THE CANADIAN SOCIETY FOR MECHANICAL ENGINEERING
LA SOCIÉTÉ CANADIENNE DE GÉNIE MÉCANIQUE
SPRING/PRINTEMPS 2024

BULLETIN

SPECIAL ISSUE ON

Sustainable Energy Systems

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STOCK ILLUSTRATION ID: 765921106 / ECOLOGY ENERGY SOLUTION. POWER TO GAS CONCEPT. HYDROGEN ENERGY STORAGE WITH RENEWABLE ENERGY SOURCES - PHOTOVOLTAIC AND WIND TURBINE POWER PLANT IN A FRESH NATURE. 3D RENDERING.)

Editor's Letter

Happy spring and summer 2024! As we anticipate the arrival of the warm weather with enthusiasm, and start planning our hiking and other outdoor adventures, we are also reminded of the many canceled trips in Summer 2023, where we recorded the hottest summer on record[1], Canada registered a record-breaking number of wildfires[2], and our cities were blanketed with heavy smoke. These events should be a call to action to engineers in Canada, and abroad, to work tirelessly toward the development of the necessary technologies to help us transition towards a net-zero emission energy system, with the goal of meeting the Intergovernmental Panel on Climate Change (IPCC) target of limiting global warming of 1.5°C above pre-industrial levels[3], thereby reducing the worst effects of climate change.

The Spring 2024 issue of the Canadian Society for Mechanical Engineering (CSME) *Bulletin* is dedicated to highlight advancements in Sustainable Energy Systems. It is co-edited with the CSME Technical Committees (TC) in Advanced Energy Systems and Heat Transfer, represented by the TC chairs Dr. **Xili Duan** and Dr. **Sunny Li**, respectively. We hope that the issue will provide CSME members with an idea of what is happening in Canada in this critical area.

This issue contains feature articles from professors **Joshua Brinkerhoff**, **Ofelia Jianu** and **Sébastien Poncet** covering topics of wind energy, hydrogen fuel, and thermal/mechanical energy storage. Prof. Brinkerhoff's article highlights the current challenges of forecasting the electrical output from off-shore wind turbine farms and outlines his group's recent developments in this area. Prof. Jianu's article explores the feasibility of using green hydrogen as a fuel to decarbonize heavy-duty trucks on Canada's highway 401. Finally, Prof. Poncet introduces us to his team's research on energy storage via air and carbon dioxide compression and sequestration, and to phase change thermal storage materials.

A new generation of faculty members in Canada are also focusing on developing novel engineering solutions to mitigate climate change. We highlight five of them: Profs. **Nyantekyi-Kwakye** from Dalhousie University, **Mayank Sabharwal** from the University of Calgary, **Seama Koohi** and **Taha Manzoor** from the University of Alberta, and **Maha Bhouri** from the Université du Québec à Rimouski. Prof. Nyantekyi-Kwakye highlights his team's research on solving two major problems faced by the wind energy industry: (i) hydrodynamic localized scouring around submerged offshore foundations and (ii) blade icing in cold regions. Prof. Sabharwal shows how his team is improving the performance and durability of different electrochemical systems, such as fuel cells, water and CO_2 electrolyzers, and redox flow batteries. Prof. Seama Koohi introduces her research on energy systems for buildings and building districts, which includes the development of heat flow models for ground-source heat pumps (GSHPs) and ground heat exchangers. Prof. Taha Manzoor introduces us to his research in low-cost renewable thermal energy systems. Finally, Prof. Maha Bhouri investigates the use of hydride-based materials for hydrogen storage.

The *Bulletin* also provides information regarding the upcoming Canadian Society for Mechanical Engineering (CSME) and the CFD Society of Canada (CFDSC) Congress, which will be held on May 26-29, 2024 at the University of Toronto. The congress will be a great opportunity for our community to come together, and exchange the latest research results in all areas of engineering. With 400 oral presentations and 14 symposia, including one in advanced energy systems, it is an excellent venue to learn from and share the latest advances in mechanical engineering.

The *CSME Student Affairs Committee* has been busy organizing the National Design Competition (NDC) and networking events with student chapters. For example, Western University and the University of Alberta CSME student chapters both hosted a networking event bringing together students and Canadian industry representatives. Prof. **Romanyk** shares details of these events, provides us an update of the current CSME student chapters, and gives us information about this year's National Design Competition.

Prof. **Ali Hosseini's** *CSME News* section highlights recent developments in reducing the cost of hydrogen technologies by combining a fuel cell and an electrolyzer into a signal device, known as a unitized regenerative fuel cell. It also celebrates the achievement of some of our mechanical engineering students in international competitions. On a less technical note, it highlights the Government of Canada's commitment to the expansion of green and clean energy resources.

The issue also contains our usual sections to keep CSME members informed, such as a section to honor members that unfortunately passed away, a list of future CSME awards and recent awardees and a list of new CSME members. Finally, in the CSME history section, Prof. **John Shen**, Director, School of Mechatronic Systems Engineering walks us through the initial development and progress of the Mechatronics program at Simon Fraser University (SFU).

The next CSME *Bulletin* will focus on highlighting advancements in solid mechanics and structures and will be led by Profs. **Hamid Akbarzadeh** and **Ali Nasiri**, chairs of the *Solid Mechanics and Materials Technology Technical Committees*. Please let the CSME editors know your suggestions for future issues.

We hope you enjoy this issue of the CSME *Bulletin (references page 29)*.

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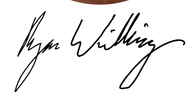

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PHOTO (GALLART): TABITHA GILLMAN / SUPPLIED PHOTOS

President's Message

Message du Président

Dear CSME members,

I am delighted to connect with you once again through our CSME *Bulletin*. As I reflect on the past two years of my presidency, I am profoundly inspired by the growth and remarkable milestones we have achieved together. I look forward to sharing exciting updates and continuing our journey of excellence in the field of mechanical engineering.

Our society is experiencing significant growth; over the last few years, we have consistently expanded in various facets. In the past year alone, we have witnessed a 20% increase in conference participants and a 14% rise in professional memberships. This remarkable growth is a direct result of the active engagement and dedication of our members.

Last year, we inaugurated a new award recognizing the innovative work of our graduate student members. The names of these distinguished inaugural winners are proudly featured on our CSME website. Additionally, it is my pleasure to announce the recipients of the CSME's 2024 technical and regular awards. These exemplary members have made outstanding contributions to our field, pushing the boundaries of mechanical engineering. You will find details of their commendable achievements in this issue on page 20.

Starting this year, participants in the CSME Congress will have the opportunity to engage in Continuing Professional Development (CPD). Attendance at the technical sessions of the Our Congress will qualify for Professional Development Hour credits, enhancing the value and impact of participating in our annual gathering.

In line with our unwavering commitment to equity, diversity, and inclusion (EDI), we have made substantial steps. In November last year, we established a dedicated EDI committee charged with crafting inclusive strategies and initiatives.

Finally, I am also honored to introduce Dr. Ali Ahmadi, who will take over as the next president of the CSME starting in June 2024. Dr. Ahmadi's extensive experience and innovative vision are sure to lead the CSME to new heights.

Looking forward, our society remains dedicated to advancing the discipline of mechanical engineering in Canada and globally. This progress is made possible by your continuous support and commitment. Thank you for being so dedicated to our shared goals.

Warmest regards,

Dr. **ALEKSANDER CZEKANSKI**, PhD, MBA, P.Eng., FCSME, FEIC, FCEEA
CSME *President*
Professor, Mechanical Engineering
Lassonde School of Engineering, York University

Chers membres de la SCGM,

Je suis ravi de pouvoir à nouveau communiquer avec vous à travers notre bulletin de la SCGM. Alors que je réfléchis aux deux dernières années de ma présidence, je suis profondément inspiré par la croissance et les réalisations remarquables que nous avons atteintes ensemble. J'ai hâte de partager des mises à jour excitantes et de continuer notre parcours d'excellence dans le domaine du génie mécanique.

Notre société connaît une croissance significative; au cours des dernières années, nous avons constamment progressé dans divers aspects. Rien que l'année dernière, nous avons constaté une augmentation de 20% des participants à nos conférences et une hausse de 14% de nos adhésions professionnelles. Cette croissance remarquable est le résultat direct de l'engagement actif et du dévouement de nos membres.

L'année dernière, nous avons inauguré un nouveau prix reconnaissant le travail innovant de nos membres étudiants diplômés. Les noms de ces lauréats inauguraux sont fièrement présentés sur notre site web de la SCGM. De plus, c'est avec plaisir que j'annonce les récipiendaires des prix techniques et réguliers de la SCGM pour 2024. Ces membres exemplaires ont apporté des contributions exceptionnelles à notre domaine, repoussant les limites du génie mécanique. Vous trouverez les détails de leurs réalisations louables dans cette édition.

À partir de cette année, les participants au Congrès de la CSME auront l'occasion de participer à des activités de Développement Professionnel Continu (DPC). La participation aux sessions techniques de notre congrès sera reconnue par des crédits d'Heures de Développement Professionnel, ce qui renforcera la valeur et l'impact de leur participation à notre rassemblement annuel.

Dans le cadre de notre engagement indéfectible envers l'équité, la diversité et l'inclusion (EDI), nous avons réalisé des avancées significatives. En novembre dernier, nous avons établi un comité EDI dédié, chargé d'élaborer des stratégies inclusives et des initiatives.

Enfin, j'ai également l'honneur de vous présenter le Dr Ali Ahmadi, qui prendra la présidence de la SCGM à partir de juin 2024. L'expérience étendue et la vision innovante du Dr Ahmadi sont certaines de mener la SCGM vers de nouveaux sommets.

En regardant vers l'avenir, notre société reste dédiée à faire avancer la discipline du génie mécanique au Canada et à l'échelle mondiale. Ce progrès est rendu possible grâce à votre soutien continu et à votre engagement. Merci d'être si dévoués à nos objectifs communs.

Avec tous mes sentiments les plus chaleureux,

ALEKSANDER CZEKANSKI, PhD, MBA, P.Eng., FSCGM, FEIC, FCEEA
Président, Société Canadienne de Génie Mécanique
Professeur, Génie Mécanique
École d'ingénierie Lassonde, Université York

PHOTO: LASSONDE SCHOOL OF ENGINEERING

CSME/CFD 2024

Conferences of the Canadian Society for Mechanical Engineering (CSME) and of the CFD Society of Canada (CFDSC)

MECHANICAL ENGINEERING BUILDING, U OF T ST. GEORGE CAMPUS

WELCOME TO U OF T!

On behalf of the Department of Mechanical & Industrial Engineering (MIE) at the University of Toronto, I look forward to welcoming you to CSME/CFD2024 (www.csmecongress.org), a joint conference of the Canadian Society for Mechanical Engineering (CSME) and of the CFD Society of Canada (CFDSC), to be held May 26-29, 2024.

Founded in 1827, U of T is proud to be considered among the world's top research universities, and with a total enrolment of almost 100,000 students on three campuses, it is also one of the largest universities in North America. And it's on the beautiful downtown St. George campus that you'll find U of T Engineering, that just celebrated its 150th anniversary (150.engineering.utoronto.ca). This is where we'll host the conference.

As for the Department of MIE, it is home to 65 professors: about 40 ME and 25 IE, about 1,300 undergraduate students in two programs, and almost 800 grad students, roughly split between MASc/PhD students doing research, and MEng students pursuing a course-based degree. The accompanying picture is of the mechanical engineering building, that's home to many of us.

We're proud of our engineering undergraduates: almost 40% of the incoming class each year is women, they come from 100+ countries, and almost 30% of our students are international. While here, they can take advantage of a rich environment that includes a robust undergraduate engineering curriculum, plus access to 25 complementary certificates and minors on topics that include Artificial Intelligence, Business, Leadership, and even Music; and 100+ engineering student clubs and teams.

On the graduate side, our MEng students have access to a large and diverse collection of ME and IE grad courses – and yes, any student can take any course – and on top of that, U of T Engineering is host to about ten specializations offered by multiple departments on topics including Data Analytics and Machine Learning (that's very popular), Robotics, Advanced Manufacturing, and Entrepreneurship/Leadership/Innovation.

Finally, our mechanical engineering professors are training grad students and postdocs while pursuing world-class research in many areas, including aspects of advanced manufacturing, biomedical engineering, coatings, multidisciplinary and multifunctional design, advanced materials and materials processing, robotics, and sustainable energy; and we are very fortunate to be able to work with industrial engineering colleagues with expertise in areas including AI and machine learning, healthcare engineering, human factors, and operations research. Many of our faculty have been recognized for their accomplishments, as evidenced, for example, by having among us six Canada Research Chairs, six Fellows of the Royal Society of Canada, and many fellows of other prominent U.S. and Canadian organizations.

My colleagues and I look forward to welcoming you to U of T in late May.

MARKUS BUSSMANN, PhD, P.Eng., FCSME
Chair, Department of Mechanical & Industrial Engineering, Faculty of Applied Science & Engineering University of Toronto

PHOTOS COURTESY OF U OF T ENGINEERING STRATEGIC COMMUNICATIONS / MIE DEPARTMENT

CSME/CFD 2024

Canadian Society for Mechanical Engineering International Congress

31st Annual Conference of the CFD Society of Canada

May 26-29, 2024 - University of Toronto

On behalf of the Canadian Society for Mechanical Engineering (CSME) and the CFD Society of Canada (CFDSC), we invite you to attend CSME/CFD2024 (www.csmecongress.org). This annual conference is a marvellous opportunity for the mechanical engineering and CFD communities in Canada and beyond to come together, to exchange the latest research results, but equally important, to build community, as it brings together students and professors with colleagues from industry and government.

The conference will be held May 26-29, 2024 on the beautiful downtown campus of the University of Toronto, that in the past few years has been transformed by The Landmark Project (landmark.utoronto.ca) into a greener, more walkable and accessible campus, that now includes a large urban geoexchange field (uoft.me/geoexchange-project).

We received almost 500 submissions of abstracts and papers. Following a review process led by Chairs and co-Chairs of the CSME technical committees (www.csme-scgm.ca), we are currently scheduling more than 400 oral presentations, including more than 300 organized into the following 14 CSME symposia: *Advanced Energy Systems* | *Advanced Manufacturing* | *Biomechanics and Biomedical Engineering* | *Computational Mechanics* | *Engineering Analysis and Design* | *Environmental Engineering* | *Fluid Mechanics* | *Machines and Mechanisms* | *Materials Engineering* | *Mechatronics, Robotics & Controls* | *Micro and Nanotechnology* | *Solid Mechanics* | *Thermal Science and Engineering* | *Transportation Systems*. As well, there'll be about 80 presentations organized into a number of different CFDSC symposia. Proceedings will be published after the conference on TSpace (tspace.library.utoronto.ca), the University of Toronto online archive.

In addition to the technical presentations, the program will include five plenary lectures (www.csmecongress.org/plenary-speakers) and a number of keynote lectures (www.csmecongress.org/keynote-speakers) scheduled throughout the three days. As well, on the Monday over lunch, we'll host an Empower Hour, a panel discussion and open forum to consider the challenges that women face in engineering, both in academia and industry. And Monday late afternoon we've organized a panel discussion for grad students and postdocs, on the topic of *What do I do with this PhD?* The conference will begin with a welcome reception on the Sunday afternoon at the new Schwartz Reisman Innovation Centre (uoft.me/SRI-campus) and a banquet on the Tuesday evening at the Arcadian Court (www.arcadianevents.ca), a beautiful restored event space at Bay and Queen in downtown Toronto. During the banquet we'll celebrate this year's CSME award winners

During the conference we'll also host a number of meetings: of the CSME Board of Directors, of the 14 CSME technical committees, of Chairs and Heads of departments of mechanical engineering in Canada, and the 2024 Annual General Members meeting of the CSME.

Finally, for those professionals who must demonstrate continuing professional development (CPD), attendance/participation in the technical sessions of the conference will qualify for up to 15 Professional Development Hour (PDH) credits, for which a certificate will be issued upon request, following the conference.

We very much look forward to seeing you in Toronto in May.

Professors **Markus Bussmann**, **Fae Azhari** and **Clinton Groth**, Co-Chairs

Farm-Scale Blockage and Wake Losses in Wind Farms

ON OCTOBER 29, 2019, DENMARK-BASED Ørsted—the world's largest developer of offshore wind farms—announced that its wind farms were producing less energy than initially forecast[1]. They attributed their under-production to two physical processes: wind farm blockage and large-scale wakes. The former is the slow-down in the oncoming wind before it reaches the wind farm, while the latter is the gradual recovery of the low-speed wake downwind of the farm. In the aftermath of their announcement, Ørsted's share price dropped precipitously in a flurry of alarming news headlines, some even calling it a "wake-up call" for offshore wind. Ørsted claimed that underestimation of these effects permeated the entire wind industry. In response, the Swedish Windpower Association held an invited workshop with turbine manufacturers, wind farm owners, consultants, and academics. A blind comparison of blockage losses by four separate consultants at ten different wind farms estimated blockage losses to be as low as 0.2% or as high as 4.5%, with predictions made by different consultants differing by over a factor of five[2]. The outcome was clear: more research is needed to understand wind farm blockage and estimate its impact on wind farms throughout the world.

DR. JOSHUA BRINKERHOFF, PhD, MCSME

Dr. Brinkerhoff is an Associate Professor in the School of Engineering at UBC Okanagan. Since 2021, he has served as the Associate Director-Research & Industry Partnerships for the School. He completed his Bachelors and PhD in Aerospace Engineering at Carleton University in 2007 and 2013. He leads the UBC Okanagan Computational Fluid Dynamics Lab, where his research team conducts high-fidelity numerical simulations of turbulent flows to advance a myriad of applications, including wind energy, aerospace, and hydrogen safety.

Wind farm scale losses

With over 900 GW of installed capacity worldwide as of 2023[3], wind energy is a critical part of a sustainable energy system. Wind turbines generate electricity by converting the kinetic energy of the wind into rotational motion that turns a generator. Utility-scale wind farms consist of many horizontal-axis wind turbines where the diameter of the massive rotor may exceed 200 m for the largest turbines. As the wind flows through the wind farm, the thrust (drag) of each turbine slows the wind upstream of the turbine ("local" blockage). Similarly, energy extraction by the rotor leaves a calmed region in its wake. These features are illustrated schematically in *Figure 1*. At the scale of an individual turbine (hundreds of meters), these two effects are well understood and have been accurately predicted for decades. But as wind farms grow ever larger, a much stronger slow-down of the wind approaching the wind farm is observed ("global" blockage). Depending on atmospheric conditions, the slow-down may be up to several percent in magnitude and extending kilometers upwind[4]. Since turbine power varies with the cube of the wind speed, the slow-down lowers annualized energy production by 3-6%, depending on site-specific characteristics of the farm[5]. It is these large-scale effects, occurring on the scale of the entire wind farm (tens of kilometers), that are poorly understood.

Wind farm/atmosphere interactions

Research following Ørsted's announcement is showing that the massive size of modern wind turbines and wind farms are triggering unexpected interactions with the atmospheric boundary layer (ABL) and the free atmosphere aloft. The ABL is a layer of air above the earth's surface, hundreds to thousands of meters thick, in which friction, turbulence, surface heat flux, and surface roughness produce a highly-stratified temperature and velocity profile. The growth of the ABL, caused by turbulent entrainment, is often limited by a sudden increase in potential temperature close to the ABL height, referred to as the capping inversion layer, while the free atmosphere aloft exhibits a stable increase in potential temperature. When these conditions occur, wind farms may trigger atmospheric gravity waves in the form of surface waves in the inversion layer and internal waves aloft. Atmospheric gravity waves are long-wavelength standing waves that propagate longitudinally and laterally, inducing horizontal pressure gradients that accelerate or decelerate the wind in the ABL. Their vertical wavelength depends on the wind speed in the free atmosphere and on the vertical potential temperature gradient, and is typically on the order of thousands of meters[6]. Depending on the local Froude number—a ratio of the wind's inertia to stabilizing buoyancy forces—surface waves within the inversion layer may either propagate in all directions (subcritical) or be carried downwind (supercritical). Under a strong capping inversion layer, i.e. a subcritical Froude number, gravity waves propagate both upwind and downwind of the wind farm, exacerbating the farm-scale blockage and altering the farm's wake recovery.

Simulating wind farm/atmosphere interaction

Engineering models for predicting wind farm production have historically glossed over these dynamic interactions with the ABL because the huge spatial scales make it challenging to gather observational data. Moreover, most computational fluid dynamics (CFD) simulations of wind farms lacked the ability to capture this problem—that is, until recently. Through an NSERC-funded collaboration with UL Renewables, a leading wind energy consultancy, the author, along with PhD students Sebastiano Stipa and Arjun Ajay and collaborator Dries Allaerts from TU Delft, developed a CFD solver called TOSCA (Toolbox fOr Stratified Convective At-

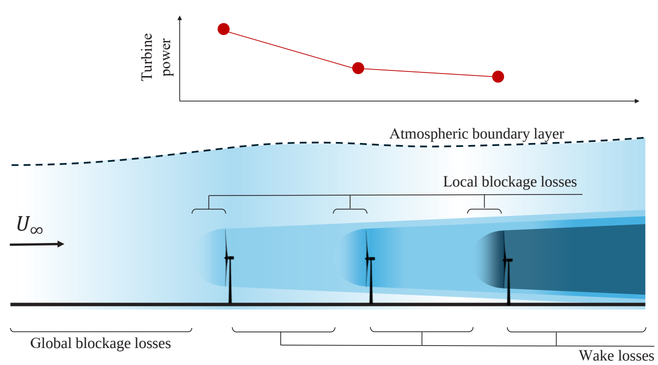

FIG. 1: A SCHEMATIC ILLUSTRATION OF LOCAL BLOCKAGE LOSSES, GLOBAL BLOCKAGE LOSSES, AND WAKE LOSSES IN WIND FARMS. DARKER SHADING INDICATES A LOWER WIND SPEED.

mospheres) that is tailored for conducting large eddy simulations (LES) of entire wind farms[7]. Actuator models are used in TOSCA to model the aerodynamics of each turbine and estimate the power produced by the farm. The spatial resolution must be fine enough to resolve the ABL turbulence and the aerodynamics of the hundreds of individual turbines. At the same time, the domain extends tens of kilometers in all directions to encompass the entire wind farm plus a large extent of the surrounding atmosphere. Special boundary treatments ensure that propagating gravity waves do not reflect artificially and pollute the solution. To accurately capture the velocity, temperature, and turbulence conditions of the incoming wind, a concurrent LES is performed in a smaller domain without a wind farm, from which the time- and spatially-resolved data is dynamically mapped as inflow conditions into a larger LES containing the full atmosphere and wind farm.

An illustrative solution from TOSCA of the N-4 wind farm cluster in the German North Sea is shown in *Figure 2*. The instantaneous wind speed and pressure perturbation (equal at a given height to the mean pressure in the absence of turbines subtracted from the instantaneous pressure) is plotted over a horizontal slice at the turbine hub height. The farm-scale blockage appears as the high-pressure region upstream of the farm, while standing lee waves are evident in the wake.

Low-cost models

The LES plotted in *Figure 2* involved over 500 million grid points and ran for 40 hours on more than 70,000 cores of the Niagara supercomputer at the University of Toronto. This is far too expensive for practical wind farm design, but the physical insights it yielded allowed the author's team to develop low-cost mathematical models[6,8]. At present, these models are tailored for offshore conditions, but future research aims to incorporate complex terrain. A comparison between the LES and the recently-developed Multiscale Coupled (MSC) model proposed by the author's team is shown in *Figure 3*, comparing the predicted velocity magnitude around the N-4 wind cluster. Compared to nearly 1 million CPU-hours on Canada's largest supercomputer required for the LES, the MSC model runs in a few minutes on a conventional laptop, yet achieves predictions within 3% of the LES in terms of total farm power.

Currently, TOSCA is being deployed by the author's team and collaborators in Brazil, Netherlands, and Belgium to investigate the mutual interaction between terrain, wind farms, and the thermally-stratified atmosphere. This is especially relevant for Canadian wind farms, many of which are surrounded by mountainous or coastal terrain, and where terrain-generated gravity waves may compete with wind-farm triggered gravity waves. The research is enabling the development of novel approaches for wind farm control to maximize their efficient integration into regional electricity grids, ultimately strengthening wind energy's contribution to a sustainable energy system.

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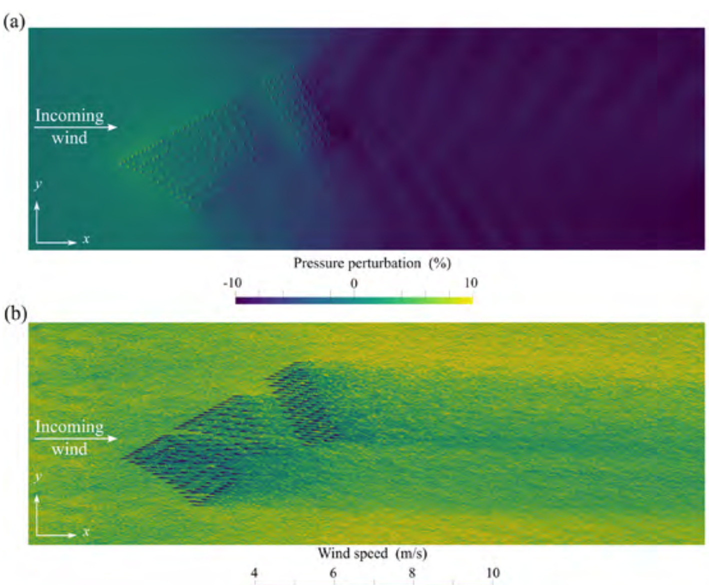
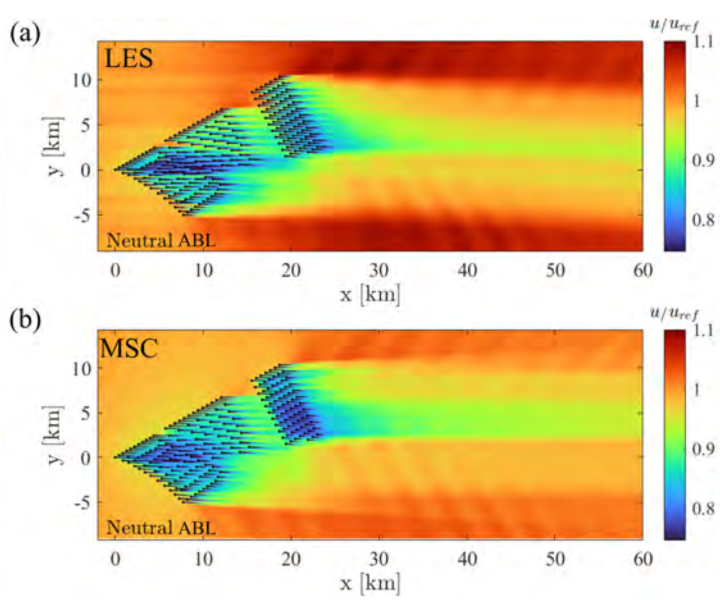


FIG 2: SIMULATION RESULTS OF THE FLOW FIELD SURROUNDING THE N-4 WIND FARM IN THE GERMAN NORTH SEA. RESULTS SHOW THE (A) PRESSURE PERTURBATION AND (B) WIND SPEED FIELDS IN A HORIZONTAL SLICE AT TURBINE HUB-HEIGHT.



NORMALIZED WIND SPEED IN A HORIZONTAL SLICE AT TURBINE HUB-HEIGHT FOR THE N-4 WIND FARM IN THE GERMAN NORTH SEA. RESULTS COMPARE (A) THE LARGE EDDY SIMULATION (LES) WITH (B) THE MULTISCALE COUPLED (MSC) MODEL.

DECARBONIZING THE FUTURE

Medium to High Temperature Thermal and Mechanical Storages for Off-Grid Resilience

GOVERNMENTS ARE PRIORITIZING ENERGY efficiency and decarbonization to reach the objectives fixed by international agreements towards net-zero emissions. Integrated systems coupling renewable energy (solar, wind) with medium to high-temperature thermal energy storage (TES) appear as an interesting solution in the energetic mix, especially for large industries, microgrids and the approximately 300 remote communities located in Northern Canada to diminish their dependence on fossil fuels. The ultimate goal of these systems is to convert renewable power to thermal energy (P2T) to charge TES systems. Later, when needed, the reverse cycle occurs (thermal to power (T2P)), using thermodynamic cycles like the Brayton, Rankine or organic Rankine ones. Alternatively, high-grade heat can be the system's deliverable. This note provides a brief overview of our recent progress in medium and high-temperature TES systems, examined both numerically and experimentally in our lab at Université de Sherbrooke. It also briefly outlines potential future research in this area.

TES systems promote renewable energy adoption by storing surplus energy from peak times, improving grid stability and reducing the need for peaking power plants. They can be categorized by transfer mode (sensible, latent or chemical), usage (daily, seasonal), and temperature range (low-grade up to 100°C, medium-grade between 100 and 400°C, and high-grade above 400°C).

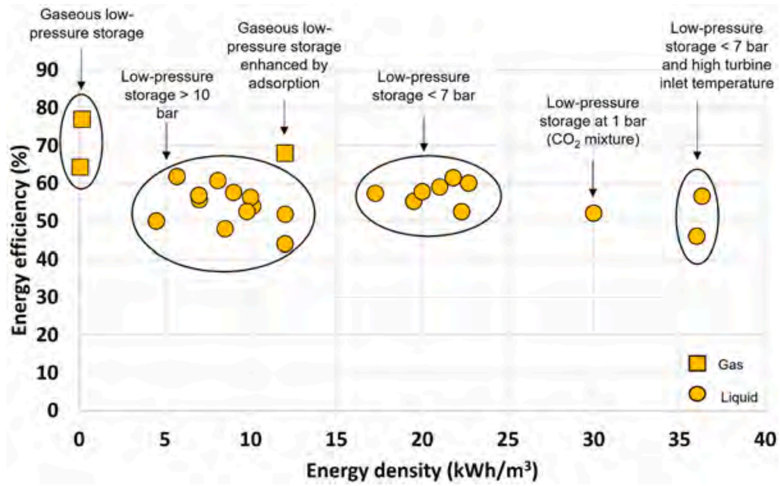


FIG. 1: EXERGY EFFICIENCY VERSUS ENERGY DENSITY FOR ABOVE-GROUND ADIABATIC CCES, AFTER DEWEVRE ET AL. (2024).

A - Medium-Temperature TES systems

Compressed air energy storage (CAES) technologies are large-scale, long-lifetime and cost-effective energy mechanical energy storage solutions. Energy produced by renewable energy sources can be used to compress air and store it in tanks, caverns, aquifers or abandoned mines. When needed, air can be expanded in a turbine to produce electricity. Until now, only two main facilities have been developed at a large scale (1 MWh of electricity) using caverns as storage media and combining electricity and gas to produce electricity: the Huntorf (1978, Germany) and the McIntosh (1991, USA) plants. At a smaller scale, Cheayb (PhD thesis, 2019) developed and validated a model of adiabatic CAES, whose capacity could fulfill the energy demand of Canadian remote communities. Through a detailed techno-economic analysis including only commercially available technologies, he demonstrated that trigenerative CAES becomes more economical than lead-acid batteries when the power scale gets higher than 5.8 kW. The trigeneration option reduces the system cost by a factor 1.67. The main remaining limitation is the acceptable pressure at the turbine's inlet, which remains very low (25 bars) with current technologies, while the storage pressure is around 200

DR. LEYLA AMIRI, PhD

Dr. Amiri has been working as an assistant professor in the mechanical engineering department at Université de Sherbrooke (UDS) since 2022. She completed her PhD in 2020 at McGill University. Leyla has received several prestigious awards, including the Claire-Deschênes and FRQNT Postdoctoral Scholarship at UDS, as well as the Killam Postdoctoral Fellowship at Dalhousie University. Her work focuses on finding better ways to improve energy efficiency, recover waste heat, and integrate renewable energy sources through numerical and experimental studies, particularly in enhancing seasonal thermal energy storage units. Beyond research, she is involved in organizing key engineering congresses and serves as a Guest Editor for energy research journals.

DR. SÉBASTIEN PONCET, ing., PhD, HDR

Dr. Poncet is currently full professor in the mechanical engineering department of UDS and holds the NSERC chair on industrial energy efficiency supported by Hydro-Québec, Natural Resources Canada and Copeland Canada Inc. since 2014. He is directing the Laboratoire de Mécanique des Fluides, Thermique et Énergétique de l'Université de Sherbrooke (https://lmfteus.wordpress.com/) focusing mainly on advanced numerical modeling of fluid flow and heat transfer in any energy systems (heat pump, refrigeration, renewable energy and energy storage). Part of his research includes the experimental characterization of the thermophysical properties of complex materials, such as slurries, nanofluids and phase-change materials. Prof. Poncet is author or co-author of more than 160 publications in peer-reviewed international journals.

DR. SEYED SOHEIL MOUSAVI AJAROSTAGHI, PhD

Dr. Mousavi Ajarostaghi has held the position of research assistant in the mechanical engineering department at UDS since 2023. Presently, Soheil is conducting research under the guidance of Profs. Sébastien Poncet and Leyla Amiri, on implementing thermal energy storage systems within greenhouse environments. Soheil has received the Excellence Scholarship 2024 at UDS. He has authored/co-authored of over 120 publications, with 95 papers in peer-reviewed international journals. Moreover, he was in the list of 2022 and 2023 world's top 2% most-cited scientists, based on science-wide Scopus databases (indicators by J.P.A. Ioannidis). His work focuses on applying cold/thermal energy storage systems in various renewable energy systems.

bars. It causes the main source of exergy losses to be in the throttling valve and limits the comprehensive efficiency of the system to maximum 35%.

Compressed Carbon Dioxide Energy Storage (CCES) systems are based on the same principle but operate with CO_2 also in closed cycles. They may allow above-ground liquid storage under non-extreme temperature conditions, while considerably decreasing the required storage volume. Dewevre et al. (2024) recently compared and classified the existing models of CCES based on the presence of an external heat source, the thermodynamic state of the stored CO_2, and the means of heat recovery and utilization. *Figure 1* presents an example of the energy efficiency and energy density achieved by the current above-ground adiabatic CCES. This type of CCES remains the most efficient one and could benefit from adding TES. Adsorption materials (like zeolite or activated carbon) inside the storage tanks may help increasing the energy density of the system (R. Ghawche's PhD thesis). As with CAES, the main source of exergy losses is the expansion in the throttling valve. The inefficiencies of the compressor and turbine constitute a second important limitation. More than for CAES, experimental studies and real scale prototypes are missing for a deep validation of the models.

Phase Change Materials (PCMs) play a pivotal role in many applications as they can store and release more thermal energy by latent heat than any single-phase fluid. For example, in CAES, they can be used during the charge phase to lower the stored air temperature and release that extracted heat before entering the turbine. It requires PCMs having a melting point between 150 and 200°C. Thus, different PCMs were fully characterized experimentally at UDS to quantify the degradation of their performance under hundreds of charge/discharge cycles to mimic the functioning of a CAES. Sugar alcohols like D-mannitol rapidly deteriorate exhibiting caramelization phenomenon (L. Vialettes, MScA thesis, 2021). On the contrary, adipic acid exhibits remarkable stability properties. Its thermophysical properties (heat capacity, latent heat of fusion, dynamic viscosity and thermal conductivity) were fully characterized experimentally for different purities and following international standards. H. Fatahi (PhD thesis, 2023) established the first very accurate database for this PCM. To improve its thermal conductivity, he synthesized a new nano-PCM based on boehmite nanoparticles (which could be easily produced from wastewater of aluminum smelters) with a silica shell (*Figure 2*). A 20% (resp. 14%) increase in thermal conductivity with boehmite (resp. boehmite-silica) nanoparticles was obtained at low concentrations (<0.5%) without compromising the PCM enthalpy. Moreover, the presence of nanoparticles delays its mass loss and reduces the subcooling degree. As for any nanomaterials, the remaining question is the applicability of such nano-PCMs integrated in large-scale facilities.

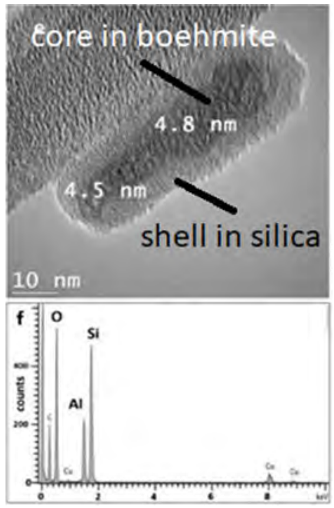


FIG. 2: TRANSMISSION ELECTRON MICROSCOPY IMAGES AND ENERGY-DISPERSIVE X-RAY SPECTROSCOPY OF BOEHMITE-SILICA CORE-SHELL NANOPARTICLES (PHD THESIS OF H. FATAHI, 2023).

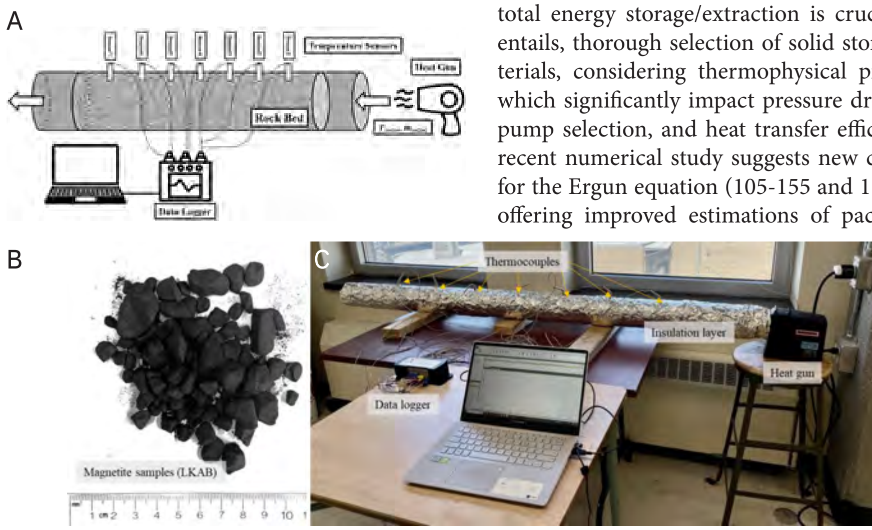


FIG. 3: (A) SCHEMATICS OF THE EXPERIMENT; (B) MAGNETITE ROCKS (LEFT); AND (C) PICTURE OF THE EXPERIMENTAL SET-UP DEVELOPED AT UDS FOR HIGH-TEMPERATURE TES (RIGHT).

B - High-Temperature TES Systems

Various materials for high-grade TES have been studied, including a potash industry by-product, castable ceramic and concrete, and rocks (Amiri et al., 2024). While concrete-based modules are low-cost and durable, thermal cycling at higher temperatures diminishes their properties like compressive strength, structural integrity, and resistance to cracking or spalling. In our recent experimental study (Figure 3), we used natural Magnetite from LKAB Minerals company. Samples underwent 10 thermal cycles from 25 to 1000°C in a Differential Scanning Calorimeter and initially showed less than 5% volume change, possibly due to humidity. Subsequent tests consistently showed no noticeable changes in the volume, specific heat, or thermal conductivity of the tested material.

In our Rock-TES system, air at 700°C is heated with a heat gun and blown through a bed of rocks for "charging". Subsequently, the bed remains in idle mode for several hours to evaluate heat losses, followed by "discharging" with low air temperature at about 25°C. Using rock beds for storage presents its own challenges, including thermocline losses, low utilization factor, high fan power demand, and thermal ratcheting , all of which our research aims to address. While many studies focus on improving TES through various storage media and particle sizes and shapes, few address modifications to the geometry of the entire system. Our recent study proposed a double thermocline system using a perforated plate to deliver hot air, bypassing the main thermocline (Ermagan et al., 2024). This innovation has crucial implications for various engineering applications, underlining the industry's importance of efficient packed bed systems. Such advancements not only enhance TES efficiency but also contribute to cost-effectiveness and sustainability across sectors like separation, carbon capture and storage.

In TES design, achieving a balance between energy consumption for fluid circulation and total energy storage/extraction is crucial. This entails, thorough selection of solid storage materials, considering thermophysical properties which significantly impact pressure drops, fan/pump selection, and heat transfer efficiency. A recent numerical study suggests new constants for the Ergun equation (105-155 and 1.45-2.05) offering improved estimations of packed bed pressure drop over original constants (150 and 1.75) (Amiri et al., 2019). Validation through experimental tests is part of our ongoing project, examining particle size and sphericity effects on TES fan power demand, as well as further investigation to quantify changes due to thermal cycling on the performance of the system.

Perspectives

For CAES and CCES, future perspectives should include the development of more efficient system components (especially turbines) before attempting to further optimize the cycle. PCM-based TES and adsorption materials appear promising to increase both their energy efficiency and energy density. Sensible TES using water or rocks could be a cost-effective, locally available alternative. Techno-economic analyses, including environmental metrics, are imperative for all options, but the top priority remains the development of experimental prototypes (ideally up to the MW scale) to demonstrate the potential of these technologies and enable improved validation of numerical models. These models could serve to optimize the systems in a further step. *Continued pg. 28*

Hydrogen Fuel for Heavy-Duty Trucks on Highway 401: Is it Feasible?

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DR. OFELIA A. JIANU, PhD, P.Eng.

Dr. Jianu is an Associate Professor of Mechanical Engineering at the University of Windsor. She obtained her PhD from University of Ontario Institute of Technology in transport phenomena in multi-phase flows with application to hydrogen production processes. Her area of expertise is in heat, mass and momentum transport with application to alternative fuels and energy conversion systems. The unique feature of Dr. Jianu's research is that she applies the 2nd Law of Thermodynamics to identify losses within energy systems and generates solutions to minimize the losses. She published over 40 manuscripts in reputable journal and conference proceedings.

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INTRODUCING SUBSTITUTE FUELS THAT MAY drastically reduce greenhouse gas emissions is essential, especially considering the detrimental effects of carbon dioxide emissions from the transportation sector on our environment. A potential solution is hydrogen fuel produced using renewable sources, hence significantly reducing the harmful greenhouse gases emitted into the atmosphere, not only during fuel production but during usage by automobiles, especially heavy-duty trucks. This article describes a techno-economic study that was carried out to determine the feasibility of building hydrogen refueling stations for class 8 (i.e. 33,001–80,000 lb and above) heavy-duty trucks to decarbonize the key highway in Canada connecting the United States of America to Quebec, Canada: Highway 401[1].

It is widely known that a large portion of the global energy demand is dedicated to the transportation sector[2], which is still heavily dependent on fossil fuel resources. It has been reported that within the transportation area, heavy-duty trucks make up a considerable proportion of about 40%[3], whereas in Canada, this sector is the main source of emissions and pollution[4]. Therefore, it is critical to implement robust procedures to decarbonize the transportation sector by transitioning to sustainable energy sources and cleaner energy carriers. There is no simple solution to decarbonizing the transportation sector since low prices of fossil fuel products, affordable cost of combustion engine technologies and existing infrastructure for vehicles, amongst others, obstruct the implementation of clean alternatives[2]. Fuel cell electric vehicles (FCEVs) have shown ample potential to be used for long-haul and heavy-duty applications due to their environmental friendliness[5], short refueling times[6], and a negligible carbon footprint during operation since the only by-product is water, which makes the technology desirable over the battery electric. Fuel cell technology is mature and new models are being developed every year with a shift towards heavy-duty trucks. For example, the International Energy Agency reported in the Global EV Outlook that of the 220 models that became available in 2022, more than half were either medium-duty trucks (over 60 models) or heavy-duty trucks (over 50 models)[7], which shows the increase in confidence to adopt the technology. The support for FCEV deployment is present with U.S. launching two consortia to advance fuel cell truck R&D[8], and in Canada with the Alberta Zero Emissions Truck Electrification Collaboration (AZETEC) which features the development of long-range fuel cell electric trucks[8], amongst others. Of course, the lifetime carbon footprint of FCEVs is highly dependent on the hydrogen production method, which currently is generated through fossil fuel-based processes such as steam methane reforming (SMR) and coal gasification. However, Ontario could be a leader in hydrogen produced using clean methods due to the availability of excess electrical energy during off-peak hours, and the potential to recover curtailed electrical power from renewable energy sources such as wind and solar.

Why Highway 401? Highway 401 is the Canadian branch of the North American Superhighway Corridor (NASCO), and connects Windsor, Ontario to Montreal, Quebec. This highway plays an essential role in the country's trade with the United States and Mexico[3]. Highway 401 is highly utilized to transport goods with more than 40,000 trucks passing by the busiest point in Toronto, Ontario, daily[9]. Hence, Dr. Jianu and her team set out to determine if it is feasible to decarbonize Highway 401 by replacing diesel powered class 8 heavy-duty trucks with H_2 powered trucks and implement a hybrid network of refueling stations in an attempt to encourage policy makers and private sector to invest in decarbonizing the transportation sector. In their study[1], a stand-alone hybrid H_2 refu-

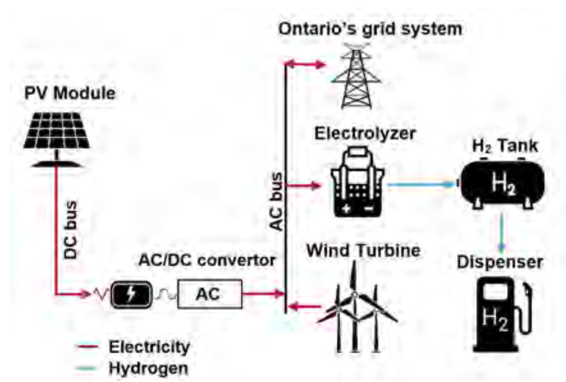

FIG. 1. GENERAL SCHEMATIC OF INTENDED HYBRID REFUELING INFRASTRUCTURE FOR HYDROGEN GENERATION[1].

FIG. 2: PRESENTATION OF HIGHWAY 401 CORRIDOR MAP AND APPROXIMATE LOCATIONS FOR REFUELING STATIONS[1].

eling station network powered by photo-voltaic (PV) modules, wind turbines, and grid backup was investigated, which is illustrated in *Fig. 1.* The proposed hybrid energy solution is designed to satisfy the required H_2 demand of 10, 30, and 50 heavy-duty trucks on the important Highway 401. The team considered four potential locations for refueling including Windsor, Toronto, Kingston, and Montreal (a total number of 8 refueling stations), as depicted in *Fig. 2.* An optimization algorithm was implemented to determine the best scenario and the cash flow chart of the detailed expenses and profits of the optimized scenario over a 25 year lifespan. The results are plotted in *Fig. 3*, in which the expenditures of the project are represented as negative and the incentives are shown as positive values. The study assumed the lifetime of the converters (CNV), wind turbines (WT), and PV modules are 15 years, 20 years, and 30 years, respectively. These intervals are shown as replacement periods in the plot where it is noticed that PV modules exhibit the highest initial cost, and the grid sale is uniform throughout the project lifetime. Although the initial cost of WT is lower than PV, a cost is associated with WT replacement at the 20-year mark, which increases WT total cost. However, there is another crucial parameter in the cash flow analysis considered in this study, namely the salvage value, which specifies the value of an energy solution at the end of the project. It is noticed from *Fig. 3* that the replacement cost of WT plays a more important role in the salvage value compared to the capital expenses as a large portion of the cost is salvaged at the end of the 25-year life of the project. Hence, the salvage cost can be viewed as an indicator of the remaining life of the equipment. Another aspect to be considered is the grid rate fluctuation as reducing the purchase from the grid would enhance the implementation of a hybrid system for hydrogen production using electrolysis. An assessment of the fluctuations in the grid rate demonstrates that higher sales to the grid promote the use of hybrid energy solutions which in return reduces the overall grid purchase. For instance, when the proposed hybrid system sells excess energy to the grid at higher costs, the net present cost of the project decreases.

Although the cost incentives are palpable, the incentive to switch to a hydrogen infrastructure is justified when looking at the CO_2 emissions that are averted from entering the atmosphere by replacing diesel fuel heavy-duty trucks with FCEVs. For a mere 50 diesel trucks replaced, over 208,000 tonnes of CO2 are prevented from entering the atmosphere over the 25-year project lifespan. That is significant considering that, according to the Ministry of Transportation, over 200,00 trucks travel on Ontario's highways daily[9].

Given the resources available along the Highway 401 from Windsor, Ontario to Montreal, Quebec, a blend of renewable energy sources could supply a H_2 infrastructure with the possibility of selling excess energy to the grid. A combination of PVs, WTs, and CNVs could be considered for H_2 production via electrolysis to reduce the dependency on the grid. For the considered hybrid system, calculations show that the levelized cost of hydrogen for 10, 30, and 50 trucks is \$2.03/kg, \$1.79/kg, and \$1.7/kg, respectively. With more and more companies announcing production of FCEV for heavy-duty class 8 trucks, the announced collaborations between manufacturers and consumers, and advancements in the technology, one can only anticipate that we will be seeing more of them on Highway 401 in the years to come.

Acknowledgements: Dr. Jianu acknowledges outstanding researchers **Amir Mohammadi** and **Reza Babaei** for their commitment and dedication to finding clean energy solutions and for conducting the research.

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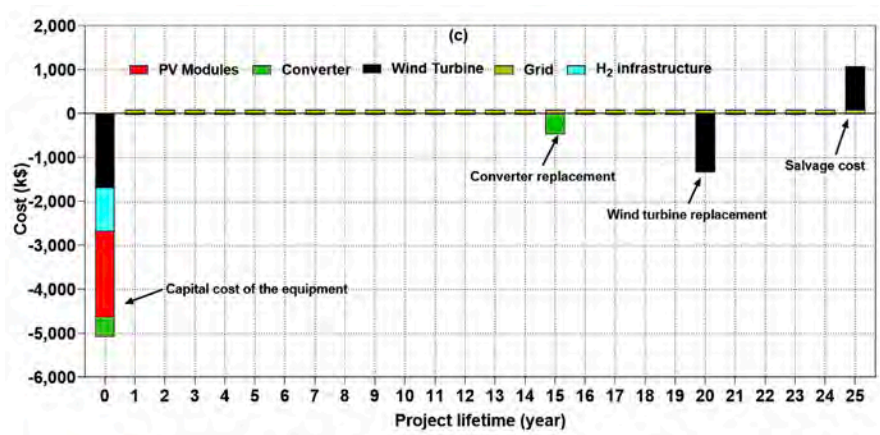

FIG. 3: CASH FLOW DIAGRAM FOR 50-TRUCK SCENARIO DURING 25 YEARS OF THE PROJECT LIFETIME[1].

ME NEWS & RESEARCH

HIGHLIGHTS

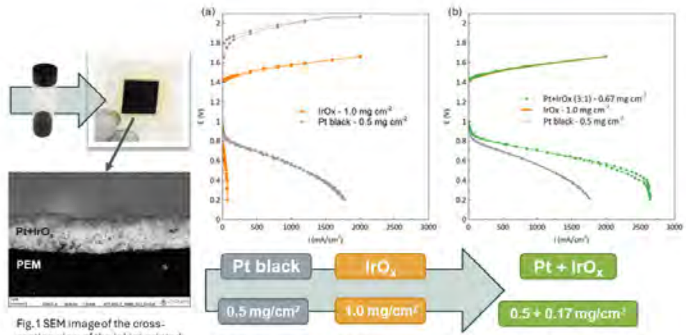

Fig.1 SEM image of the cross-section view of the inkjet-printed mixed catalyst layer.

Fig.2 Polarization curves in fuel cell and water electrolyzer with (a) Pt black and IrOx individually, and (b) compared with the inkjet-printed mixed electrode.

Fabrication of Electrodes for Unitized Regenerative Fuel Cells using Inkjet Printing

Hydrogen energy storage emerges as a promising solution for mitigating the variability of renewable energy sources. Producing hydrogen through electrolysis powered by renewable electricity does not leave any emission footprint during its life cycle. This hydrogen, as an energy carrier, can then be efficiently stored either as a compressed gas or a cryogenic liquid. Additionally, the impressive theoretical specific energy density of fuel cell-based systems renders them appealing in applications such as aerospace where weight and space are critical design considerations. A unitized regenerative fuel cell (URFC) presents a solution, by consolidating an electrolyzer and a fuel cell in one integrated design. This integration has the potential to reduce costs almost by half compared to acquiring separate electrolyzers and fuel cells. Nevertheless, operating with a single unit necessitates designing the system to accommodate both processes, often resulting in compromises to optimize overall performance.

Dr. Marc Secanell and his research team at the University of Alberta have introduced an innovative design, detailed in a publication in the Journal of Power Sources. Their study delved into the impact of varying the platinum (Pt) to iridium oxide (IrOx) ratio and ionomer loading, while maintaining a constant Pt content and total catalyst loadings. This investigation aimed to elucidate the catalyst/ionomer interactions, as well as the effects of overall loadings. To efficiently explore numerous catalyst configurations using minimal amounts of catalyst, inkjet printing (IP) was employed as the fabrication technique. Utilizing IP enabled the creation of several electrodes using less than 50 mg of Pt and Pt/C, providing precise control over total catalyst loading. Notably, this methodology for URFC electrode fabrication has not been previously documented in open literature.

Their proposed design demonstrates one of the highest performances documented in research papers, i.e., an over 50% round-trip efficiency, particularly notable given the low catalyst loading (0.67 $mgPt+IrOx/cm^2$). This remarkable efficiency stems from meticulous optimization of the Pt-to-Ir ratio in cutting-edge catalysts, overall catalyst loading, and ionomer loading. By minimizing catalyst loading and thinning the catalyst layer for bifunctional oxygen electrodes (BOEs), the system achieves low ohmic losses and enhanced mass transport within and out of the catalyst layer. — *Technical Editor, Dr. Sayyed Ali Hosseini*, MCSME

Canada's Commitment to the Expansion of Green and Clean Energy Resources

The Canadian government's Hydrogen Strategy, released in December 2020, outlined an ambitious plan to position Canada as a global leader in clean hydrogen production, utilization, and export, aligning with its net-zero emission goals. In Budget 2023, Canada allocated $21 billion to support clean technologies, including the introduction of the Clean Hydrogen Investment Tax Credit, offering tax incentives ranging from 15% to 40% of eligible project expenses, with higher support for projects generating low-carbon intensity hydrogen.

An exemplary instance of government financing occurred in February 2024 to support the development of a commercial-scale green hydrogen and ammonia facility in Newfoundland and Labrador, the first of its kind in Canada. This collaboration between World Energy GH2, Export Development Canada, and the Canadian government involves approximately $128 million in credit support for Project Nujio'qonik, situated on the province's west coast, aiming to showcase Atlantic Canada as a clean energy frontrunner.

Another government initiative announced in February 2024 aims to promote power generation using nuclear power in Ontario, leveraging Canada's recognized global competitiveness in this sector, addressing rising clean energy demands, and fostering job creation. This initiative supports Bruce Power with federal funding of up to $50 million to explore new prospects of energy generation at its Tiverton site, potentially powering almost five million residential and commercial facilities in Ontario. Furthermore, the Canada Infrastructure Bank revealed a $970-million investment to progress Canada's first small modular reactor (SMR) project at grid-scale at Ontario Power Generation's Darlington site, furthering the country's endeavors toward providing clean energy to its citizens.

The federal government plans to allocate $300 million to Alberta via the Strategic Innovation Fund's Net Zero Accelerator program. Alberta will also contribute $161.5 million to support a $1.6 billion project spearheaded by Air Products Canada Ltd. This initiative seeks to advance the adoption of clean fuels and energy solutions in Canada, fostering the creation of many middle-class jobs. The allocated funds will enable the establishment of a hydrogen production and liquefaction plant in Edmonton, utilizing autothermal reforming and carbon capture technologies. — *Technical Editor, Dr. Sayyed Ali Hosseini,* MCSME

Reference: Article 1

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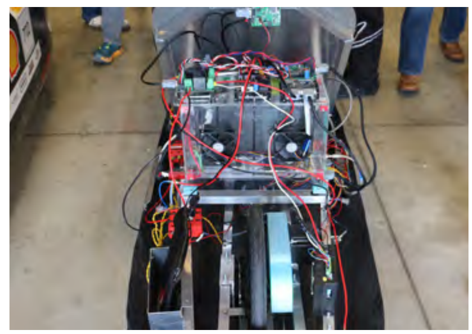
THE SUCCESS STORY OF THE U ALBERTA ECOCAR TEAM

The UAlberta EcoCar team received first prize in the Prototype Concept H2 category at the Shell Eco-marathon Americas 2024. Shell Eco-marathon is one of the world's leading energy efficiency engineering programs that provides a platform for high school and university teams to build their own ultra-energy-efficient cars and take them on the track in competition. The vehicle categories are Prototype and Urban Concept, each of which has its own energy categories such as internal combustion engine (ICE), hydrogen (H2), and battery electric (BE). The UAlberta EcoCar team scored a mileage of 323 km/m3 H2, i.e., 3,882.2 km/kg H2 (a Toyota Mirai has a 5 kg H2 tank), the highest mileage of any hydrogen car in the competition. EcoCar passed technical and safety inspection in under 2 hours and in addition to first prize in the Hydrogen Fuel Cell Prototype category, they also received first prize for the Safety Award and the Spirit of Shell Eco-marathon Award out of over 50 teams. The Safety Award is presented to the Team which demonstrated the best overall Health, Safety, Security, and Environmental (HSSE) performance on site. The Spirit of Shell Eco-marathon Award is presented to a team which demonstrates the spirit and values of the competition such as overcoming obstacles and helping other teams. EcoCar overcame a crash incident in just over an hour and shared spare parts such as a pressure relief valve, tubing and fitting with other teams which allowed them to pass inspection and win. This has been the best year for the UAlberta EcoCar in terms of efficiency, awards, and overall performance as a team. — *Technical Editor, Dr. Sayyed Ali Hosseini*, MCSME



CANADIAN STUDENTS FEATURED AS FINALISTS IN INTERNATIONAL CARBON REMOVAL CHALLENGE

Carbon capture is quickly gaining popularity as a tool to help fight climate change. Direct Air Carbon Capture (DACC), a type of carbon removal technology that takes C02 out of ambient air, shows great promise but is currently an expensive technology. To increase the efficiency of these devices a team of engineering students at Western University have set out to build an autonomous DACC device with a novel 3D printed solid sorbent structure. The Western Engineering Green Technology club was established one year ago with the goal of competing in OpenAir's Carbon Removal Challenge. The Western team has been selected as a finalist out of 28 submissions for this international competition. Along with two other Canadian teams from UWaterloo and TrentU/UOttawa, the Western team will be traveling to New York City in May 2024 to present their DACC device at the Carbon Unbound showcase. — *Technical Editor, Dr. Sayyed Ali Hosseini*, MCSME

Dalhousie University
Dr. Baafour Nyantekyi-Kwakye

Role of vortex dynamics on offshore renewable energy exploration

Increasing levels of concern regarding environmental pollution and greenhouse effect has prompted countries to explore renewable energy (RE) resources and develop technologies to harness them. Offshore wind energy (OWE) is one of the most widely exploited RE resources. Canada has abundant resources to generate OWE and, hence, sets of new and highly efficient technological concepts need to be developed to open the ice-bound waters for exploitation. Two major problems arise: (i) hydrodynamic localized scouring around submerged foundations[1] and (ii) blade icing in cold regions. Icing on offshore wind turbine (OWT) blades changes their aerodynamic shape, reduces output power, and can damage electronic sensors[2]. Increased interest in the development of OWT farms in the cold climate of Canada confirms the need for cutting-edge research on blade icing phenomena. As the director of the Turbulent, Ice and Marine Energy (TIME) lab at Dalhousie University, Dr. **Nyantekyi-Kwakye** and his team are using non-intrusive optical velocimetry techniques (PIV and LDV) coupled with numerical tools to explore turbulent flow analysis and vortex dynamics on power generation. This research aims to explore effective technologies to mitigate scouring, reduce associated hydrodynamic and aerodynamic drag, and prevent ice accretion on OWT blades. The goal of the TIME lab is to develop a solid framework for setting up OWT farms, and wave energy converters for optimized RE production.

Dr. Nyantekyi-Kwakye extensively investigated unsteady flow beneath ice covers[3] and jams, and the turbulent characteristics of submerged three-dimensional offset jets (3DOJ) commonly encountered at hydropower generation stations, as well as in heating, ventilation, and air condition systems. He developed useful correlations for predicting entrainment patterns of 3DOJ and elucidated the role of vortex dynamics to this process. This research was the first to systematically evaluate the interaction between wall roughness, sustained backflow, and high turbulence levels typical in flows downstream of hydropower generation.

In collaboration with Dr. **Xili Duan**, Dr. **Yuri Muzychka**, and Dr. **Rocky Taylor** at Memorial University of Newfoundland (MUN), Dr. Nyantekyi-Kwakye has conducted cutting-edge research on drag reduction using superhydrophobic coating (SHC)[4], de-icing of marine structures[5], and interfacial ice melt[6], respectively. The tested SHC are Ultra Ever Dry, fluoroacrylic solution with fluorinated nanoparticles and FlouroThane-MW. The SHC surface was observed to have formed an imperceptible air layer between the fluid and the surface that led to a reduction in friction drag by 30%. In another collaborative work with Dr. **Kevin Pope** at MUN, we examined turbulent scales (spatial and temporal) through shrouded hydrokinetic turbines and their role on efficient tidal power generation[7]. These projects have provided insights into developing novel strategies to improve the performance of offshore systems for effective RE exploration.

The TIME lab is currently investigating unsteady vortex dynamics around an array of submerged OWT foundations[8]. *Figure 1(a-b)* shows a computational domain of foundations arrays with two inline spacing configurations of $6D_1$ and $8D_1$ (where D_1 is the base diameter of the foundation). The unsteady vortex propagation behind the foundations, depicted in *Fig. 1(c-d)*, provides an indication of the spatial extent required for wake recovery in an OWT farm. The formation of horseshoe vortices and ring vortices around the foundations combine farther downstream to form a complex chain of vortices that influences power generation. The horseshoe vortex at the base, *Fig. 1(c-d)*, facilitates localized scouring and those at the top will impose undesirable hydrodynamic foundation loading, suggesting the urgent need for flow controls. The team at the TIME lab is developing active systems that conform with vortex propagation to mitigate their adverse effects on foundations to prolong their operational life span. Also, the TIME lab is investigating unsteady flow dynamics on ice formation on OWT blades and working to develop effective anti- and de-icing technologies. The goal is to develop a technique that uses a combination of the water repelling properties of SHC and incipient thermal energy for anti- and de-icing OWT blades during winter months.

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Dr. BAAFOUR NYANTEKYI-KWAKYE, PhD, MCSME
Dr. Nyantekyi-Kwakye joined the Department of Mechanical Engineering as an Assistant Professor at Dalhousie University in 2023. He completed his MSc and PhD (2016) degrees at the University of Manitoba, after attaining his BSc degree from the Kwame Nkrumah University of Science and Technology. As the director of the Turbulence, Ice, and Marine Energy (TIME) lab, Dr. Nyantekyi-Kwakye and his team are engaged in research that investigates the role of vortex dynamics on localized scouring, safe operation, and power generation from offshore turbines. The TIME lab also seeks to develop novel anti-icing and de-icing technologies to enhance offshore renewable energy generation in cold regions.

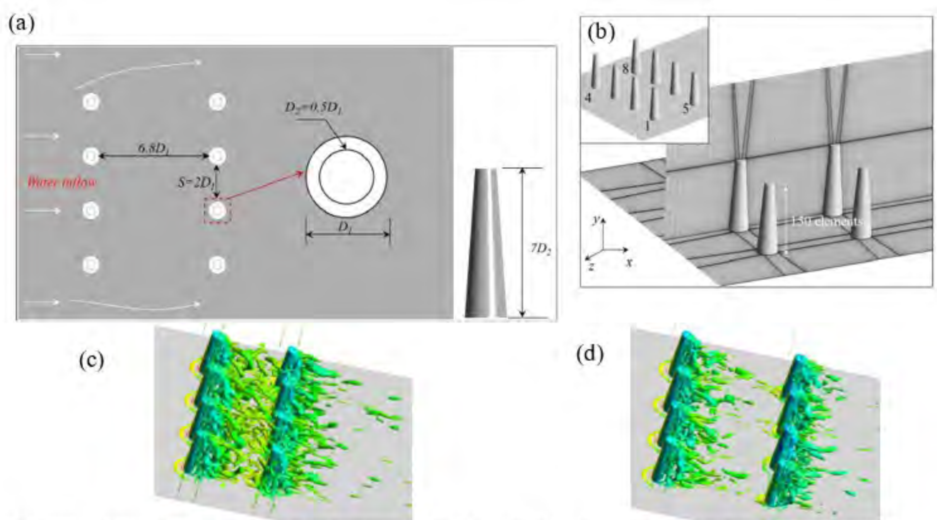

Figure 1: (a) submerged foundation array, (b) near-wall grid refinement, (c) and (d) vortical structures around submerged foundation array. D_1 is the base foundation diameter

University of Calgary Dr. Mayank Sabharwal

In-situ *and* Operando *Diagnostics of Electrochemical Systems*

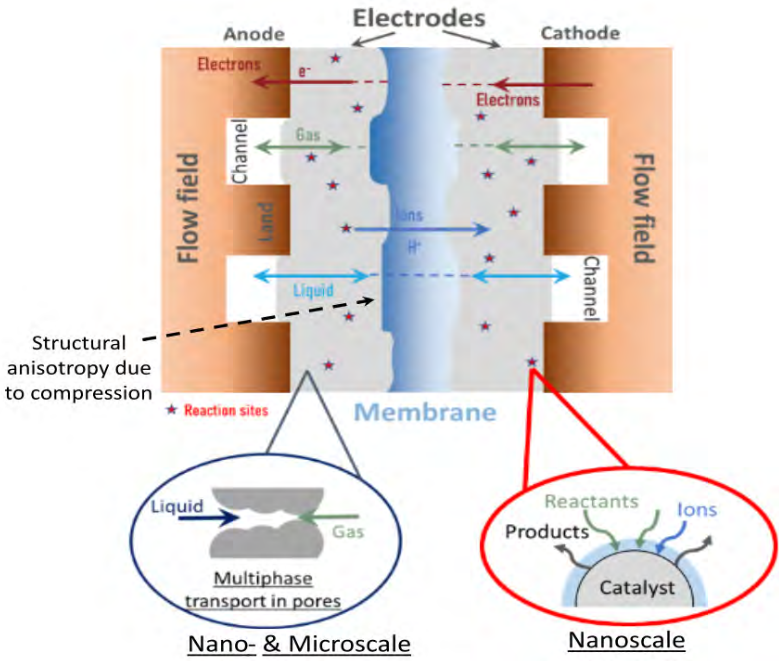

FIG. 1: SCHEMATIC OF AN ELECTROCHEMICAL CELL SHOWING DIFFERENT TRANSPORT AND ELECTROCHEMICAL PROCESSES AND LENGTH-SCALES.

Dr. MAYANK SABHARWAL, PhD, MCSME

Dr. Sabharwal is an Assistant Professor and Chair of Sustainable Hydrogen Engineering in the Department of Chemical and Petroleum Engineering at the University of Calgary. He received his PhD in Mechanical Engineering from the University of Alberta. Thereafter, he was a postdoctoral fellow at Paul Scherrer Institute, Switzerland (2019-2021) and Lawrence Berkeley National Laboratory, USA (2021-2023). Prior to graduate studies, he also worked on fuel cell research for Mercedes-Benz. The focus of his research group is the development of next-generation membrane electrode assemblies for electrochemical systems for hydrogen production and utilization, energy storage and CO_2 conversion to fuels.

Advanced Sustainable energy solutions are critical to control and reverse the effect of unprecedented levels of global warming due to human-induced greenhouse gas emission. The hydrogen economy proposes to use hydrogen as the primary energy carrier. In this scenario, hydrogen is produced using water electrolysis and transported to factories, homes and fueling stations where it can be used as a fuel for power and heat. This can help to decarbonize several sectors such as power generation, automotive applications and chemical industries, such as steel manufacturing and ammonia production. Ideally for a sustainable hydrogen economy, 'green' hydrogen should be produced using renewable electricity and then used as a fuel for power and heat generation resulting in zero carbon emissions. The Laboratory for Electrochemical Energy Devices Research (LEEDR) at the University of Calgary is working to improve the performance and durability of different electrochemical systems, such as fuel cells, water and CO_2 electrolyzers, and redox flow batteries, for hydrogen production and use.

The electrochemical cells (fuel cells, electrolyzers and flow batteries) consist of porous electrodes responsible for the transport of fluids, charge and heat as well as providing high surface area for the electrochemical reactions. Losses associated with the transport phenomena (spanning different length scales; see *Fig. 1*) and reaction kinetics limit the performance and efficiency of the electrochemical cells. Development of high-performance materials with desired properties (such as high activity electrocatalysts, high conductivity supports for water electrolyzers) and novel porous electrode designs (which minimize transport losses) can help improve the performance of these cells. To achieve this, Dr. Sabharwal's group is combining *in-situ* and *operando* imaging-based diagnostics with traditional electrochemical experiments and multiscale numerical modeling to correlate the performance losses to electrode structure and properties and use a data-driven approach to optimize the design of novel porous electrodes. The ultimate goal of Dr. Sabharwal's research is to build a framework which utilizes imaging- and simulation-based diagnostics to facilitate the translation of novel materials to electrodes, thereby addressing a major gap in the current electrochemical systems' research.

In-situ and *operando* x-ray computed tomography (XCT) imaging is ideal to study the multiphase transport in the porous electrodes of electrochemical cells with micron-sized pores due to the high spatial (1-2 µm) and temporal (sub-second) resolution. Sub-second temporal resolution can be achieved at synchrotron beamlines at Canadian, Swiss and Advanced Light Sources. Currently, Dr. Sabharwal's team (in collaboration with researchers at the University of Calgary) is investigating the: *i) effect of local gas bubble formation and transport in the titanium-based porous layer used in proton exchange membrane water electrolyzers, ii) effect of local wettability on liquid-gas interactions in CO_2 electrolyzers, and iii) interactions of suspended solid phase particles with the electrode in multiphase flow systems in redox flow batteries*. Dr. Sabharwal's group performs the imaging experiments using specially designed tomography cells which are miniaturized versions (active area of ~ 1 cm^2) of the actual electrochemical cells. The tomography cell design depends on several factors, including, x-ray attenuation of materials, flow field orientation with respect to the x-ray beam and electrochemical stability of materials. Imaging experiments produce large datasets (several terabytes) which need to be processed to extract meaningful information. Machine learning algorithms are being developed to significantly reduce the processing cost in terms of manual oversight. 3D morphology of the porous electrode from the imaging experiments is used for pore-scale numerical simulations. Imaging and simulation results are combined to provide a wholistic understanding of the transport and electrochemical processes in the electrode and understand the effect of the structure and local anisotropy on the distribution of the multiphase species in the electrode. The insights from these diagnostics are informing the optimization of the electrode structure for the electrochemical cells.

IMAGES COURTESY OF THE RESEARCHERS

Université du Québec à Rimouski
Dr. Maha Bhouri

Hydride-based Materials for Hydrogen Storage and Cold Production

Over the past two decades, materials scientists have focused on developing hydride-based materials with high storage capacities and improved reaction kinetics, particularly for hydrogen storage across various mobile and stationary applications. However, for many applications, the strong exothermic and endothermic nature of hydrogen absorption and desorption reactions, coupled with the low thermal conductivities of these storage materials, presents a challenge.

Traditional heat management techniques in solid-state H_2 storage systems conventionally relied on heat transfer fluid tubes and jackets. However, emerging methodologies have introduced innovative approaches, such as integrating metal hydrides with either phase change materials (PCMs) or thermochemical heat storage materials (TCMs). This integration enables the exchange of thermal energy between the hydride-based material and the thermal energy storage material, whether it's a TCM or PCM, resulting in an overall adiabatic storage system. Nonetheless, the heat storage capacities of these thermal energy storage materials could be hindered by their low thermal properties. Therefore, successfully integrating these energy storage systems requires a deep understanding of the transport phenomena through their storage media and efficient heat integration and management solutions during their hydrogen or heat uptake and release processes. Dr. Bhouri's research interests address these areas through numerical modeling of heat and mass transport in these storage media, as well as implementing efficient thermal management solutions.

During her PhD at the Hydrogen Research Institute (University of Quebec at Trois-Rivieres), Dr. Bhouri collaborated with researchers from the Savannah River National Laboratory (U.S.) to optimize the design of a solid-state hydrogen storage reactor using sodium alanate hydride for light-duty fuel cell vehicles. Her research findings demonstrated the effectiveness of using a metallic honeycomb structure heat exchanger to achieve high H_2 refueling rates without compromising the gravimetric and volumetric capacities of the hydrogen storage system[1]. This innovative concept was subsequently adopted by the DOE Hydrogen Storage Engineering Center of Excellence (U.S.) in the development of an adsorbent-based hydrogen storage system[2]. Her research work at the German Aerospace Centre, focusing on optimizing solar thermochemical energy storage systems and integrating metal and complex hydride hydrogen storage systems in fuel cell forklifts, inspired her to develop a novel adiabatic hydrogen storage system. This innovative concept combines a high-temperature metal hydride with a thermochemical material, resulting in significant reductions in weight and cost compared to an established technology marketed by the French company McPhy and based on the use of a PCM[3].

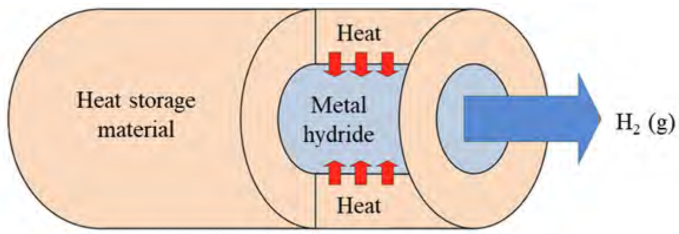

FIG. 1. SOLID-STATE HYDROGEN STORAGE SYSTEM USING HYDRIDE-BASED AND HEAT STORAGE MATERIALS

Dr. MAHA BHOURI, PhD

Dr. Bhouri has been an Assistant Professor in the Department of Mathematics, Computer Science, and Engineering at the University of Quebec at Rimouski since August 2023. Before this, she spent three years as a Teaching Assistant Professor in the Department of Mechanical Engineering at Memorial University of Newfoundland. She earned her PhD in Energy and Materials Sciences from the University of Quebec at Trois-Rivieres, followed by two postdoctoral fellowships at the German Aerospace Centre (DLR) and Dalhousie University. Her research interests focus on advancing the clean energy transition through the development of solid-state hydrogen storage systems and thermal energy storage systems.

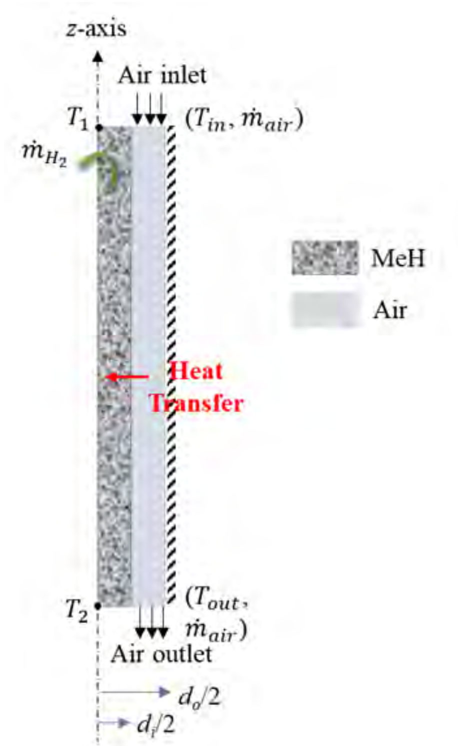

FIG. 2. 2D-AXISYMMETRIC GEOMETRY OF A SINGLE MEH-AIR TUBE.

Currently, Dr. Bhouri and her research team are focusing on exploring the integration of the adiabatic hydrogen storage system concept into stationary applications. Their main goal is to develop a low-cost, high-capacity solid-state hydrogen storage system designed to supply electricity to remote and off-grid communities. Their approach involves combining a low-temperature hydride-based material with a thermal energy storage material to store large amounts of hydrogen at low temperature and pressure while avoiding additional heat management requirements (*Figure 1*). Dr. Bhouri's group also targets exploring the capability of metal hydrides (MeHs) to generate cooling effects under specific operational conditions with hydrogen and air being used as a heat transfer fluid. The feasibility of this concept has been demonstrated through analytical and numerical studies of a simple, modular, air-cooled MeH reactor[4] (*Figure 2*), and research efforts will now focus on investigating the cooling capabilities of MeH-air based heat exchangers, particularly for cooling passenger cabins in electric vehicles or small-scale facilities. The projects' outcomes will guide experimental work and facilitate the design of optimal configurations for hydrogen and thermal energy storage systems. This will lead to the development of efficient and cost-effective energy storage solutions and their integration into transportation and stationary sectors, thereby advancing Canada's transition to a sustainable energy economy.

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University of Alberta Dr. Taha Manzoor

Renewable Thermal Energy Systems

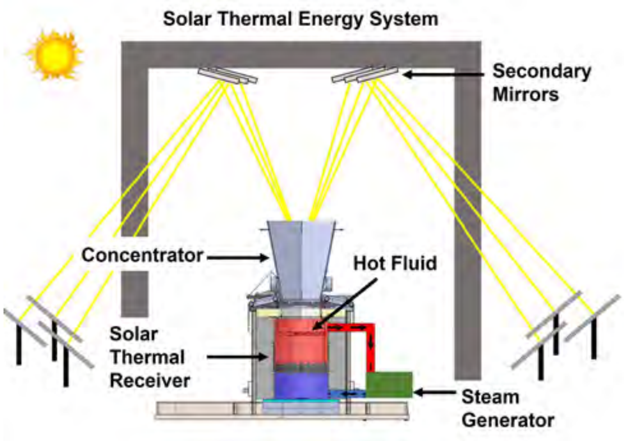

FIG. 1: MODULAR SOLAR THERMAL ENERGY SYSTEMS SCHEMATIC

Dr. Manzoor leads the Renewable Thermal Lab (RTL) at the University of Alberta which focuses on developing low-cost renewable thermal energy systems. The decarbonization of the industrial heat sector, representing 74% of the total industrial energy demand, is critical for combating climate change. Currently, only 9% of this demand is met by renewable sources and the sector heavily depends on fossil fuels. One of the main reasons for the limited share of renewable energy, such as solar and wind, is that they are intermittent in nature. Implementation of a highly intermittent heating infrastructure lacking long-duration storage (> 24 hr) is unreliable and compromises a nation's energy security. The renewable energy market had a global size of $856B in 2021, which is expected to reach $2T by 2030[1]. The thermal energy storage market is expected to grow to 800 GWh of installed capacity by 2030, tripling in size from the 2019 capacity[2]. So far, a commercial scale solution that can effectively target the industrial heat sector at varying temperatures ranges while providing long-duration storage of greater than 24 hours remains unavailable. The RTL focuses on the development of a robust renewable thermal energy system, accelerating the competitiveness, growth, and reputation of Canada's technology and innovation sector.

In recent years, Dr. Manzoor's team worked on the thermal design optimization of modular concentrated solar thermal systems, which are a promising solution to the industrial heat problem (*Figure 1*). These systems use highly reflective mirrors to concentrate solar energy into an open tank filled with high temperature fluids such as molten salts. The solar radiation is absorbed, converted to heat, and stored as thermal energy in a tank. The energy can be dispatched on-demand directly as heat, or converted to electricity by using a steam turbine. The team developed mathematical models which captured the complex interactions between radiation-induced natural convection and volumetric heating, governing the thermofluid response of the system[3]. The models were deployed to optimize the design of the system and later validated experimentally using a high-flux solar simulator (*Figure 2*). Apart from this study, the team developed low-cost concrete based thermal energy storage tanks that can be used to contain high-temperature and highly corrosive molten salts. The team developed lab-scale prototypes and provided a proof-of-concept for concrete based storage tanks by testing them under extreme conditions[4]. These studies acted as a steppingstone towards the development of advanced renewable thermal energy storage systems in Canada.

In the coming years, the RTL will build on these previous studies and extend the investigation of the fundamental heat transfer mechanisms involved in converting solar energy into thermal energy. The RTL will employ a combination of advanced experimental techniques and theoretical modeling to optimize the design and performance of these systems , leading to highly efficient systems and enhancing the market share of these advanced systems. The focus will be on building functional prototypes for the entire system including energy conversion, storage, and heat extraction. The RTL will continue to explore low-cost materials suitable for high-temperature applications, incorporating advanced manufacturing techniques such as 3D printing. The RTL remains eager to collaborate on topics related to radiative heat transfer, buoyancy-driven flows, and materials for extreme environments.

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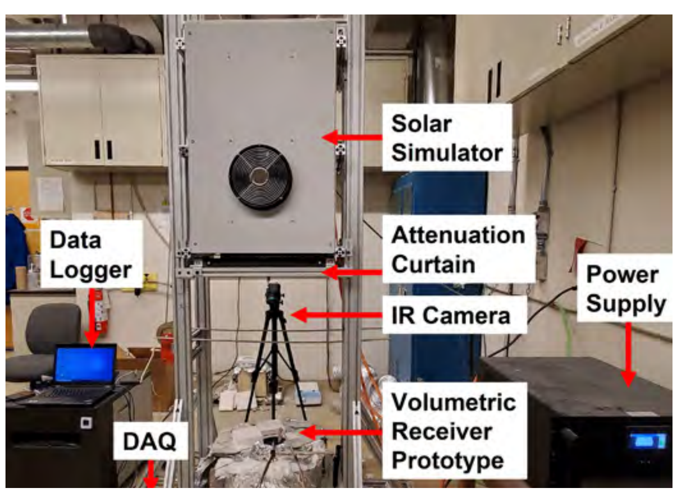

FIG. 2: HIGH-FLUX SOLAR SIMULATOR EXPERIMENTAL SETUP USED FOR MODEL VALIDATION STUDIES.

Dr. TAHA MANZOOR, PhD

Dr. Manzoor is an Assistant Professor, Energy Systems, in the Department of Mechanical Engineering, at the University of Alberta. He received his PhD in Mechanical Engineering from McGill University in 2023. There, he designed the largest solar simulator facility in Canada and received the prestigious Tomlinson Doctoral Award. Prior to that he completed his master's degree from KAIST, South Korea and his undergraduate degree from NUST, Pakistan. As an Energy Storage Specialist at Hatch, he assisted government-owned utilities and leading mining companies in the deployment of commercial-scale energy storage systems. His current research focuses on the development of advanced renewable thermal energy systems.

IMAGES COURTESY OF THE RESEARCHERS

University of Alberta
Dr. Seama Koohi

Sustainable heating and cooling for buildings

Dr. SEAMA KOOHI, PhD, P.Eng.

Dr. Koohi is an Assistant Professor in the Department of Mechanical Engineering at the University of Alberta since September 2022. Prior to joining the University of Alberta, she was an Associate Teaching Professor at Ontario Tech University and an Energy Analyst at WSP (an engineering consulting company) in Toronto since 2017. Her area of expertise is in heat transfer with application to energy systems for buildings and building districts. In the past, she has worked on several energy-related projects, including work on ground-source heat pumps (GSHPs) and ground heat exchanger heat flow models as well as use of the second law of Thermodynamics to improve design aspects of heat exchangers. She has co-authored over 20 journal and book chapter publications as well as two books on GSHPs and tri-generation district energy systems. With her students at the University of Alberta, she investigates ways to develop and improve the efficiency of geothermal and district energy systems.

In Canada, heating and cooling of buildings is primarily based on direct and indirect use of fossil fuels, and as such causes a large contribution to GHG emissions. To lower the emissions related to this sector, various options exist. Energy efficiency improvements in buildings, including those for heating and cooling systems, have been the key contributor in keeping the growth of energy use (and GHG emissions) by buildings at moderate levels[1], but they are lacking pace to meet Canadian goals of Net Zero Emissions by 2050[2]. Dr. Koohi's research is focused on application of thermal sciences to develop and improve energy systems for buildings to achieve higher efficiencies and lower emissions. These goals involve modelling and simulation of Ground-Source Heat Pumps (GSHPs), thermal energy storage and district heating and cooling.

Ground-Source Heat Pumps. Due to the high efficiency of GSHPs and their environmental benefits compared to conventional heating and cooling systems, their application is expected to increase in the coming years. As power generation moves towards use of renewable and sustainable energy sources, the environmental benefits of GSHPs will become even more pronounced since they can use zero-emission electricity to provide heating and cooling. However, their overall sustainability is still debated due to the high initial costs of the ground heat exchangers that are integral to GSHPs, especially when these systems are used in extreme Canadian climates. A key part of the analysis of GSHPs involves examination of heat flows in the ground surrounding ground heat exchangers, as well as their direct relation to the heat pump cycle and the building heating and cooling loads. Dr. Koohi and her team aim to use expertise in analytical and numerical ground heat conduction modelling to improve the design of ground heat exchangers by proposing new component designs and heat exchanger configurations. This would ultimately result in lowering the cost of GSHPs and enhance their adoption in the future.

District Energy Systems. Another efficient method of heating and cooling buildings is through central generation of heating and cooling and distribution via underground thermal distribution networks. Several district energy system designs exist, including one at the University of Alberta, and various aspects of their designs (e.g., source heat and distribution network temperature) can be improved. Low-temperature systems (with thermal networks operating at temperatures below 30°C), in particular, would open energy source options that would otherwise be unavailable for use in buildings. Examples of such energy sources are waste heat from industries and power generation plants, whether using conventional energy sources or using renewable ones, but also waste heat from other buildings. Dr. Koohi and her team focus on mathematical and numerical modelling of thermal energy systems at a system level to optimize design and configuration of next-generation low-temperature district energy distribution networks that are integrated with renewable (e.g., geothermal and solar) and waste energy sources. The insight from this research helps cities and urban planners to propose new energy-efficient urban architectures.

Dr. Koohi's research[3,4] supports achieving Canada's 2030 Emissions Reduction Plan and efforts in reducing GHG emissions through the use of efficient and renewable energy technologies. It would also open economic opportunities for Canadian communities to use heating and cooling energy at more affordable costs.

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The Canadian Society for Mechanical Engineering
A constituent society of the Engineering Institute of Canada

La Société Canadienne de génie mécanique
Une société constituante de l'Institut canadien des ingénieurs

NEWS COMMUNIQUÉ

March 2024

The Canadian Society for Mechanical Engineering (CSME), founded in 1970, is pleased to announce the winning recipients of its 2024 regular awards. These awards may be bestowed to members of the society for their outstanding contributions to specific areas of mechanical engineering in Canada.

In addition to the three previously-announced 2024 technical award winners, five exceptional engineers will be presented with regular society awards during the 28 May banquet of the 2024 CSME International Congress hosted on 26-29 May by the MIE Department of the University of Toronto, ON.

Please consider attending the 2024 CSME International Congress to congratulate all of these exceptional award winners and network with colleagues: www.csmecongress.org.

Clifford N. Downing Award
For "distinguished service to the CSME over many years"

Ali Dolatabadi, PhD, FCSME
Professor, University of Toronto
Toronto, ON

I.W. Smith Award
For "outstanding achievement in creative mechanical engineering within 10 years of PhD degree"

Dan Romanyk, PhD, MCSME
Assistant Professor, University of Alberta
Edmonton, AB

2024 CSME Fellows
For "excellence in mechanical engineering and significant contributions to the progress of the profession"

Carlos Escobedo, PhD, FCSME *(2024)*
Professor, Queen's University
Kingston, ON

Patrick Lee, PhD, FCSME *(2024)*
Professor, University of Toronto
Toronto, ON

André McDonald, PhD, FCSME *(2024)*
Vice-President & Professor, University of Alberta
Edmonton, AB

Call for Nominations – 2025 CSME Awards

Nominations of CSME peers are currently solicited for three of the society's six technical awards, specifically CSME medals for outstanding contributions to the fields of Emerging Technologies, Jules Stachiewicz (Heat Transfer) and Mechatronics medals, and other regular 2025 awards. Note that members cannot nominate themselves – worthy candidates from the diverse CSME community must be nominated by CSME Fellows.

The deadlines for submission are:
Emerging Technologies, Jules Stachiewicz and Mechatronics Technical Awards: **30 September 2024**
All other regular 2025 Awards: **31 January 2025**

For Procedures, Terms/Criteria and the Nomination Form, visit: csme-scgm.ca/awards

Dr. Ali Dolatabadi

Clifford N. Downing Award

Dr. Dolatabadi is a leading researcher and educator in the field of multiphase flows and surface engineering. His research on multiphase flows develops fundamental understanding of sprays for thermal spray processes, and of droplet dynamics, heat transfer and phase change for development and characterization of novel functional coatings. His research group has developed electro-catalytically active electrodes for hydrogen evolution, micro filtration membranes, superhydrophobic, icephobic, and slippery coatings. He has provided valuable and consistent service to the mechanical engineering community through his roles in CSME as well as the Engineering Institute of Canada (EIC).

He was the Chair of Student Affairs on the CSME Board from 2010-2012, was elected Senior Vice President of the CSME (2012-2014) and subsequently President of the CSME (2014-2016). During his mandate as President of the CSME, he collaborated with several stakeholders to build collaborative partnerships and address EDI challenges to better serve mechanical engineers (ME) across the country.

Dr. Dan Romanyk

I.W. Smith Award

Dr. Romanyk is an Assistant Professor in the Department of Mechanical Engineering, with additional appointments in Biomedical Engineering and the School of Dentistry, at the University of Alberta. He also completed his PhD and Postdoctoral Fellowship at the University of Alberta. Dr. Romanyk's primary areas of research surround the mechanical characterization of natural and synthetic biomaterials in the craniofacial environment and studying the biomechanics of orthodontic treatment. In 2022, Dr. Romanyk served as the Planning and Events Chair for the CSME International Congress, where he was also named as the Chair of the Student Affairs Committee. Through both research and service activities as an early-career academic, Dr. Romanyk has made significant contributions to the field of mechanical engineering.

Dr. Carlos Escobedo

Fellow

Dr. Escobedo is a Full Professor at Queen's University who served as Technical Chair for the CSME for five years, and continues to volunteer for the society to the present. He holds a BEng (UNAM, MX), a master's (U Toronto) and PhD (U Victoria) in Mechanical Engineering and has ample industrial experience. He was founder and head of the Mechanical Engineering Division at Innovamedica R&D, where he was part of a team that developed an artificial heart that was commercialized and successfully implanted in humans. His contributions to the nanotech-based sensing field include multiple articles and co-authored IP that led to the creation of the multi-awarded startup Spectra Plasmonics. He is the recipient of several awards including the Excellence in Research Award (Queen's), the Early Researcher Award (Ontario Government), and the TD Bank's 10 Most Influential Hispanic Canadians Award which honours 10 outstanding Hispanics from across Canada each year.

Dr. Patrick Lee

Fellow

Dr. Lee received his PhD in Mechanical Engineering from the University of Toronto in 2006 and is the founding director of Multifunctional Composites Manufacturing Laboratory at the University of Toronto. Dr. Lee is an international leader in the areas of polymer foam processing/characterization, nanolayered composites, bioinspired hybrid composites, and processing-structure-property relationships of nanocomposites and foams. He has 95 journal publications, over 140 refereed conference abstracts/papers, five book chapters, and 30 filed/issued patent applications and invention disclosures.

Among his honors, Dr. Lee received the G.H. Duggan Medal from CSME in 2020, the U.S. National Science Foundation Early Faculty Career Development Award (NSF CAREER) in 2018, the Polymer Processing Society (PPS) Morand Lambla award in 2018, and the Hanwha Advanced Materials Non-Tenured Faculty Award in 2017.

Dr. André McDonald

Fellow

Dr. McDonald is the Associate Vice-President (Strategic Research Initiatives and Performance) and a Professor of Mechanical Engineering at the University of Alberta. His work in heat transfer has been innovative, diverse, interdisciplinary, and sits at the nexus of heat transfer, materials science, and advanced manufacturing. His research on the metallization of polymers is internationally recognized as cutting-edge work on the functionalization of polymeric structures to provide heating for airfoils and mitigate freezing in pipes.

Through leadership roles as President of the ASM Thermal Spray Society Board, Editor-in-Chief of the *Journal of Thermal Spray Technology*, and Director of the Experiential Learning in Innovation, Technology, and Entrepreneurship Program for Black Youth, he has facilitated dissemination and awareness of new knowledge and technology development and supported work-integrated training of engineering students through academic-government-industry-community partnerships.

STUDENT AFFAIRS REPORT

CSME

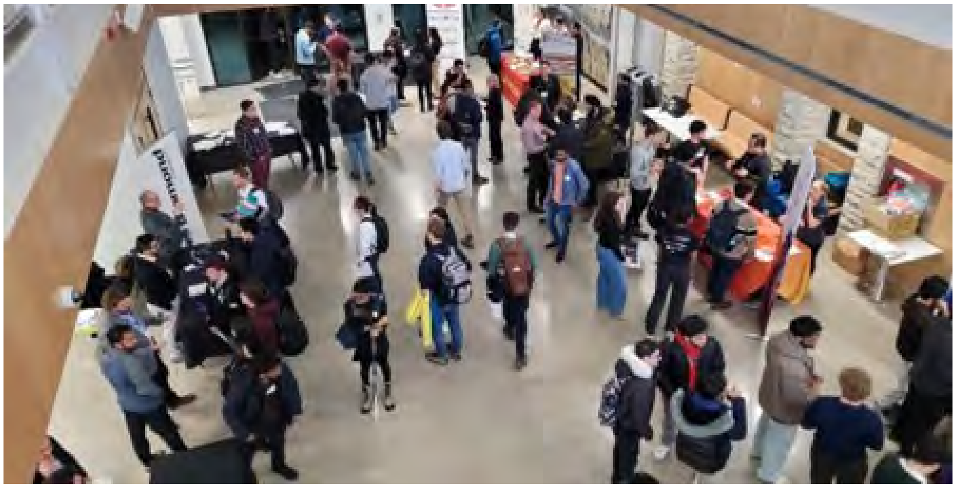

PHOTO ABOVE: WESTERN UNIVERSITY INDUSTRY SPOTLIGHT NIGHT

AS CSME LOCAL STUDENT CHAPTERS have become official with established charters, we are now focusing on increasing the activity of local chapters through professional development events and outreach. Specifically, we are trying to increase the in-person presence they have within their areas. The Western University Local Chapter held an Industry Spotlight Night in collaboration with Western Engineering Career Services on January 25, 2024 to facilitate connections between local industry and undergraduate students. The event was extremely successful and attracted local industry representation from: Ferrero Canada, Great Lakes Copper Ltd., Dr. Oetker Canada Ltd., General Dynamics Land Systems-Canada, Formet Industries, ArcelorMittal Dofasco, Diamond Aircraft Industries Canada, Schaeffler Canada Inc., and Parker Hannifin. In a similar manner, the University of Alberta Local Chapter held an in-person Industry Mixer on March 8, 2024 where industry representatives from Shell, Atco, and Volant were present. It is exciting and encouraging to see the return of in-person local chapter student events taking place with such success (*appended event pictures)*. The focus for the upcoming year will be to increase networking among active local chapters and facilitate further professional development events held by chapters.

Efforts throughout 2023/2024 surrounding the National Design Competition (NDC), led by Grant McSorley, focused on expanding interest in the event and increasing the number of submissions for this year's competition. We have made extensive use of student (i.e. local chapters) and department networks to spread word of the NDC. We opted to have the same key themes focusing on projects that consider tackling climate change, affect social changes, and demonstrate exceptionalism in mechanical engineering. We are very hopeful that our added efforts in advertising and increase in student network activity will help to increase involvement in this year's NDC. For any questions or matters surrounding the CSME NDC, please feel free to contact Grant McSorley (gmcsorley@upei.ca)

PHOTO BELOW: UOFA CSME LOCAL STUDENT CHAPTER INDUSTRY MIXER

Current local chapters:

- Western University
- University of Toronto
- University of Alberta

For any questions surrounding the formation of CSME Local Student Chapters or associated events, please contact Dan Romanyk (dromanyk@ualberta.ca) as the SAC Chair.

2025 Engineering Institute of Canada Awards

The Engineering Institute of Canada (EIC) is accepting nominations for its 2025 senior awards and EIC fellowship inductees. The deadline for nominations is midnight, 15 November 2024 for awards to be remitted at the EIC Gala in April 2025. Nomination rules and form can be found on EIC's website: eic-ici.ca/honours_awards/nomination

Dr. LATIF IBRAHEEM, PhD

Dr. Ibraheem is a leader in thermofluids and energy systems research at Shield Group of Companies, located in Mount Pearl, Newfoundland, Canada, where he serves as the Director of Research and Development. Leveraging his PhD in Mechanical Engineering from Western Michigan University and his M.Sc. in Energy Systems Engineering from Memorial University, Dr. Ibraheem brings a depth of knowledge to his role. His research interests span heat transfer, renewable energy, and aerodynamics, as evidenced by his prolific publication record. Dr. Ibraheem fosters innovation and excellence in mechanical engineering by bridging the gap between academic theory and industry application.

Q: How will thermal insulation help meet Canada's net-zero targets?

Thermal insulation, particularly removable insulation solutions like those developed by Shield Group, plays a crucial role in reducing energy consumption within the oil and gas, marine, buildings, and broader industrial sectors. These industries rely heavily on maintaining optimal temperatures in pipes, vessels, and equipment for efficient operation.

Shield Group's focus on removable insulation offers a two-fold benefit:

Energy savings: Our high-performance insulation solutions minimize heat loss from pipes and equipment, leading to significant reductions in energy consumption required to maintain desired temperatures. This translates to lower operational costs for our clients.

Reduced emissions: Removable insulation lowers greenhouse gas emissions associated with industrial processes by minimizing energy usage. This aligns with the overall goal of reducing Canada's environmental footprint.

Furthermore, the reusability of Shield Group's removable insulation solutions offers an additional sustainability advantage. Unlike traditional insulation that may need replacement after a single use, our removable jackets and covers can be easily removed for maintenance or inspection and then reinstalled. This significantly reduces waste and contributes to a more environmentally conscious approach within the industrial sector.

Q: What are the most important advancements in the area of thermal insulation over the past decade?

The past decade has seen exciting advancements in thermal insulation:

High-performance materials: The development of new materials with superior thermal resistance allows thinner insulation layers to achieve the same level of performance. This translates to lighter building structures and potentially increased usable space within buildings and industrial applications.

Aerogels and nanotechnology: Innovation in materials like aerogels, with their exceptional thermal resistance and low weight, offers exciting possibilities for future insulation solutions. Nanotechnology also promises to create even more efficient insulation materials with tailored properties.

Sustainable insulation solutions: Increased focus on environmentally friendly materials like bio-based and recycled content insulation promotes sustainability within the construction industry.

Q: Why does your company collaborate with academics? What are the benefits?

Shield Group actively collaborates with academics for several reasons:

Cutting-edge research: Universities and research institutions are at the forefront of developing new and innovative insulation materials and technologies. Collaboration allows us to stay informed about the latest advancements and integrate them into our product development.

Talent pipeline: Universities are a valuable source of skilled engineers and scientists. Collaboration fosters a strong connection with academia, allowing us to identify and recruit top talent for our R&D team.

Joint research projects: Partnering with academics enables us to tackle complex research challenges related to thermal insulation. This collaborative approach can lead to groundbreaking discoveries and advancements that benefit the entire construction industry.

Q: Why are you interested in thermal insulation?

At Shield Group, we are passionate about thermal insulation because it directly contributes to a more sustainable future. By developing and promoting efficient insulation solutions, we can help reduce energy consumption in industrial applications and minimize environmental impact. It's an area with constant innovation and the potential to make a significant difference in achieving net-zero goals.

Q: What does your company think the future holds in your research area?

The future of thermal insulation is bright and filled with exciting possibilities. We anticipate advancements in several areas:

Further material development: Continued research will lead to even higher-performing insulation materials with improved thermal resistance and potentially new functionalities.

Integration with building systems: Insulation solutions may become more integrated with building systems and a broader range of industrial applications, allowing for smarter and more energy-efficient operations.

Focus on sustainability: There will be an ongoing push for even more sustainable insulation solutions, using recycled content and bio-based materials while minimizing environmental impact during production and disposal.

Shield Group is committed to being at the forefront of these advancements, developing innovative insulation solutions that contribute to a more energy-efficient and sustainable future for Canada's building industry.

Call for Applications

Editor-in-Chief, Transactions of the Canadian Society for Mechanical Engineering (TCSME)

The Transactions of the Canadian Society for Mechanical Engineering (TCMSE) is looking for an Editor-in-Chief to succeed Dr. Marius Paraschivoiu, whose term ends June 30, 2024.

THE JOURNAL

TCSME (cdnsciencepub.com/journal/tcsme) is a quarterly journal that features high-quality research from international authors across a wide range of mechanical engineering disciplines, with a focus on multidisciplinary advancements in the field and novel technology developments. *TCMSE* published its first issue in 1972. The journal is affiliated with the Canadian Society for Mechanical Engineering (csme-scgm.ca) and is published by Canadian Science Publishing, an independent not-for-profit science publisher.

THE ROLE

The Editor-in-Chief is responsible for securing quality journal content, issuing editorial decisions, shaping editorial priorities, and guiding journal development. This involves:

- working with the publisher on journal direction, priorities for journal growth, and strategies to enhance the journal's reputation and attract high-quality content;
- building relationships and working with journal stakeholders to expand author and reviewer pools that include more diverse voices and perspectives;
- managing a board of Associate Editors who handle manuscripts through peer review;
- issuing decisions on manuscripts following the Associate Editor's recommendations;
- appointing and working with Associate Editors who represent the diverse disciplines and populations the journal serves; and
- holding the journal to a high standard of peer review and ethical best practice in research and reporting.

The Editor-in-Chief reports to the Executive Editor-in-Chief at Canadian Science Publishing. Editor-in-Chief is a volunteer position.

WHAT WE'RE LOOKING FOR

The ideal Editor-in-Chief for TCSME:

- is a member in good standing with the Canadian Society for Mechanical Engineering;
- is a leader in their research community, well positioned to help grow the volume of quality, Canadian submissions to the journal;
- is experienced as an editorial board member, a guest editor, or an editor and is familiar with trends in scientific journal publishing; possesses a strong understanding of research integrity, and of peer review and publication ethics;
- shares the publisher's goals to advance open science and to promote equity, diversity, inclusion, and accessibility within the board, journal, and field;
- is willing to be a confident champion for the journal within their own networks, and is committed to reach out to new, previously excluded or untapped communities;
- communicates effectively, tactfully, and promptly with journal stakeholders; and
- can dedicate time on a regular basis to support and grow the journal.

APPLICATIONS SHOULD INCLUDE

- Full CV
- A letter (maximum 2 pages) including: (A) a summary of your editorial experience and why you are interested in this role, and (B) a brief description of your vision and goals for the journal over the next few years, including how you would build on the journal's success and how you would promote equity, diversity, inclusion, and accessibility within the journal.

Canadian Science Publishing is committed to equity, diversity, inclusion, and accessibility (EDIA) and seeks to ensure that journal leadership reflects the diverse identities and characteristics of its research communities. We encourage applicants to highlight any additional information about their background that would contribute to this diversity of perspective and lived experience.

APPLICATIONS AND NOMINATIONS ARE DUE BY MAY 1, 2024.

Ideally, the term would begin June 1, 2024, enabling overlap with Dr. Paraschivoiu; length of term is negotiable.

Applications and nominations should be sent to **Lucy Shen** (lucy.shen@cdnsciencepub.com).

MECHATRONICS PROGRAM AT SIMON FRASER UNIVERSITY

SFU SCHOOL OF MECHATRONIC SYSTEMS ENGINEERING (MSE) CELEBRATES 10 YEARS.

MECHATRONIC SYSTEMS ENGINEERING (MSE) at Simon Fraser University (SFU) started as a concentration within the School of Engineering Science in the Faculty of Applied Science (FAS) in 2007, with Prof. **Farid Golnaraghi** serving as its founding program director. The first Bachelor of Applied Science (BASc) in Mechatronics class had 85 students. The MSE PhD and Master of Applied Science (MASc) programs were launched in 2008. The first undergraduate class graduated in 2011, and the MSE program received its official accreditation by the Canadian Engineering Accreditation Board (CEAB) in the same year. In 2013, MSE became an independent school within FAS with an enrollment of 586 undergraduate and 100 graduate students and Prof. Farid Golnaraghi serving as its founding school director. The School of MSE celebrated its 10th anniversary in 2023 with a vibrant curriculum and world-class research portfolio. The mission of the School of MSE is to advance knowledge, enable applications, and train future high-tech leaders through research and education in the technical fields of sensing, actuation, intelligent systems, advanced manufacturing, healthcare, power, and energy. We value creativity, innovation, teamwork, equity, diversity and inclusiveness.

Our dynamic program at the state-of-the-art Surrey campus takes a unique multidisciplinary approach. We combine electronic, mechanical, and software engineering to train our students to tackle real-world problems with synergistic and inventive solutions. We teach students how to innovate and actualize solutions in the marketplace, adding essential communication and business skills that bring elegant new problem-solving products to the real world. In 2015, we launched the Technology Entrepreneurship (Tech-e) Certificate Program in partnership with SFU's Beedie School of Business. These entrepreneurial building blocks train our students to create and manage their start-up companies. Many start-up companies were founded by our students/alumni over the relatively short period of MSE, often with the technical concepts and teams formulated while they were still in school. Moment Energy, Intuitive AI, and IUVOX are just some successful stories.

Our rigorous MSE curriculum is planned with the real-world in mind. Students are trained in vital hands-on technical skills, while our mandatory co-op program provides invaluable practical experience, connecting students directly to future employers who recognize the value of their cross-discipline skills. It's why our graduates are highly sought-after among potential employers with an almost 100% job placement record.

Our faculty members are amongst the most active researchers in the field, and they have received a total annual research grant award of around $5M for the past ten years. They are engaging in many exciting research projects, ranging from gravity sensors for lunar exploration to ex-skeleton robotics to 3D printing to fuel cell and hybrid thermal/electric microgrids to biomechatronics. They're the bedrock of our convergence of multidisciplinary skills – and the reason our students forge successful careers in diverse fields from automotive to robotics to biomedical and aerospace.

Breakthrough technologies, such as artificial intelligence, robotics, Industry 4.0, and the Internet of Things, profoundly change how we live, learn, and work. SFU's School of MSE and other MSE programs worldwide have a unique opportunity—through research and teaching—to provide the critical link between the cyber and physical worlds in an increasingly cyber-physical society. The profound experience and innovative spirit of our students, faculty, staff, and alumni in sensing, actuating, and system integration make us uniquely positioned for this crucial role.

We have recently launched two new initiatives to address these changing needs. Our new Master of Engineering in Smart Manufacturing and Systems program aims to prepare professionals for Canada's Industry 4.0 and digital transformation. Unlike the conventional thesis-based masters programs, we emphasize hands-on training in our state-of-the-art Smart Manufacturing Hub, which mimics a modern smart factory, a mandatory industrial internship, and core courses in Industry 4.0, Industrial Internet of Things, Big Data Analytics, 3D Manufacturing, Machine Learning, and AI. Our new BASc in Mechatronics Agri-tech Concen-

Dr. Z. JOHN SHEN, PhD, P.Eng.
Dr. Shen has been a professor and director of the School of Mechatronic Systems Engineering at Simon Fraser University, Canada, since 2022. He received his BS from Tsinghua University, China, in 1987, MS, and PhD from Rensselaer Polytechnic Institute, Troy, NY, USA, in 1991 and 1994, all in electrical engineering. He has 34 years of academic, industrial, and entrepreneurial experience in the field of power electronics and power semiconductor devices and ICs. He has authored or co-authored over 350 publications and 20 issued US patents. He is a Fellow of IEEE and the US National Academy of Inventors.

tration program aims to provide students with specialized, hands-on training in biology, precision agriculture, bioprocess and biosystems engineering, and standard MSE courses. The goal is to address the agritech workforce need in BC's food production revolution.

In addition, MSE offers several short courses to both students and practitioners from the industry. We have been offering the Siemens Mechatronic Systems Certification Program (SMSCP) since 2017, a comprehensive industry skills certification program offered in collaboration with Siemens, a world-leading manufacturing company. SMSCP focuses on system understanding, troubleshooting, and problem-solving skills through a learn-by-doing approach, which has been used in training Siemens employees. We have trained hundreds of participants to receive their Level 1 and 2 SMSCP certificates. We recently completed a Level 3 SMSCP short course to train and qualify Level 1 and Level 2 trainers for the very first time in the history of SMSCP worldwide. We also regularly offer bootcamp short courses to industrial participants on Smart Manufacturing, Industrial IoT, and Agritech.

One major challenge with our current curriculum is the high credit hour requirement (currently at 148) and long graduation time

(on average 5.7 years), partially due to the multidisciplinary nature of mechatronic Systems Engineering. This puts us at a disadvantage in competing with computing science (120 credit hours) and negatively impacts the students' college experience. Still, it also leaves no room to integrate emerging technical topics such as AI, machine learning, data analytics, IoT, etc. We are undergoing a major curriculum reform to consolidate and merge several conventional MSE courses while adding new digital control and programming courses and project-focused hands-on design studio courses. We wish to explore solutions to this common challenge through discussions and collaborations with colleagues from other MSE programs in Canada and worldwide.

Mechatronics is a thriving field and a great career for students to choose as society and industry become increasingly cyber-physical. However, we need to adapt to the emerging challenges to remain relevant and vibrant.

In Memoriam
Remembering David Stewart Weaver (1940-2023)

Dave was a 1998 FCSME, a 1997 Past-President of the Society, and the recipient of many other honours and awards bestowed by the CSME and other technical / professional organizations such as the American Society of Mechanical Engineers, and the Canadian Academy of Engineering. Professor David S. Weaver was a distinguished member of the McMaster University faculty since 1971 and a revered chair of the Mechanical Engineering Department.

As President of the Canadian Society for Mechanical Engineering, he left an indelible mark on the community. He became a permanent member of the CSME Board of Directors, remembered fondly by all Board members over three decades for his insightful history of our mechanical engineering society.

Professor Weaver was a beacon of professionalism in research, setting a standard for excellence and integrity. His belief in the power of mentorship transformed the lives of countless graduate students, whom he often reminded that "technology is transferred to industry through graduate students". His legacy will live on through the innovations and achievements of those he mentored.

Until very recently (2022), he was a great support to successive CSME Boards of Directors in the role of Honorary Secretary of the society for many, many years. His corporate memory, sound advice and friendship were invaluable and highly treasured by many of us. He will be greatly missed.

TECHNICAL COMMITTEE REPORTS

Computational Mechanics

The interests of this TC include the development of new algorithms and non-standard applications of existing algorithms. Routine use of software packages for various simulations falls outside its interests.

- The TC has completed its website.
- The TC participates in the activities of the International Association for Computational Mechanics. The distribution of individual memberships among its members is being completed.
- The TC is organizing a Symposium on Computational Mechanics as a part of the 2024 CSME Congress. This Symposium is sponsored by the Canadian National Committee for Mechanics (IUTAM).

– *Dr. J.M. Floryan*, FCSME

Fluid Mechanics

Dr. Dana Grecov from the University of British Columbia has served as the Chair, and Dr. Fabian Denner from Polytechnique de Montreal has served as the Vice-Chair of this TC since July 2023.

The TC Chair, Vice-Chair, and a local Co-Chair are currently serving as the Co-Chairs for the F*luid Mechanics Engineering Symposium* at the CSME 2024 Congress. Similar to previous years, the Chairs have been responsible for reviewing the submissions (50 abstracts and papers) for the Fluid Mechanics symposium

The TC organized a webinar series. The second webinar, on April 11th, featured Dr. Dennice Gayme from Johns Hopkins University on the topic "Wind farm modeling and control."

The TC chair has served as an associate editor for *TCSME*.

— *Dr. Dana Grecov*, FCSME

Manufacturing

Current activities:

1. Serving as an associate editor for the Transactions of the Canadian Society for Mechanical Engineering (TCSME).
2. Organizing the Manufacturing symposium at the 2024 CSME Congress at the University of Toronto.
3. Organizing the CSME webinar series on Manufacturing.

Future activities:

1. Continuing to serve as an associate editor for TCSME.
2. Continuing the CSME webinar series on Manufacturing, featuring both international and national invited speakers.

– *Dr. Farbod Khameneifar*, MCSME

Materials Technology

- Ali Nasiri is helping with the organization of the CSME 2024 Congress at U of T.
- Committee membership has been updated and now we have representatives from most Canadian universities.
- The technical committee web page has been updated with the new list of members.

– *Dr. Mamoun Medraj*, MCSME

Mechatronics, Robotics and Controls

- Recruiting active members from different universities and regions; significantly increased the number of TC Members and organized contact list and updated the website.
- Currently organizing the Symposium on MRC that will be held during the CSME 2024 Congress. Finalizing the program and schedule of the symposium.
- Ad-hoc Panel Discussions on Topics of Interest (on going).
- Webinar: Feb. 19, 2024: Dr. Victor Huang; "Overview of IEEE Standards Development"
- MRC Three-Minute Contest: Plan to organize this in 2024; graduate students in the field of mechatronics, robotics and controls are welcome to participate in the contest.
- Sketching the domain of Mechatronics technical areas, academic scope, and relevant industries in Canada (in process).

– *Dr. Yang Shi*, FCSME

Microtechnology and Nanotechnology

1. Dr. Wen has reached out to the field and identified a vice chair, Prof. Xian Wang from the Queens University. Xian joined the TC in later 2023;
2. Both Prof. Wen and Prof. Wang, together with Prof. Edmond Young, reviewed all abstracts and papers which were submitted to CSME/CFD2024. Recommendations have been made.
3. A list of colleagues working in the field has been identified.
4. Webinars on research strengths and recent technology breakthroughs of the related members is being scheduled.

— *Dr. John Wen*, MCSME

Solid Mechanics

- Prof. Akbarzadeh, Prof. Khondoker, and Prof. Azhari serve as CSME Solid Mechanics Symposium Chair and Co-Chairs at CSME/CFD2024 Congress in Toronto.
- CSME Solid Mechanics Symposium has been promoted among solid mechanics community in Canada and international mechanics community.
- In collaboration with TC Chairs of Fluid Mechanics and Computational Mechanics and CSME Executive, Prof. Akbarzadeh, as the Chair of Solid Mechanics TC, has contributed to updating the CNC-IUTAM mandate and members.
- Prof. Chun II Kim and Prof. Marwan Hassan have accepted to serve as members of CNC-IUTAM on behalf of Solid Mechanics TC.
- Prof. Akbarzadeh co-edited the Fall 2024 edition of CSME *Bulletin* on "Advanced solids and structures".
- Prof. Zengtao Chen and Prof. Akbarzadeh co-organize a mini-symposium at 16th World Congress on Computational Mechanics and 4th Pan American Congress on Computational Mechanics in Vancouver in 2024.
- Prof. Akbarzadeh has been serving actively as an Associated Editor in *Transactions of the Canadian Society for Mechanical Engineering* for papers submitted in the area of solid mechanics and manufacturing.

— *Dr. Hamid Akbarzadeh,* MCSME

Transportation Systems

CSME 2024 Congress

- The TC members reviewed 2 abstracts and 15 papers submitted to the Symposium of Transportation Systems at 2024 CSME Congress at University of Toronto, May 26-29, 2024.
- Dr. Yuping He (TC chair) and Dr. Bruce Minaker (TC vice chair) will co-chair the Symposium.

TCSME

- Dr. Yuping He (TC chair) serves as an associate editor of *TCSME*.

— *Dr. Yuping He,* FCSME

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FEATURES *Cont'd . . .*

Drs. Amiri, Poncet, Mousavi Ajarostaghi, Decarbonizing the Future (p. 10-11)

Acknowledgment
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Dr. Maha Bhouri, Hydride-based Materials for Hydrogen Storage and Cold Production (pg. 17)

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WELCOME NEW CSME/SCGM MEMBERS

1 OCTOBER 2023 TO 30 APRIL 2024

Mr. Kenneth Adele
Prof. Mohammed Jalal Ahamed, *University of Windsor*
Dr. Khurshid Alam, *Sultan Qaboos University (Oman)*
Dr. Shams Anwar, *University of Waterloo*
Dr. Ikechukwu Anyanwu, *Université du Québec*
Dr. S.M. Amin Arefi, *University of British Columbia*
Mr. Jonathan Athaide, *Trophy Foods Inc.*
Dr. Anwar Demsis Awol, *University of Western Ontario*
Dr. Mohammad Rezasefat Balasbaneh, *University of Alberta*
Mr. Cordell Barron Aon
Ms. BhawiBhawya,*University of Windsor*
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Dr. JoshuaBrinkerhoff, *University of British Columbia*
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Dr. Sylvester Djokoto, *BlueFalls Manufacturing*
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Ms. Fatemeh Haghayegh, *York University*
Dr. Amir Hossein Behravesh, *University of Toronto*
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Dr. Sima Baheri Islami, *Zinc8 Energy Solutions Inc*
Dr. Basel Ismail, *Lakehead University*
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Dr. Charles Chelem Mayigue, *University of Toronto*
Dr. Scott Noble, *University of Saskatchewan*
Dr. Baafour, Nyantekyi-Kwakye, *Dalhousie University*
Prof. Onaizah Onaizah, *McMaster University*
Prof. Dominique Poirel, *Royal Military College*
Dr. Lina Rose, *University of Windsor*
Dr. Mayank Sabharwal, *University of Calgary*
Dr. Mohammad Saeedi, *Dalhousie University*
Dr. Nitish Ranjan Sarker, *University of Toronto*
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Dr. Surendra Verma
Prof. Viet-hung Vu, *Royal Military College*
Prof. Xian Wang, *Queen's University*
Dr. Anqi Wang, *University of Waterloo*
Dr. Chao Yan, *McGill University*
Dr. Mohammad Zargartalebi, *University of Toronto*
Prof. YongZeng, *Concordia University*

Calls for Submissions

Advanced Solids & Structures

As the editors of the Canadian Society for Mechanical Engineering (CSME) Bulletin, I would like to invite you to submit any of the following items for consideration for publication in the next CSME Bulletin issue.

The next issue focuses on **Advanced Solids and Structures** and will be published in November 2024. The guest editors of this issue will be the chair of the CSME Solid mechanics technical committee, Prof. **Hamid Akbarzadeh**, and the chair of the CSME Materials Technology technical committee, Prof. **Ali Nasiri**.

- **Feature articles:** The aim of the featured articles is to give our readers an overview of a given sub-topic of the theme (Advanced Solids and Structures), the most recent advancements in the area, and finally, the most critical aspects for future research. The article should be 1,200 words (9,000 characters including spaces) long. If you are interested in submitting a featured article, please submit an Expression of Interest (EoI) by sending a 300-word abstract of the article and a 50-word biography to either Marc Secanell (secanell@ualberta.ca) or Ryan Willing (rwilling@uwo.ca) by by July 15th, 2024. The most significant contributions will be invited to submit a full featured article that will be due on October 1st, 2024.
- **Faculty spotlight:** This section highlights new faculty in the Mechanical Engineering Departments across Canada within 4 years of their appointment, ideally working on the topic of the issue (though not essential). The aim of this section is to introduce new faculty members to the CSME community; therefore, the article should provide a short biography, an introduction to your research (what is the topic of your research? why is the research topic important?), and a description of your laboratory including past and future work. If you are eligible and interested in submitting an article, please submit an Expression of Interest (EoI) by sending a 100-word abstract and a 50-word biography to either Marc Secanell (secanell@ualberta.ca) or Ryan Willing (rwilling@uwo.ca) by July 15th, 2024. The most significant contributions will be invited to submit a full article (500 words or 4,000 characters) that will be due on October 1st, 2024.
- **Short news:** Items of interest to the ME community prior to September 15th, 2024.
- **Recognitions:** Highlighting the achievements of ME peers (not self) prior to September 15th, 2024.
- **In memorials:** Recognizing the passing of ME members prior to September 15th, 2024.

For examples of the above, please see previous issues at www.csme-scgm.ca/bulletin.

Thank you for your consideration. We look forward to hearing from you soon.

Marc Secanell, PhD, P.Eng.
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