp Memorial Fund**—perpetuates Dave's memory by supporting IEEE programs that match his passions, including Young Professionals and students in Canada
- **The IEEE Canadian Foundation Dr. John Bandler Graduate Scholarship in Engineering Design Fund**—supports a national scholarship in microwave and millimetre-wave engineering, imaging, inverse-scattering, engineering design optimization, or space mapping
- **Luc Matteau Memorial Fund**—perpetuates Luc's memory by supporting IEEE programs that match his passions.
- **(New) Terry Branch Scholarship Fund**—perpetuates a national scholarship aligned with his enthusiasm for student growth.

Donate

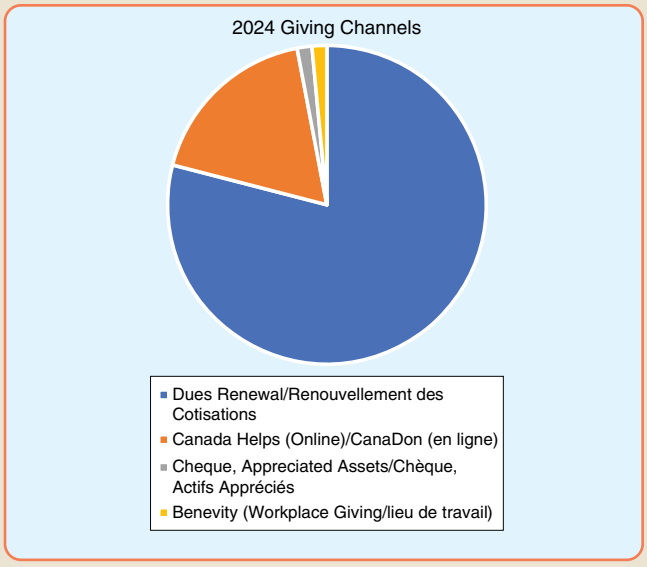
Looking ahead—We appreciate your past support and urge you to continue to do so and increase your contributions where possible. If you have not yet made a donation, please join your peers—this is your opportunity to stand with others who choose to make a difference. We could do so much more with your financial support. All the different ways to give and donor recognition programs are fully described on our website.

The IEEE Canadian Foundation wants to hear from you—if we can better engage and support our community, please let us know at info.ieeecanadianfoundation@ieee.ca.

Many IEEE members in Canada contribute to the all-volunteer effort that is the IEEE Canadian Foundation, including the invaluable assistance of Anader Benyamin-Seeyar, Dan Coode, John Mowbray and many others in the preparation of this 2024 Honour Roll of Donors.

Yours sincerely,

David H. Whyte
President,
IEEE Canadian Foundation
https://www.ieeecanadianfoundation.org



- **Bourse de la Fondation canadienne de l'IEEE Dr. John William Bandler d'études supérieures en conception technique**—soutient une bourse nationale reconnaissant en ingénierie des micro-ondes et des ondes millimétriques, en imagerie et en diffusion inverse; en optimisation de la conception technique; ou en cartographie spatiale
- **Fonds commémoratif Luc Matteau**—perpétue la mémoire de Luc en soutenant les programmes de l'IEEE qui correspondent à ses passions
- **(Nouveau) Fonds de bourse Terry Branch**—perpétue une bourse nationale alignée avec son enthousiasme pour la croissance des étudiants

Faire un don

Regarder vers l'avant—Nous apprécions votre soutien passé et vous exhortons à continuer de donner et d'augmenter vos contributions dans la mesure du possible. Si vous n'avez pas encore fait de don, veuillez vous joindre à vos pairs - c'est l'occasion de vous tenir aux côtés de ceux qui choisissent de faire la différence. Nous pourrions faire bien plus avec votre soutien financier. Toutes les différentes façons de donner et les programmes de reconnaissance des donateurs sont décrits en détail sur notre site Web.

La Fondation canadienne de l'IEEE veut vous entendre - si nous pouvons mieux engager et soutenir votre communauté, veuillez nous le faire savoir. Vous pouvez me contacter à info.ieeecanadianfoundation@ieee.ca

De nombreux membres de l'IEEE au Canada contribuent à l'effort de bénévolat de la Fondation canadienne de l'IEEE, y compris l'aide inestimable de Anader Benyamin-Seeyar , Dan Coode, John Mowbray et de nombreuses autres personnes pour pépeparer ce tableau d'honneur des donateurs 2024.

Cordialement,

David H. Whyte
President,
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https://www.ieeefondationcanadienne.org

The 2024 investments of $98,430 allocated in support of the IEEE Canada community:

- five IEEE Canadian Foundation Scholarships
- 11 IEEE Canadian Foundation Special Grants
- five McNaughton Learning Resource Centre Grants
- one IEEE Canada Women in Engineering Prize
- one Alden Scholarship
- one Findlay Scholarship
- one Gargantini–Strybosch Scholarship
- seven IEEE Canada Award Medals
- three Vehicular Technology Awards
- one IEEE Canada Student Training Workshop
- seven other endowed Section awards and scholarships.

Investissements 2024 de 98 430 $ alloués au soutien à la communauté IEEE Canada:

- Cinq bourses de la Fondation canadienne de l'IEEE
- Onze subventions spéciales de la Fondation canadienne de l'IEEE
- Cinq subventions de Centres de ressources éducatives McNaughton
- Une prix IEEE Canada Femme en génie
- Une bourse Alden
- Une bourse Findlay
- Une bourse Gargantini-Strybsosh
- Sept médailles IEEE Canada
- Trois Prix Technologies véhiculaires de l'IEEE Canada
- un atelier de formation des étudiants de l'IEEE Canada
- Sept autres prix et bourses sont proposés.seven other endowed Section awards and scholarships.

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Tableau d'honneur des donateurs 2024

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Chaque don fait une différence. Le tableau d'honneur reconnaît officiellement ceux qui font des dons de 25 $ ou plus. La fondation remercie également les donateurs qui ne sont pas listés.

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In 2025, this Fund opened for on-line giving directly to the IEEE Canadian Foundation via Canada Helps. Those donors will be recognized in the 2025 Honour Roll of Donors.

En 2025, ce Fonds a été ouvert pour des dons en ligne directement à la Fondation canadienne de l'IEEE via Canada Helps. Ces donateurs seront reconnus dans le Tableau d'Honneur des Donateurs de 2025.

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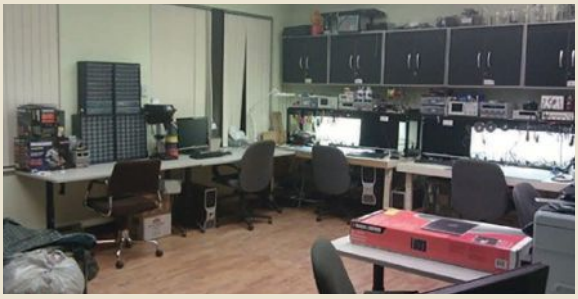

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From Research Labs to Remote Communities: MUN's Global Impact

by Godfred Atinkum

At the heart of Memorial University of Newfoundland (MUN) lies a recognized commitment of one of Canada's premier universities to advancing research that not only serves its communities but also extends benefits to the wider global society. One such initiative is the research toward providing clean and alternative energy solutions to various communities in Africa and Asia.

Energy poverty remains one of the most pressing challenges facing the developing world. Millions of people in sub-Saharan Africa, parts of Asia, and South America still live without reliable access to electricity. In these regions, the absence of sustainable power limits opportunities in education, health care, and economic development. Addressing this challenge requires innovative, context-specific solutions that combine technical feasibility with economic viability. This is an area where Canadian expertise and research at MUN are making a tangible difference.

This article shares a summary of a recent work by researchers at MUN. It focuses on a technoeconomic analysis of a renewable energy-based microgrid designed for a remote community in Ghana, highlighting its potential to improve electricity access and sustainability in remote areas [1]. The study aims to

- design a microgrid system optimized for Azizakpe's energy needs and renewable resource availability.
- conduct a cost–benefit analysis to evaluate the economic feasibility of the system.
- perform sensitivity analyses on key variables like fuel price, inflation, and renewable resource availability.
- assess the impact of load variations and efficiency improvements on system performance.

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Challenges of Energy Access in Ghana

The International Energy Agency estimates that approximately 600 million people in the sub-Saharan Africa region live without electricity [2]. Ghana, being a country in the region, is not untouched by it either, with 14.9% of its population lacking access, according to a 2022 World Bank report. Most of these people reside in rural, remote, and inaccessible communities, mostly around Lake Volta. These communities rely on diesel generators and kerosene lamps, which are inefficient and environmentally harmful. The absence of electricity affects education, health care, and local business investments. In addition, the lack of electricity in rural areas of Ghana significantly hampers socioeconomic development and quality of life. This situation has led to different government initiatives like the National Electrification Scheme and the Ghana Energy Development and Access Project, which aim for 100% electrification [3]. Despite these efforts from government and international partners, progress remains uneven. To bridge this gap, research into context-specific solutions, such as the most cost-effective technologies and optimal microgrid configuration, is required.

Renewable Energy Solutions for Electrification

In remote and hard-to-reach communities where grid extension is technically challenging or economically not feasible, stand-alone microgrids serve as the alternative solution.

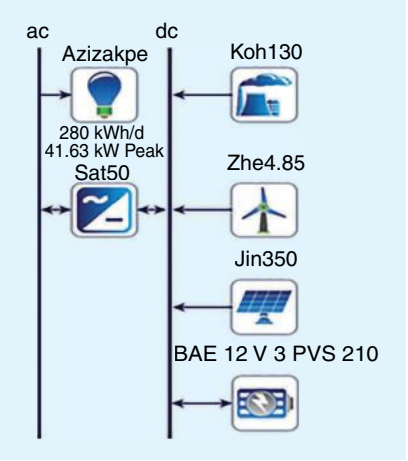

Figure 1: Proposed system architecture.

They are well suited for small-scale power generation and distribution, making them effective in meeting the modest yet essential energy needs of rural and remote communities. Microgrids can reliably power infrastructure such as lighting, cooking, water pumps, and refrigeration, which are essential for improving the living standards and economic activities of local communities. Moreover, microgrids reduce dependence on fossil fuels, can provide energy security, and allow for localized planning and management. By utilizing locally available resources, microgrids can integrate multiple generation sources into a hybrid, thereby offering high reliability, flexibility, and low-cost systems tailored to the specific needs and local conditions of remote communities. Another advantage of microgrids is their ability to operate independently or connect to the utility grid, with stand-alone systems preferred in remote areas.

Technoeconomic Design of a dc Microgrid

This study presents a comprehensive design and analysis of a renewable-energy-based microgrid for a remote community in Ghana, focusing on economic feasibility and environmental impact. Here we present some key highlights of this work:

- The study emphasizes the need for context-specific solutions to optimize technology and configuration for rural electrification.
- In existing literature, and to the best of my knowledge, research in using HOMER to size and design dc microgrids for remote and island communities tends to focus on isolated case studies. Emphasis is placed on either technical performance, economic feasibility, or a combination of both. However, these studies often adopt a narrow perspective, overlooking comprehensive models that consider dynamic load conditions.
- This study thus 1) models multiple load levels and 2) implements efficiency packages to assess how the proposed system responds to changes in load levels, seasonal load variations, and user behaviour.

Resource Availability and Community Profile

The study focuses on Azizakpe, an island community in Ghana with significant renewable energy potential. Azizakpe is located on Lake Volta at a latitude of 5°46'39.6"N and a longitude of 0°39'48.9"E. The town has a population of roughly 590 people, who are engaged primarily in farming and fishing [4]. The average annual daily solar irradiation is 5.06 kWh/m^2/day, with an average wind speed of 4.79 m/s, indicating strong potential for PV and wind energy generation. The community's energy consumption is estimated at 2.5 kWh/day per household, primarily from lighting, refrigeration, and fans.

Component Modeling and System Design

Based on the resources available on site, the proposed microgrid combines solar, wind, a diesel generator, and battery energy storage systems (BESSs) as the optimum system configuration.

- *Solar PV system*: Jinko JKM 350M-72 panels with a rated capacity of 350 W and efficiency of 18%.
- *Wind turbine*: Zhejiang Huaying model with a rated power of 4.85 kW and a cut-in wind speed of 3 m/s.
- *BESS*: BAE Secura 12 V with a maximum capacity of 201 Ah and round-trip efficiency of 85%.
- *Diesel generator*: Sized to serve as a backup, with an initial capital cost of $8,528.78 and a lifetime of 15,000 h.

HOMER Pro is employed to size and simulate the hybrid dc system. The following optimal component sizes were determined after running a series of simulations: solar: 102 kW; wind: 24.3 kW; diesel generator: 30 kW; converter: 50 kW; and battery: 289 kWh. The total annual energy production is 207,827 kWh, with a renewable fraction of 98.6%. The estimated yearly CO_2 emissions are 1,488 kg, indicating environmental friendliness.

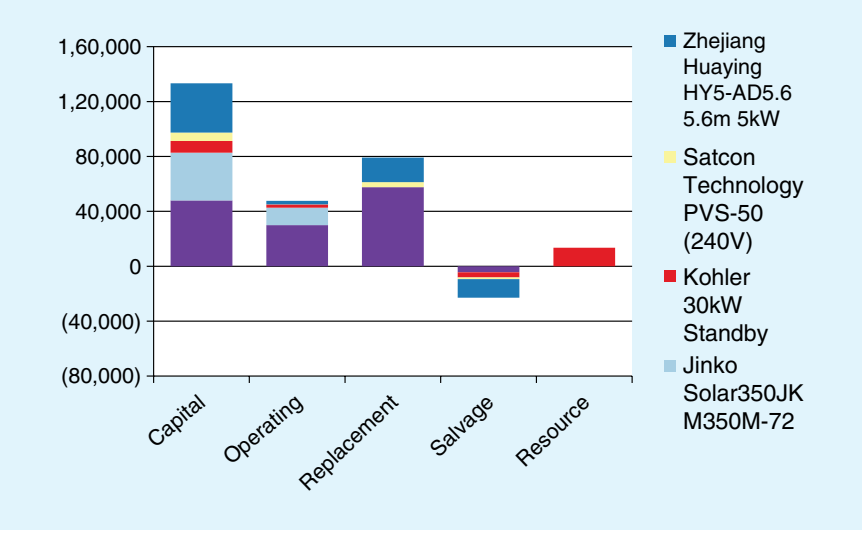

Figure 2: Cash flow of proposed system.

Economic Analysis and Cost Parameters

The economic viability of the microgrid is assessed through various cost metrics. The cost parameter used is the net present cost (NPC), which includes capital, replacement, and operational costs over the project's lifetime. The system's capital, net present, and operating costs are $133,275, $250,689, and $4,696.54, respectively. Additionally, the levelized cost of energy (LCOE) is $0.09812, with a simple payback period of approximately seven years and a 35.4% return on investment. Finally, key economic indicators reveal a high renewable fraction of 98.6% and a minimal unmet electrical load of 0.0017%.

Sensitivity Analysis of Key Variables

The sensitivity analysis, otherwise known as *what-ifs*, reveals how various factors impact the system's performance and costs, highlighting its robustness. Next is a summary of the sensitivity analyses conducted on the system:

- Increasing wind speed (3.83 m/s to 5.75 m/s) reduces fuel consumption, LCOE, operating cost, and NPC.
- Higher GHI penetration reduces the number of wind turbines, lowering LCOE and NPC.
- Higher inflation rates lead to lower COE but higher NPC.
- BESS annual throughput decreases with rising inflation and fuel prices.
- Minimum state of charge (SoC) impacts operations and maintenance costs and NPC, with significant increases beyond 20% SoC.

Load and Efficiency Impact on the System

The system's adaptability to varying load conditions is analyzed, indicating its resilience to changes in demand and efficiency.

- The system can handle a 30% increase in load demand and efficiency.

- Increased load efficiency reduces yearly energy consumption and operating costs.
- Higher load demand leads to increased operating costs and reduced renewable fraction.
- Excess generation waste occurs with higher load efficiency, impacting LCOE and the component's lifespan

Conclusions and Future Directions

The study concluded that the proposed microgrid system is a viable solution for rural electrification, emphasizing sustainability and reliability. It also investigated the impact of efficiency packages and load increments on the proposed system performance. Next are some of the key findings from the study:

- Optimal component sizes include a 102-kW PV, 24.3-kW wind, a 30-kW DG, and 120 battery units.
- Economic metrics indicate a solid investment with a favorable payback period.
- Environmental analyses confirm the system's low emissions and high renewable fraction.
- Future strategies could further minimize environmental impact through intelligent load management and optimized BESS utilization.

In conclusion, this work exemplifies how Canadian research extends beyond national borders to address global challenges. By publishing studies and developing solutions such as renewable-energy-based microgrids for communities around the world, MUN demonstrates the role of academia in advancing knowledge that is globally impactful. ■

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About the Author

Godfred Atinkum received his Bachelor of Science degree in electrical and electronics engineering from the Kwame Nkrumah University of Science and Technology, Ghana, in 2022. Following his undergraduate studies, he worked as a graduate electrical engineer at AngloGold Ashanti (AGA), Obuasi Mine, from 2022 to 2023. During his time at AGA, he was involved in the maintenance and optimization of electrical systems in a large-scale mining environment, strengthening his foundation in power systems, safety standards, and real-world engineering applications. He is currently pursuing his Master of Engineering degree in electrical and computer engineering at Memorial University of Newfoundland (MUN), Canada. At MUN, he is a research student of Prof. Md Tariq Iqbal and Prof. John E. Quaicoe, where his work centers on the design and analysis of renewable energy systems.

IEEE Canadian Foundation
Philanthropy Framework Enhancing IEEE Interests in Canada

In essence, the separation of a technical/professional association and its charitable partner allows for better risk management, more focused fundraising, and clearer operational structures, all while ensuring that charitable funds are used for their intended purposes.

Approved in 1993 by the Canada Revenue Agency (CRA) as a charity and public foundation, we transformed from International Electrical and Electronics Conference Inc., a Toronto activity, were later joined by Montreal Conferences Inc., and formalized our practices of grant making.

Today, the IEEE Canadian Foundation supports one IEEE and will engage with any IEEE initiative where there is mutual opportunity, albeit primarily with IEEE Canada as a Region, and its Sections and members.

Legal and Structural Separation

- Technical/professional associations are typically incorporated as nonprofit corporations or similar entities focused on member services, networking, education, certifications, and so on.
- These associations often do not have charitable status and thus cannot issue official donation receipts or receive certain kinds of tax-exempt gifts.
- Establishing a separate charitable entity, usually a registered charity (including a public foundation), creates a distinct legal corporation responsible for charitable activities, enabling compliance with charitable laws, avoiding regulatory conflicts, and protecting resources.
- Separation ensures clarity for regulators, donors, and the public about how charitable funds are used, complying with legal rules that charity resources be used exclusively for charitable purposes without "blurring" them with association activities.

Fundraising and Tax Advantages

- Charities are granted the ability to issue official donation receipts for Canadian income tax purposes, which is a major incentive for donors to contribute.
- Some donors, other foundations, and government grant programs only fund Canadian registered charities, not nonprofit associations, unincorporated groups, or foreign entities.
- Having a separate registered charity expands fundraising capabilities beyond what the technical/professional association can typically achieve.

Distinct Operational and Financial Activities

- Charitable organizations often undertake programming or educational activities with public benefit goals that differ in scope and purpose from the association's member-centric activities.
- A separate charity can manage and hold charitable assets (such as endowments or real estate) and be structured to protect these assets from the liabilities or risks associated with the association's operational activities.
- Foundations and charitable partners can provide funding grants to the parent association or related projects, creating complementary roles (operating versus funding).

Governance and Compliance Requirements

- Canadian charities face stringent rules on governance, use of funds, and reporting, which can conflict or complicate governance if merged inside a technical/professional association.
- Separating the charity as its own entity allows clear governance lines and helps fulfill CRA expectations about charity independence. Our all-Canadian directors are obliged to act in the best interests of the IEEE Canadian Foundation.
- This separation also limits liability risks for the association from charitable activities and vice versa.

Flexibility and Strategic Planning

- Multiple corporate entities allow the overall organization (association plus charity) to undertake diverse activities with appropriate tax and regulatory treatment.
- This allows flexibility to balance what might be considered excess surpluses of the association to be transformed into enduring charitable benefit to the community.
- This enables the association to focus on its technical/professional mission, while the charity concentrates on education, community benefit, philanthropy, or public-interest programming consistent with charitable law.

Different Countries, Different Rules

- The IEEE Canadian Foundation is fit for purpose in Canada. In the United States, the IEEE Foundation and IEEE Inc. are both charities, in the U.S. sense, operating as parallel charities. Global IEEE India has charitable status within India, primarily of benefit in attracting corporate social responsibility giving. ■

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Our framework supports roughly 35 national, provincial, and local programs. A total of $120,325 of public benefit aligned with IEEE interests in Canada is approved in our 2025 budget as the available total for all supported programs. This varies each year, based on prior year donations and investment income.

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Questions ou commentaires

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