H_2 and Fuel Cells

Book of Abstracts

Montreal, Canada—July 23, 24, 25, 2025

Contact Information of the Project

Project Website:
https://h2excellence.eu/

Email address:
jildimarasantana@gmail.com

Funded by the European Union

This project has been funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

Jildimara de Jesus Santana
Olga Guerrero
Gregory S. Patience

July 22, 2025

Universidad de Málaga

Fundación Unicaja

Cycle Momentum

propolys

Università degli Studi di Padova

PENG
Green fuels from wasted natural gas

SIEMENS

Harnois Énergies

Charbone Hydrogen

University of Oxford

Massachusetts Institute of Technology

University of Waterloo

CanmetÉNERGIE
VARENNES
CanmetENERGY

UQTR
Université du Québec à Trois-Rivières

McGill University

DNV

Université Concordia University

CRATOS
Creating tomorrow's solutions

Contents

Section 1

Preface

The future of energy is being reshaped by a collective commitment to sustainability, innovation, and international collaboration. It is with great enthusiasm that we present this conference booklet, a reflection of the global effort to accelerate the deployment of hydrogen and fuel cell technologies in the pursuit of a cleaner and more equitable world.

This event is part of the H2 Excellence program, a European-Canadian partnership dedicated to fostering excellence in green hydrogen and fuel cell technologies through advanced training, research, and transnational cooperation. It brings together scientists, engineers, educators, and entrepreneurs from diverse backgrounds who share a common goal: to make hydrogen energy not only technically feasible, but also affordable, safe, and widely accessible.

The speakers featured in this booklet represent a rich tapestry of expertise, vision, and passion. Their contributions span from cutting-edge scientific developments and policy frameworks to innovative educational platforms and real-world industrial applications. We are especially proud to highlight initiatives that bridge academia and industry, and that promote knowledge mobilization across borders and disciplines.

We invite you to explore the pages that follow with curiosity and purpose. May they ignite new insights, meaningful partnerships, and a renewed sense of urgency to address the energy challenges of our time.

Welcome to the future of hydrogen. Welcome to the H2 Excellence experience.

We will address:

Session 1: Frontiers of the Green H_2 Economy

H2Excellence: Bridging education, research, and business in the green hydrogen revolution

Decarbonization strategies in Europe and the Role of Functional Materials in them

Uses and safety handling of hydrogen: my advises as a former professional and academic researcher.

Stability of polypyridine ruthenium complexes and their potential uses for hydrogen evolution reaction and artificial photosynthesis

Session 2: Decarbonization Technologies & Energy Transition

Thermally-coupled hydrogen storage and carbon capture

Challenges of hydrogen for the gas turbine world

Synthesis and Evaluation of a Novel Catalyst for Direct Joule Heating Steam Methane Reforming

Vacancy Patterns and Hydrogen Trapping/Diffusion in (Ti,V) Ternary Nitride Precipitates: Implications for Hydrogen Embrittlement

Safer Hydrogen Transportation through Liquid Organic Hydrogen Carriers (LOHCs)

Session 3: Risk, Regulation, and Readiness

H_2 process safety management

Hydrogen incident — Lessons learned

Hydrogen introduction in facilities associated with buildings

Online - H_2 and computational fluid dynamics in Phast Safety

Low Carbon Hydrogen Economy: Catching Up with Market Readiness

Session 4: Policy, Industry, and Innovation

Decarbonizing heavy-duty transportation with on-board LOHC powertrains (On line)

Advancing Canada's hydrogen economy through codes and standards

The Canadian hydrogen safety centre (CH2SC) (On line)

Harnois Energies, hydrogen and the energy transition

Hydrogen Engineering Consultant with Cratos Can—Electrolyzer system process and functional safety considerations

Effect of catalyst-ionomer interactions on the oxygen evolution reaction in nickel-based AEM electrolyzers

Session 5: Startups in Action

Hydrogen startups—Pitfalls and key strategies for innovators

Carbon Exel

Cycle Momentum

ClearWatt

Hythermal

Jean-Philippe Harvey

Session 6: Scaling Up: Applications and Materials

Charbone—Daniel Charette

Hydrogène Québec—Steven Blaney

Mechanochemical synthesis of electrocatalyst for H2 production

Hydrovel

1.1 Organizing Committee

Role	
Chair	Gregory S. Patience
Co-Chair	Jildimara de Jesus Santana
Co-Chair	Olga Guerrero

Main Objectives (H_2Excellence)

- Establish CoVEs in green hydrogen to close skill gaps.
- Implement training for students, teachers, and SMEs.
- Create an international platform for knowledge sharing.
- Promote hydrogen use across sectors and global collaboration.

H_2Excellence Community

- Education: Higher Secondary Institutes (HEI) and Vocational Education Training (VET) Providers
- Research: Universities, Research Institutes, Laboratories, Innovation Hubs
- Business: Hydrogen Related Industries, SMEs, Clusters, and Associations
- EU Level: EACEA, Other COVE Networks, and EU Projects/Institutions
- Authorities: National and Regional Qualification Authorities and Policymakers
- VET and University Students/Parents, Engineers, and Life-long Learners

H_2Excellence in a Nutshell: Mission and Vision

Mission

- To provide education, training, knowledge, applications, tools, support, and networking opportunities to green hydrogen sector players
- To address skills shortage in critical areas of the H2 value chain
- To support hydrogen sector players to address scientific and technical challenges by fully exploiting the green hydrogen technology and associated applications in various sectors

Vision

- To strengthen end to end green hydrogen value chain through world leading centers of excellence (CoVEs) and vocational training in fuel cells and hydrogen
- To become a focal point and major driving force of the international efforts towards development and adoption of green hydrogen technology

Time	July 23rd	July 24rd	July 25rd
09:00 – 09:30	Welcome & Opening Remarks	Dr. Paolo Mocelin – (University of Padua)	Paul Shenouda (Propolys)
09:30 – 10:00	Dr. Karna Dahal (H2Excellence)	Jean-Paul Lacoursière – (H_2 Safety)	Dr. Christopher Panaritis (Startup)
10:00 – 10:30	Dr. Olga Guerrero-Pérez (University of Málaga)	Hocine Ait Mohamed (HYDROGEN INCIDENT – LESSONS LEARNED)	Cycle momentum
10:30 – 10:50	**Coffee Break**	**Coffee Break**	**Coffee Break**
10:50 – 11:20	Dr. Oumarou Savadogo	Jacques Renaud (engineer from Régie du bâtiment du Québec)	ClearWatt-(Startup)
11:20 – 11:50	Dr. Stephane Ruggeri	Daragh Stokes (DNV) – Online	Dr. Yanfa Zhuang - (Startup)
11:50 – 12:20	Dr. Gabriel Mercier	Dr. Philippe Tanguy - Chief Executive Officer Hynergy Consulting	Dr. Jean-Philippe Harvey
12:20 – 13:30	**Lunch Break**	**Lunch Break**	**Lunch Break**
13:30 – 14:00	Dr. Alexander Harrison (University of Oxford)	Sayandeep Biswas (MIT) – Online	Shaffiq Jaffer VP Total Energies
14:00 – 14:30	Dr. Pierre Q. Gauthier (Siemens Canada)	Dr. Marzouk Benali and Dr. Olumoye Ajao - Natural Resources Canada (NRCan)	Daniel Charette- CEO Charbone
14:30 – 15:00	Henok Katile (PhD student-Jamal)	Dr. Nirmal Gnanapragasam (Canadian Nuclear Laboratories)	Steven Blaney Président-directeur général, Hydrogène Québec
15:00 – 15:30	**Coffee Break**	**Coffee Break**	**Coffee Break**
15:30 – 16:00	Ziqi Cui (McGill University)	Dr. Catherine Gosselin (Harnois)	Dr.Thomas Auvray Institut de Recherche sur l'Hydrogène
16:00 – 16:30	Dr. Mohammad Latifi	Justin Cao (Cratos Can Inc)	Dr. Mohammad Khodabandehloo (Startup)
16:30 – 17:00	Safer Hydrogen Transportation through Liquid Organic Hydrogen Carriers (LOHCs).	Dr. Elena Baranova (Concordia University and University of Ottawa)	Closing Remarks (Farewell)

Section 2

Speakers

H_2Excellence: Bridging education, research, and business in the green hydrogen revolution

Karna Dahal

Abstract The transition to a carbon-neutral economy demands not only technological innovation but also a skilled workforce capable of driving the transition. The H_2Excellence project, funded by the Erasmus+ programme of the European Union, is a collaborative initiative designed to strengthen Europe's green hydrogen ecosystem. It will create a skilled workforce for the hydrogen industry and bridge the gap between education, research, and industry collaboration. Led by Vaasa University of Applied Sciences (VAMK), the project unites 24 partners from nine EU countries (Finland, Portugal, France, Greece, Germany, Poland, Italy, Spain, and Romania) and one international partner (Canada) to establish Centers of Vocational Excellence (CoVEs) focused on fuel cell and green hydrogen technologies. H_2Excellence develops modular training programmes aligned with the European Qualifications Framework (EQF) 3-8 levels, supports teacher upskilling, and promotes lifelong learning. By integrating research into vocational and higher education and collaborating with both large companies and small and medium sized enterprises (SMEs) working in the green hydrogen field, the project ensures training meets real industry needs. Key activities include curriculum development, pilot training, mobility programmes, industrial placements, capacity building, education-business-research forums, the Hydrogen Academy, industrial advisory events, and the development and implementation of a digital learning platform. By aligning skills with labour market needs, H_2Excellence plays a vital role in green hydrogen revolution and driving regional innovation. The workshop presentation outlines the project's core objectives and activities, industry-education -research collaboration, and project's contribution to a sustainable and inclusive energy transition across Europe and globally.

Figure 2.1: Karna Dahal

Bio Dr. Karna Dahal is an EU Project Manager and Lecturer in Renewable Energy at Vaasa University of Applied Sciences (VAMK), Finland. He currently coordinates the H_2Excellence project which focuses on fuel cell and green hydrogen technologies. He received his PhD in Energy Transition and Carbon Neutrality from the University of Helsinki (2015– 2018). He has held postdoctoral research positions at the University of Eastern Finland (UEF) (2021–2023) where he worked on fine particles and small-scale solid fuel combustion technologies and at Chalmers University of Technology in Sweden (2019–2021) where he focused on alternative fuels and propulsion systems. With a multidisciplinary background, Dr. Dahal has authored about 20 scientific publications and contributed to innovative solutions including the development of a UV/TiO_2-based kitchen grease filtration system. His work bridges academic research and practical applications in the fields of clean energy, environmental technology, and sustainable development.

Decarbonization strategies in Europe and the Role of Functional Materials in them

Professor Olga Guerrero

Abstract The European Union has set renewable energy production targets to reduce its dependence on fossil fuels in the coming decades. Owing to the instability of renewables and the fact that they cannot be produced in all geographical areas, it is necessary to develop strategies to store and transport energy. This is not an easy task. The fabrication of efficient energy storage devices requires rare elements, the production costs of green H2 are high, and the transportation and storage of H2 is a complex process that has not yet been developed. Therefore, new materials with tailored properties that would serve as photo- electro- catalysts, adsorbents, and gas separation membranes must be developed to commercialize processes and products such as: i) energy storage devices that avoid the use of metals and rare elements; ii) photocatalytic water splitting of water for H2 production, avoiding the use of expensive electrolizers; iii) direct electrolysis of salt water, to avoid the costly water purification steps that are actually required for electrolysis, iv) carbon capture storage devices and catalytic process for CO2 transformation into fuels. In addition to the research effort to develop these technologies, a specialized workforce is required to achieve EU objectives.

Figure 2.2: Olga Guerrero

Bio Olga Guerrero-Perez (born in Madrid, 1974) is Full Professor of Chemical Engineering at Malaga University (Spain). She received the Ph.D. in 2003 at the Universidad Autónoma in Madrid. During 2003 and 2004, she was a visiting scholar at different institutions. First, at the Polish Academy of Sciences (Cracow, Poland), working on the selective destruction of organic pollutants. Then, at Lehigh University, investigating novel techniques of characterization of materials; and then at University of Cincinnati, developing new synthesis methods to prepare nanoporous materials. During 2004 and 2007, she obtained a researcher position at the Chemical Engineering Department of the University of Málaga. During 2007 and 2008, she was as postdoctoral fellow at the Instituto de Catálisis (Madrid) to work on new concepts and ideas on glycerol valorization. In 2008 she moved again to the University of Malaga, where she was awarded a position as Assistant Professor, in 2010, she was promoted to Associate and in 2015, to Full Professor. During the last decades, she has participated in several national and european projects, having published more than 100 peer-review papers in the field of chemical engineering, materials, and enviromental sciences. She has also served as Deputy Vicepresident for Malaga University.

Status on the development of Fuel Cells Technologies

Oumarou Savadogo

Abstract Based on the principles of Fuel cells, their advantages and disadvantages of Fuel cells will be shown. The actual status of the various technologies will be discussed. The sectors of current applications: mobility (PEMFC), stationary (PAFC, MCFC and SOFC). The development of Direct carbon Fuel Cell we are developing will be presented. The different types of utilizations including heating, peak generation, passenger cars, Mid-Duty and High-Duty Vehicles, marine vessels, Fuel cell buses, trains, aviation, Unnamed Aerial Vehicles (Drones), Forklift trucks, trucks, peak generation, passengers' cars, etc. will be presented. The pricing of various technologies will be shown. The status of Fuel Cell market will be discussed.

Bio Oumarou Savadogo has held the UNESCO Chair in Sustainable Engineering and Applied Solar Technologies since February 2021 at Polytechnique Montréal. He holds a Doctorat d'État in physical sciences, a doctorat and a DEA in materials science from the École Nationale d'Ingénieurs de Caen (France), specializing in materials science and electrochemistry. Oumarou worked as a process engineer at Rhone-Siltec (France) and as a postdoctoral fellow at CNRS (France). He has been a researcher, assistant professor, associate professor and full professor at Polytechnique Montréal. His research interests include the development of new materials for energy, electrochemistry, electrolytic production and use of hydrogen, new generations of solar cells, energy storage systems, fuel cells, microbial fuel cells and metallurgical processes. He has designed and taught courses in energy, materials science, solid state physics, hydrometallurgy and electrometallurgy for the energy and materials engineering programs. He is founder and director of Laboratoire des nouveaux matériaux pour l'énergie et l'électrochimie (since 1992). He was responsible for the renewable energies graduate programs in power engineering (since 2013) and in energy and sustainable development (2005-2021). He is also founder of the international scientific journal Journal of New Materials for Electrochemical Systems (since 1998) and of the symposium of the same name. He has authored or co-authored over 240 publications in international journals.

Uses and safety handling of hydrogen: My advice as a former professional and academic researcher

Stephane Ruggeri

Abstract As a speaker at this hydrogen workshop, Stéphane sees hydrogen as a key enabler of the energy transition, with transformative potential for transportation, industrial decarbonization, and energy storage. By promoting collaboration among researchers, startups, and companies, he helps accelerate the deployment of hydrogen technologies to meet urgent environmental and economic challenges.

Figure 2.3: Stephane Ruggeri

Bio Originally from France, Stéphane Ruggeri completed a PhD in Energy and Materials Science at INRS. His work on nickel-metal hydride rechargeable batteries marked his early contribution to energy storage, laying a foundation for his future involvement in hydrogen technologies. He was among the first to apply mechanical milling to battery materials, foreshadowing the advanced methods later used in hydrogen fuel systems. After completing his doctorate, Stéphane joined the National Research Council of Canada, then returned to INRS for a postdoctoral fellowship with Professor Jean-Pol Dodelet in collaboration with General Motors. He worked on proton exchange membrane (PEM) fuel cells for automotive use—one of the most promising applications of hydrogen in the push for decarbonized mobility. At a time when hydrogen was still emerging, Stéphane was already contributing to its industrial feasibility. Throughout his career, he has remained engaged in sectors where hydrogen plays a growing role. As a technology advisor at PRIMA Québec and now as a Growth and Innovation Specialist at Longueuil's Economic Development agency, he champions clean energy innovation. He works to bridge academia and industry, facilitating the transition of scientific discoveries—especially in hydrogen and related technologies—into real- world solutions.

Stability of polypyridine ruthenium complexes and their potential uses for hydrogen evolution reaction and artificial photosynthesis

Gabriel M. Mercier, Ilyes Oubaha, Edouard Dray, Garry S. Hanan

Abstract To face many of the modern challenges, hydrogen is very attractive due to its high energetical density and low carbon footprint, assuming it can be produced using renewable energy. This can be achieved by electrolysis, even though the global efficiency of such a process is quite low. As a result, chemists have researched alternative ways to produce hydrogen for decades, trying to mimic the photosynthesis process. In this process, plants use simple components (CO2 and water) and sunlight energy to synthetize molecules with added energetical contents (e.g. sugars). Our purpose here is to develop a stable system, which synthetize hydrogen using only water and sunlight as inputs.

In that regard, ruthenium polypyridyl complexes have attracted considerable interest thanks to their useful optical properties, e.g., visible light absorption and long-lived excited states, and ease of incorporation into artificial light-harvesting systems1.

This talk will cover the main challenges of such ruthenium-based technologies: the choice of the stability vs the efficiency, how can we get both, and more importantly, can we translate this knowledge towards cheaper metal-based systems such as iron or cobalt?

Figure 2.4: Gabriel Mercier

Bio Dr. Gabriel Mercier was born in 1989 in Belgium. He studied chemistry at UCLouvain where he received his BSc in 2012 and his MSc in 2014. He joined the group of Pr. Tom Leyssens where he studied photochemistry of anils and crystal engineering and received his Ph. D. in 2022. He obtained an excellence scholarship from Wallonie-Bruxelles International (WBI) in 2023 and came to University of Montreal (UdeM), Canada, to start postdoctoral research in the group of Pr. Garry Hanan. He is now studying the stability of polypyridine ruthenium complexes and their potential uses for hydrogen evolution reaction and artificial photosynthesis.

Thermally-coupled hydrogen storage and carbon capture

Alexander Harrison

Abstract In order to provide stable electricity supply to users, energy systems based primarily on intermittent renewable power rely on a combination of energy storage, excess generation capacity, and backup fossil fuel infrastructure. Hence, clean energy carriers, such as 'green' hydrogen from electrolysis, are required to balance daily power output, and minimise reliance on dispatchable fossil fuels during periods of insufficient wind. Green hydrogen produced by electrolysis, and stored in the form of solid metal hydrides, offers a relatively safe and high density method of long duration energy storage, but is limited by poor thermal efficiency. Here, we present a framework for coupling intermittent wind power with solid hydrogen storage, using the heat evolved from the hydrogen storage reaction, that would otherwise be wasted, to drive a useful carbon capture process. Incorporating heat recovery overcomes a major limitation of solid-state hydrogen storage (poor thermal efficiency), and offsets CO_2 emissions from the use of back-up gas turbine capacity. Thermal integration of the solid hydrogen storage improves round-trip efficiency fivefold to ∼18%, comparable to compressed gas storage, with superior energy density. Modelling power supply and energy storage over five years for onshore and offshore windfarms using real-world data, combined hydrogen storage and carbon capture was the only system able to meet daily electricity demand with net-zero CO_2 operating emissions. This work highlights the importance of accounting for storage costs when designing energy systems with net-zero CO_2 emissions, and the role of heat integration between processes in minimising wasted energy during grid-scale storage.

Figure 2.5: Alexander Harrison

Bio Dr Alexander Harrison is a postdoctoral researcher at the University of Oxford, in the Energy Storage and Energy Carriers group in the Department of Engineering Science. His current research work focusses on integrating thermo-chemical energy recovery for heat management in solid hydrogen storage systems, investigating the system through both experiments and process modelling. His other projects include developing novel reaction systems for processes such as low-pressure ammonia production and CO2 utilisation, and applying recycled magnesium- aluminium alloys as hydrogen carriers. He completed his BA (2019), MEng (2020), and PhD (2024) degrees at the Department of Chemical Engineering and Biotechnology at the University of Cambridge, as a member of Emmanuel College. His doctoral research, performed in the group of Dr Ewa Marek, focussed on the fundamentals and applications of chemical looping catalysis for selective oxidation reactions.

The Challenges of Hydrogen for the Gas Turbine World

Pierre Gauthier

Abstract Combustion Computational Fluid Dynamics (CCFD) has established itself as an effective predictive tool for the design and analysis of Gas Turbine Combustion, for both Aero and land Based applications.

The main challenge in CCFD, however, remains the modelling of the two-way coupling between the highly turbulent flow field and the chemical reactions occurring within the flame.

The wide range of flame types found in Gas Turbine Combustion Systems, and now the introduction of Hydrogen as a fuel, has greatly exacerbated these difficulties greatly.

This talk will present the current state of the art in CCFD, as well discuss some future developments.

Figure 2.6: Pierre Gauthier

Bio Prof. Pierre Gauthier is a recently retired Combustion Key Expert and Global Technical Focal Point for Combustion Computational Fluid Dynamics (CFD) at Siemens Energy, where he was responsible for the Combustion CFD Methods and Tools Roadmap and Strategy. He has over 35 years of experience in the Gas Turbine Industry, 25 of which with Rolls-Royce and now Siemens. He is a Royal Academy of Engineering Visiting Professor of Low emissions Combustion Modelling at Cranfield University in the UK, where he lectures and supervises Research Fellows, PhDs and Master's students. Dr. Gauthier is also an Affiliate Associate Professor of Mechanical and Aerospace Engineering at Concordia University in Montréal, Canada, where he lectures in Combustion, Gas Dynamics, Fluid Mechanics and Aerodynamics. He has published several papers on Combustion Modeling and Computational Methods.

Synthesis and Evaluation of a Novel Catalyst for Direct Joule Heating Steam Methane Reforming

Henok Atile, Jaber Shabanian, Saad Chidami, Gholamreza Roohollahi, Mohammad Latifi, Jamal Chaouki

Abstract Steam methane reforming (SMR) is a widely adopted technology for producing hydrogen (H_2) and carbon monoxide (CO) that are essential to numerous industries, such as ammonia and methanol production, oil refining, and steel production. However, the conventional SMR technology experiences inefficiencies due to uneven temperature distribution in the commonly used fixed bed reactors heated conventionally. It also poses environmental challenges by contributing up to 3% of annual global CO_2 emissions as it commonly relies on fossil fuels to provide sensible and reaction heat. Electrification of this technology through direct Joule heating (DJH) in dense fluidized bed reactors offers a promising pathway for its decarbonization, noting its potential to integrate renewable energy sources and provide uniform heating throughout the dense bed. However, this technology requires electrically conductive catalysts that maintain both reforming activity and electrical conductivity under reaction conditions. Therefore, in this study, we focused on developing a DJH reactor and synthesized a novel electrically conductive catalyst system specifically designed for electrified-SMR applications. We synthesized the catalyst by enriching nickel/alumina (Ni/Al_2O_3) with molybdenum carbide (Mo_2C) to enhance its electrical conductivity and resistance to coke formation. Performance evaluation showed enhanced stability and reaction performance at S/C = 1 with over 95% methane conversion and an H_2/CO ratio of 3.2. Owing to Mo_2C's resistance to coking, this can yield a substantial decrease in water and energy requirements for steam generation. These findings show the potential of $Ni/Mo_2C/Al_2O_3$ for efficient, electrified SMR processes, offering pathways toward a more sustainable H_2 production.

Figure 2.7: Henok Atile

Bio Henok Atile is a Ph.D. candidate in Chemical Engineering at Polytechnique Montréal, working under the supervision of Prof. Jamal Chaouki. He earned his bachelor's degree in Manufacturing Technology from Menschen für Menschen ATTC (Ethiopia) and holds two master's degrees: one in Sustainable Energy from Jimma University (Ethiopia) and another in Mechanical Engineering from National Taiwan University of Science and Technology (Taiwan). Prior to his doctoral studies, Henok served as a lecturer in the Department of Mechanical Engineering at Ambo University, where he taught a broad range of undergraduate courses—including thermodynamics, strength of materials, machine design, fluid dynamics, energy and environment, and renewable energy—to students across multiple departments. His research experience spans biomass pyrolysis for phosphorus fertilizer, bone char granulation, compost pelletization, and chemical looping gasification of spent coffee grounds for syngas production. His current Ph.D. research focuses on process electrification and hydrogen production using advanced fluidized bed reactor technologies. Henok is passionate about clean energy innovation and engineering education.

Vacancy Patterns and Hydrogen Trapping/Diffusion in (Ti,V) Ternary Nitride Precipitates: Implications for Hydrogen Embrittlement

Ziqi Cui

Abstract Steam methane reforming (SMR) is a widely adopted technology for producing hydrogen (H_2) and carbon monoxide (CO) that are essential to numerous industries, such as ammonia and methanol production, oil refining, and steel production. However, the conventional SMR technology experiences inefficiencies due to uneven temperature distribution in the commonly used fixed bed reactors heated conventionally. It also poses environmental challenges by contributing up to 3% of annual global CO_2 emissions as it commonly relies on fossil fuels to provide sensible and reaction heat. Electrification of this technology through direct Joule heating (DJH) in dense fluidized bed reactors offers a promising pathway for its decarbonization noting its potential to integrate renewable energy sources and provide uniform heating throughout the dense bed. However, this technology requires electrically conductive catalysts that maintain both reforming activity and electrical conductivity under reaction conditions. Therefore, in this study, we focused on developing a DJH reactor and synthesized a novel electrically conductive catalyst system specifically designed for electrified-SMR applications. We synthesized the catalyst by enriching nickel/alumina (Ni /Al_2O_3) with molybdenum carbide (Mo_2C) to enhance its electrical conductivity and resistance to coke formation. Performance evaluation showed an enhanced stability and reaction performance at S/C = 1 with over 95% methane conversion and H_2/CO ratio of 3.2. Owing to Mo_2C's resistance to coking, it can yield a substantial decrease in water and energy requirements for steam generation. These findings show the potential of Ni/Mo_2C/Al_2O_3 for efficient, electrified SMR processes, offering pathways toward a more sustainable H_2 production.

Figure 2.8: Ziqi Cui

Bio A Ph.D. candidate in Materials Engineering at McGill University, I am driven by the desire to address critical challenges in the field of sustainable materials. My research focuses on hydrogen embrittlement in high-strength steels, specifically investigating substoichiometric nitride precipitates and their role in hydrogen trapping and diffusion. By leveraging advanced atomistic modeling and machine learning, I aim to design next-generation materials that are more resistant to hydrogen-induced degradation. My work holds the potential to significantly impact hydrogen-related industries, facilitating the safe and efficient adoption of hydrogen energy, a key component in the global transition toward sustainability.

Thermodynamic optimization of syngas production from bio-oil via combined steam reforming and partial oxidation

Mohammad Latifi

Abstract Bio-oil derived from biomass is a promising platform for advancing sustainable fuel synthesis and reducing reliance on fossil resources, especially when transformed into syngas (H_2 + CO), a critical precursor for Fischer-Tropsch synthesis. This work explores a thermodynamically optimized pathway to produce syngas from bio-oil combining steam reforming and partial oxidation (CSPO) strategy. Rather than focus on catalysts or reactor engineering, the approach emphasizes the fundamental interplay between process inputs, steam, oxygen, and temperature, to tailor product composition, energy, and carbon output. The key challenge is generating a H_2-rich syngas with an H_2/CO ratio of 2.15 under autothermal conditions while avoiding carbon formation. Using equilibrium modeling and response surface methodology, the study maps the multidimensional thermodynamic space to uncover ideal operating conditions. The analysis demonstrates how partial exothermic oxidation can thermally drive the highly endothermic steam reforming reaction, creating a self-sustaining, carbon- neutral process that requires no external heat input. By optimizing the steam-to-bio-oil and oxygen-to-bio-oil ratios alongside temperature, the process can be tuned for efficiency and compatibility with downstream synthesis routes. The findings highlight a broader opportunity: integrating endo- and exothermic reactions, inspired by the balance of natural metabolic systems, enables clean, tailored fuel producing only biomass-derived liquids, H_2O, and O_2. Ultimately, this study provides a foundation to rethink how we convert complex bio-oils to synthetic fuels. It offers a pathway to scalable, carbon-negative energy systems where thermodynamics, not just catalysis, is leveraged as a design tool, bringing us closer to sustainable chemical manufacturing driven by renewable inputs.

Bio Dr. Mohammad Latifi is a Research Associate at Polytechnique Montréal and an expert in H_2 and syngas production from alternative resources, with additional expertise in process electrification, fluidized bed reactor design, and critical minerals processing. Since 2012, his multidisciplinary research has focused on developing sustainable, electrified processes, particularly fluidized and multiphase systems, for producing clean H_2 and syngas from biomass, plastics, and other carbon-rich feedstocks. His pioneering work also spans the circular economy, CO_2 capture and conversion, and the extraction and recycling of critical and strategic materials. Dr. Latifi has secured over $1.4 m in research funding as an early-career Principal Investigator and has supervised >40 graduate students, postdocs, and research associates. He teaches Biomass Conversion, Minerals Processing, and Advanced Design of Fluidized Bed Reactors at Polytechnique, incorporating cutting-edge technologies such as induction- and microwave-assisted reactors into both his teaching and research programs. As co-founder and CTO of NeoCtech Corp., Dr. Latifi has led the development of patented technologies for rare earth element recycling and sustainable metallization, and has recently expanded the company's portfolio to include electrified processes for clean fuel and advanced materials. His industrial innovations have attracted over $4 m in funding, enabling collaborations with UBC, University of Toronto, CÉPROCQ, CanmetMINING, AEM Technologies, Geomega Resources, and Norda Stelo, which have produced breakthroughs in electrified processing, circular economy pathways, and waste-to-resource valorization. With over 70 publications, several patent filings, and a proven record of strategic leadership, Dr. Latifi plays a pivotal role in positioning Canada at the forefront of the energy transition, clean energy innovation, and responsible critical materials production. He earned his Ph.D. at Western University, where his doctoral research focused on bio-oil gasification in fluidized bed reactors, and an an MSc from the University of Tehran.

Decarbonizing heavy-duty transportation with on-board LOHC powertrains

Sayandeep Biswas

Abstract As a member of the Green Lab, the researcher is working on the development of hydrogen carriers for mobility applications. Their thesis focuses specifically on ammonium formate, liquid organic hydrogen carriers (LOHCs), and ammonia-based systems. In this context, low- pressure ammonia absorption has been proposed as a potentially viable alternative separation method for small-scale renewable ammonia production. Metal chloride salts are known for their selectivity in incorporating ammonia into their crystal lattice with remarkably high capacity. The regeneration and stability of these salts are further enhanced by dispersing them onto porous silica supports. This project investigates optimal preparation methods for supported metal halides, as well as the ideal conditions for ammonia uptake and release. Key parameters such as metal halide salt particle size, support particle size, support composition, and preparation techniques are optimized to improve material stability, uptake/release kinetics, and maximum ammonia capacity. An automated system was designed to rapidly screen absorption/ desorption conditions and assess material stability, and it was employed to determine optimal cycling conditions. The absorption and desorption processes were conducted under temperature and pressure conditions designed to minimize energy input while maximizing ammonia uptake and release within practical timeframes. These findings contribute to the advancement of supported metal halide salts as promising sorbents for low -pressure ammonia storage and separation, with potential applications in sustainable hydrogen carrier systems.

Figure 2.9: Sayandeep Biswas

Bio Sayandeep received an M.S. in Chemical Engineering from MIT in 2023, and a B.Eng. in Chemical Engineering from the University of Minnesota, Twin Cities in 2020. He is currently a PhD candidate under the supervision of Prof. William H. Green and is focused on developing hydrogen carriers and researching their utilization to drive decarbonization efforts in the energy and transportation sectors. His work spans the development of experimental powertrain designs, simulation of energy systems, and techno -economic assessment of novel low-carbon processes.

Safer Hydrogen Transportation through Liquid Organic Hydrogen Carriers (LOHCs)

Charlie Houle, Reda Habboubi, Judith Tully, Marc-Aurèle Hounkpatin

Abstract Hydrogen is a key clean fuel for the future, yet its storage and transport pose major safety and logistical challenges. Liquid Organic Hydrogen Carrier (LOHC) technologies offer a promising solution by chemically binding hydrogen to a stable liquid molecule. Among these carriers, **benzyltoluene** stands out for its favorable safety profile: in its hydrogenated form (H_{12}-BT), it is non-flammable, non-explosive, and non-corrosive to metals. Unlike compressed or liquefied hydrogen, it does not require high-pressure containment or cryogenic temperatures. This project aimed to design a 10,000 tons per year hydrogenation plant using benzyltoluene as the carrier. The hydrogenation reaction adds six molecules of H_2 per benzyltoluene molecule, producing H_{12}-BT for safe transport. The plant features two slurry-phase hydrogenation reactors (57 m^3 and 47 m^3), achieving a total conversion of 94% at 30 bar and 270 °C with a Ni/Al $_2O_3$ catalyst. A HAZOP analysis identified hydrogen release as the most critical deviation. To mitigate this, the plant design includes MSA Ultima X5000 gas detectors, 30 cm- thick reinforced concrete walls, active mechanical ventilation, and emergency shutdown systems. In the worst-case scenario of a reactor explosion (43 tons TNT equivalent), a safety radius of over 2.2 km would be needed to limit structural damage to under 5%. Estimated equipment costs for the hydrogenation unit total $6.6 million. When factoring other direct and indirect costs for construction, the overall capital investment reaches $42 million. Spread over 10 years, the hydrogenation cost is $2.30/kg H_2. The resulting cost at the pump, combining production ($2.00/kg), hydrogenation, transportation ($0.50/ kg), and distribution ($2.15/kg), totals approximately **$7.00/kg H_2**.

Figure 2.10: Reda Habboubi and Charlie-William Houle

Bio Us four (Charlie Houle, Reda Habboubi, Judith Tully & Marc-Aurèle Hounkpatin) embarked on our journey in Chemical engineering in 2021. 4 years later, graduating from Polytechnique Montreal marks the beginning of a new journey for us. Having faced many challenges from our baccalaureate, we are delighted to share our capstone project with you all. In collaboration with Canmet Energy, we were mandated to find an innovative solution to Hydrogen transport and evaluate its viability. With the help of Pr. Patience, we went far beyond the classroom. The project demanded creativity, self-direction, and interdisciplinary collaboration. We believe this initiative and our ability to apply what we've learned to a complex, real-world problem is exactly being a chemical engineer is meant to be.

Emerging H_2 Applications: Identifying Critical Safety Gaps

Paolo Mocellin

Abstract Hydrogen is gaining momentum as a cornerstone of the global energy transition. Yet, the rapid deployment of emerging hydrogen technologies—ranging from urban refueling stations to distributed electrolyzers—often outpaces the development of safety knowledge, risk methodologies, and regulatory harmonization. Hydrogen's physical properties, including high diffusivity, low ignition energy, and wide flammability range, make it behave differently than conventional hazardous substances, requiring tailored approaches to hazard identification, consequence modelling, and risk reduction measures. Current safety frameworks are challenged by significant data gaps related to ignition probability, leak frequencies, explosion dynamics, and material degradation. In parallel, classical safety tools such as HAZOP and QRA are being adapted to account for hydrogen-specific deviations and novel risk scenarios, especially in the context of renewable energy interfaces, confined installations, and decentralized applications. These methodological updates include the integration of resilience-based thinking and case-based scenarios assessment. Fragmentation across regulatory regimes and land-use planning practices creates barriers to technology deployment and slows down innovation. At the same time, public trust hinges on transparent risk communication, effective detection strategies, and clear safety criteria for installations, even those falling below formal "major hazard" thresholds. Addressing these knowledge gaps requires coordinated efforts: experimental validation, cross-disciplinary training, and international collaboration on standards and incident data sharing. Bridging safety gaps is not only a technical necessity—it is a prerequisite for societal acceptance and the scalable, sustainable deployment of hydrogen across diverse sectors and geographies.

Figure 2.11: Paolo Mocellin

Bio Paolo Mocellin is a researcher and lecturer at the Università degli Studi di Padova, specializing in Chemical and Process Engineering, Safety Engineering, and HSE consulting. His research focuses on industrial safety, fire protection engineering, and the safe design of chemical plants handling energy vectors such as hydrogen, LNG, and CO_2. With a passion for advancing sustainable and safe industrial processes, Paolo brings a wealth of expertise in intrinsic safety design, risk analysis, CCS, GTL, and process electrification. He also shares his knowledge through academic teaching and professional training, aiming to inspire the next generation of engineers.

H_2 Process Safety Management

Jean-Paul Lacoursiere

Abstract The rapid development of H_2 refuelling stations introduces potentially serious risks to workers and public safety. As a result, H_2-related safety concerns have become a priority in process safety management. This document proposes a comprehensive methodology for hazard identification and risk management tailored to H_2 facilities.

In Quebec and across Canada, various regulations govern H_2 infrastructure. In Quebec, H_2 facilities are regulated under the Quebec Building Act (Chapter 1.1) and its associated Construction Code and Safety Code (chapter B-1.1 r.3). The Canadian Environmental Protection Act, 1999 (S.C. 1999, c. 33) and the Environmental Emergency Regulations, 2019 (SOR/DORS 2019-46 O 53) also apply.

The construction and process safety management of H_2 facilities are supported by the following standards: 1) CAN/CSA Z767-24: Process Safety Management Standard; 2) CAN/BNQ 1784-000/2022: Canadian H_2 Installation Construction Code; and, 3) ISO 19880-1: Gaseous H_2— Fuelling Stations—Part 1: General Requirements.

Hazard identification is the cornerstone of Process Safety Risk Management (CAN/CSA Z767-24, clause 7.3.5). To implement effective safety management, it is recommended to use the HAZOP methodology. This approach identifies inherent process risks and existing safeguards, evaluates their risk-reduction capabilities, and focuses on critical controls. It also helps determine the current risk level and recommends additional barriers where necessary to define the residual risk.

Bow-tie analysis is also proposed to visually represent potential threats, preventive and mitigative barriers, incident scenarios, and their possible consequences. Since barriers degrade over time, identifying degradation mechanisms and corresponding controls is essential. Bow-tie diagrams enable the consolidation of HAZOP or other hazard assessment data onto a single page and assist in assigning responsibilities for barrier management.

To effectively deploy process safety management, engineering capacity must be strengthened. The following excerpt from an OECD workshop on engineering education held in Montreal in 2003 remains highly relevant:

Engineers have a professional responsibility to society, as well as to themselves, their employers, colleagues, and other stakeholders, to consider the potential for their work to create, increase, or reduce risks to human health, the environment, and property. Therefore, safety and risk management considerations must integrated into every aspect of an engineer's work.

Risk management principles should be applied throughout all phases of a facility's lifecycle—from design, construction, and operation to audit/ review, maintenance, and decommissioning. Furthermore, these principles are critical in prevention, preparedness, and emergency response activities. Integrating risk management principles into engineering education is of paramount importance.

- People have the right to demand a safe environment.
- Emerging technologies, including H_2, are becoming integral to the energy portfolio.
- Resources are limited; facilities must be functional and reliable upon commissioning.
- Failure is not an option—for the safety of individuals and to maintain public confidence in H_2.

Bio Graduated in Chemical Engineering from Polytechnique Montréal in 1966, with a career spanning over five decades. From 1966 to 1991, worked at Union Carbide Canada as a Production Engineer, Project Engineer, and later as Department Head for Safety, Environment, and Health. Since 1991, has been an independent consultant in Process Safety Management. Actively contributed as a member of the CAN/CSA Z767 Technical Committee on Process Safety Management and the OECD Working Party on Chemical Accidents. Currently serves as an Adjunct Professor at Polytechnique Montréal.

Hydrogen introduction in facilities associated with buildings

Jacques Renaud

Abstract This presentation will explore the regulatory landscape for gas installations in Québec and Canada, with a particular focus on hydrogen. It will cover the role of the **Régie du bâtiment du Québec (RBQ)** as the authority having jurisdiction, as well as the integration of the **Canadian Hydrogen Installation Code (CHIC)** within Québec's Construction and Safety Codes.

Key topics will include:

- Gas regulatory context in Canada
- Jurisdiction and mandate of the RBQ
- Overview of regulated gases under the Québec Construction and Safety Codes (CCQ and SCQ)
- Application of the CHIC to hydrogen installations
- Integration of CHIC with other regulatory domains (pressure vessels, electricity, building codes)
- Considerations for laboratories and refueling stations
- Ensuring safety through CHIC compliance and other mandatory obligations
- Licensing requirements for contractors and engineers under CCQ
- Owners' responsibilities under the SCQ
- Continuous improvement through regulatory amendments based on inspections and field experience.

Bio From 2001 to 2006, he served as a technical adviser in all domains administered by the RBQ except building. Since 2006, he has specialized in the Gas domain, where he has played a key role in shaping regulations and ensuring safety across the province.

His responsibilities have included:

- Managing and amending the Gas Regulation of Québec
- Interpreting codes and standards
- Processing variances
- Representing the RBQ on several technical committees

Jacques is a voting member on the following BNQ and CSA committees:

- BNQ 1784-000 – Canadian Hydrogen Installation Code
- CSA B149.1 – Natural Gas and Propane Installation Code
- CSA B149.2 – Propane Storage and Handling Code
- CSA B149.3 – Field Approval of Fuel-Burning Appliances and Equipment
- CSA B108.1 & B108.2 – Compressed and Liquefied Natural Gas Refueling Station Installation Codes
- CSA Z276 – Liquefied Natural Gas (LNG) Production, Storage, and Handling
- CSA Z662 – Oil and Gas Pipeline Systems

His extensive experience makes him a key contributor to the safe integration of hydrogen and gas technologies in Québec's evolving energy landscape.

HYDROGEN INCIDENT – LESSONS LEARNED

Hocine Mohamed

Abstract Four incidents of explosions in cryogenic activated carbon purifiers have been reported in European Industrial Gases Association (EIGA) publications up to 2013. In each incident, the purifiers had been operating for many years with no reported problems. The explosions occurred in the activated carbon trap of a neon purification system, in a helium purification system, and in a hydrogen liquefier. The presentation will cover the investigation results of a hydrogen liquid plant explosion. The explosion occurred in the cold box section of the liquefaction process, in an activated carbon cold adsorber vessel. The presentation will also address the numerous lessons learned and the safe operation of cryogenic activated carbon gas purifiers, with a brief on understanding the hazards and safeguards.

Figure 2.12: Hocine Mohamed

Bio Professional Engineer (P.E.) – OIQ (#101241)
CFPS – Certified Fire Protection Specialist
NFPA 120/122 (National Fire Protection Association)
Certificate Risk Management (CRM)
HAZOP Leader Certification
Layers of Protection Analysis (LOPA) certification
Hocine has over forty years of experience in loss control, process safety management, fire prevention and protection system analysis, and risk management. He worked for international companies in North Africa, the Middle East, and North America. Participated in and led several process hazard analyses, SIL studies, safety audits, and insurance surveys in the oil & gas and petrochemical industries, chemical, pulp & paper, and mining and mineral processing industries. Major strengths include practical knowledge and implementation of codes and standards (NFPA, API, NBCC, IBC, IFC, ASME, OSHA, FM) related to process safety, fire safety, and development and management of safety programs. Hocine is a Technical Practice Leader based in Montreal, Canada. He joined Paragon Risk Services in August 2022. He provides engineering services for oil and gas, petrochemical, chemical, pulp and paper, and mining and metal accounts underwritten by multi-national insurance companies. The services include conducting property risk engineering surveys, completing technical desktop reviews, providing process hazard analysis assessments, and client loss prevention training. He is a member of the Technical Committees (NFPA 120/122, CSA Z767-Process Safety). He holds a professional engineer designation (OIQ) and is a certified fire protection specialist.

H_2 and Computational Fluid Dynamics in Phast and Safeti

Daragh Stokes

Abstract DNV is an independent assurance and risk management provider operating in over 100 countries. Leveraging deep technical expertise and a global perspective, DNV supports organizations in achieving excellence in safety, sustainability, and digital transformation. With a legacy dating back to 1864, DNV's purpose is to safeguard life, property, and the environment—guiding its vision to be a trusted voice in addressing global transformations. As a global leader in classification and certification, DNV plays a pivotal role in the energy transition, particularly in advancing the safety and reliability of hydrogen technologies. Through its extensive work with renewables, offshore structures, electric grids, and critical infrastructure, DNV helps shape secure, low-carbon solutions for a sustainable future. The company invests 5% of its annual revenue into research and development to support cutting-edge innovation, including hydrogen production, storage, transport, and use. With a strong focus on digitalization and cybersecurity, DNV ensures the safe operation of assets and the integration of clean technologies. Its commitment to diversity and inclusion—spanning more than 120 nationalities—amplifies its ability to meet the complex challenges of the energy transition and to build resilient, forward-thinking solutions with its partners and clients worldwide.

Figure 2.13: Daragh Stokes

Bio Daragh Stokes is the regional contact for all things Phast and Safeti. Mechanical engineering degree from Loughborough University in the UK. He has spent the last 15 years taking care of Phast users through projects, technical support and training.

Low Carbon Hydrogen Economy: Catching Up with Market Readiness

Philippe Tanguy

Abstract The objective of this presentation is to provide an updated overview of the techno-economic landscape of the green hydrogen supply chain. It will address key developments across the entire value chain—from production to storage, distribution, and end-use—highlighting the most recent trends in cost evolution, infrastructure deployment, and technology readiness levels. Particular attention will be given to the short-term dynamics of the industrial market, including how current technological advancements and policy incentives are accelerating the commercialization of green hydrogen solutions. The presentation will also explore the challenges that remain for scaling up, such as investment requirements, regulatory frameworks, and supply chain constraints, while identifying the most promising opportunities for innovation and collaboration across sectors. Emerging technologies and strategies for optimizing efficiency and reducing costs will be discussed, with a focus on realistic implementation timelines and market competitiveness. In addition to the technical and economic dimensions, a brief analysis of the current geopolitical context will be included, particularly as it relates to energy security, resource access, and international cooperation. This broader perspective will help situate green hydrogen within the evolving global energy transition. Finally, the presentation will outline possible pathways forward for industrialized countries aiming to position themselves as leaders in the hydrogen economy. It will highlight strategic approaches to investment, infrastructure development, and partnerships, offering insight into how nations can align sustainability goals with economic and industrial growth through green hydrogen deployment.

Figure 2.14: Philippe Tanguy

Bio Philippe Tanguy is president and principal consultant in the hydrogen sector at Hynergy Consulting Ltd. and an adjunct professor at Polytechnique Montréal. He has held leadership roles including Chief Strategy Officer at HTEC Inc., President of Polytechnique Montréal, and Deputy CTO at TotalEnergies. Tanguy significantly contributed to Quebec's Green Hydrogen Strategy, co-founded the Hydrogen Council, served as president of the World Council of Chemical Engineering, and also led two industrial research chairs at Polytechnique Montreal. He is a founding member of the Hassan II Academy of Science and Technology, a Fellow of the Canadian Academy of Engineering, and holds a Doctorate in Physics (Sorbonne) and a PhD in Chemical Engineering (Laval), with executive training from MIT Sloan.

Advancing Canada's Hydrogen Economy Through Codes and Standards

Olumoye Ajao, Marzouk Benali

Abstract As H_2 technologies continue to evolve and scale, the importance of a coordinated, up-to-date, and future-ready regulatory framework becomes increasingly critical. The Canadian Hydrogen Codes and Standards Roadmap initiative, led by Natural Resources Canada (NRCan), provides strategic guidance to ensure Canada's H_2 economy develops safely, efficiently, and in harmony with international best practices. This roadmap offers a structured approach to identifying gaps in current codes and standards and proposes targeted actions to support the adoption and deployment of hydrogen across various sectors. With safety as a cornerstone, the roadmap addresses challenges related to hydrogen production, storage, transportation, and end-use applications—such as mobility, power generation, and industrial processes. By aligning Canadian codes and standards with global developments, the initiative strengthens the foundation for innovation, investment, and public confidence. It also ensures that Canadian companies can compete in international markets while maintaining high safety and environmental standards at home. The roadmap was developed through a collaborative process involving federal and provincial governments, industry leaders, researchers, regulators, and standards development organizations. Their collective insights helped prioritize areas where updates or new standards are most urgently needed — from infrastructure permitting and performance requirements to safety protocols for emerging hydrogen applications. Ultimately, the Canadian Hydrogen Codes and Standards Roadmap serves not only as a planning tool, but as a national call to action. It invites all stakeholders to engage in shaping a regulatory environment that enables the sustainable growth of the hydrogen sector—one that is innovative, safe, inclusive, and globally aligned.

Figure 2.15: Olumoye Ajao, Marzouk Benali

Bio Olumoye Ajao is a Biorefinery Specialist at Natural Resources Canada (NRCan), where he leads initiatives in hydrogen production, storage, delivery, and end-use applications. With deep expertise in green process development, energy conversion systems, and biorefining technologies, he provides technical and policy guidance to multiple federal branches including Finance Canada and Environment and Climate Change Canada (ECCC). Dr. Ajao co-leads the Canadian Hydrogen Codes and Standards Working Group (CSWG) and previously chaired a task force under the International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE). He has directed cross-sector stakeholder engagement for hydrogen modeling, codes, and standards, and conducted extensive techno-economic evaluations. In addition to managing diverse contracts and supervising multidisciplinary teams, he coordinates integrated business planning efforts for hydrogen implementation and standards development. His work ensures that Canada's hydrogen strategy is grounded in robust science, policy integration, and sustainable innovation.

Marzouk Benali is a Research Scientist at Natural Resources Canada, specializing in forest biorefinery and industrial process optimization. His research bridges chemical process design, clean fuel development, hydrogen systems, and net-zero GHG emissions. With a focus on innovation, Dr. Benali advances the modeling and optimization of biorefinery and bioenergy processes, including wood biomass pretreatment and sugar platform technologies at pilot scale. His work integrates techno-economic assessments, environmental evaluations based on life-cycle analysis (LCA), and carbon accounting. He also contributes to policy impact analysis and develops multi-criteria decision-making tools to support strategic planning in open innovation ecosystems. As a seasoned project manager, he leads initiatives that promote sustainable industrial transformation through science, data, and collaborative innovation.

Canadian Hydrogen Safety Centre (CH_2SC)

Nirmal Gnanapragasam

Abstract

- Safety of hydrogen handling in any quantities requires various components and human aspects of safety that could be collectively termed as dimensions.
- The safety principles of engineered systems required to handle hydrogen have been developed in the process industry and followed for more than 70 years worldwide.
- The application and implication of these principles in newer hydrogen technologies need exploration, such as:
  - Electrolysers,
  - Compressed gas storage in high-pressure mobile tanks,
  - Underground caverns,
  - Long-distance pipelines,
  - Transportation vehicles.
- This exploration ensures that safety is approached from a preparation focus and not just as a planning focus.
- The presentation will cover these topics in the context of the formation and purpose of the Canadian Hydrogen Safety Centre (CH_2SC).

Figure 2.16: Nirmal Gnanapragasam

Bio Dr. Nirmal Gnanapragasam created the Canadian Hydrogen Safety Centre (CH_2SC), a not-for-profit company in Canada. He leads strategy, commercialization, and research and development (R&D) for CNL hydrogen technologies and service areas, as well as R&D projects with industry partners in Canada and abroad. He also advises on hydrogen and energy technologies for strategic planning in various federal and provincial entities. Dr. Nirmal Gnanapragasam has 13 years of experience in hydrogen, nuclear, and renewable energy research, including 5 years focused on hydrogen isotopes (deuterium, tritium) and heavy water. He is a licensed Professional Engineer in Ontario and holds a doctoral degree in Mechanical Engineering from the University of New Brunswick, Fredericton.

Harnois Énergies, hydrogen, and the energy transition

Catherine Gosselin

Abstract Harnois Énergies has been an energy distributor for over 65 years. Harnois Énergies aims to provide the right energy for the right application to its various customers, both in the retail network and with its industrial customers, freight transport fleets, and for customers in the propane sector. The presentation will focus on Harnois Énergies' various hydrogen initiatives. Over the years, we've had the opportunity to implement or participate in initiatives that have advanced the use of hydrogen for mobility. We were the first to open a hydrogen distribution station in Quebec; it has been in operation since 2019, and to this day, we remain the only hydrogen station east of the Rockies. Furthermore, Harnois Énergies was the official distributor for the first North American hydrogen train, which allowed us to distribute hydrogen at a higher pressure than what is currently available on the Quebec market. Finally, Harnois Énergies was the first company to test a hydrogen-powered truck in the summer of 2024. This trial allowed us to understand the benefits, but more importantly, the limitations, of this device. Our current and future electric charging network will be present. Finally, I will present a brief overview of the new fuels available on the market. Harnois Énergies' goal is to provide the right energy to our customers, but also to innovate and experiment with new energy sources.

Figure 2.17: Catherine Gosselin

Bio Catherine Gosselin is an expert in hydrogen and alternative energies at Harnois Énergies. She holds a doctorate in hydrogen storage and an MBA in project management. Before joining the Harnois Énergies team, she worked in sustainable and smart public transportation, where she was responsible for creating innovative project opportunities. Her work experience in areas of hydrogen-powered innovative solutions technology has allowed her to take a multidisciplinary approach to in technological innovation. In the summer of 2023, Catherine was responsible, among other things, for supplying hydrogen to Alstom's Coradia iLint train in the Charlevoix region. In 2024, she was the driving force behind the project to put the first hydrogen-powered truck on Quebec's roads.

Hydrogen Engineering Consulting

Justin Cao

Abstract Wide deployment of hydrogen electrolyzers takes so much more than just good cell stacks. It requires a well-designed system around it to manage the power, fluids, and heat that enable the core electrolysis to happen safely and reliably. One key aspect that is often underappreciated is the process safety design and safety systems. Hydrogen is difficult to handle, mainly due to the small molecule's propensity to leak, as well as its very wide flammability range when mixed in air or oxygen. There is a lot of experience and precedent in the world for handling hydrogen, but it tends to be concentrated in the oil and gas and industrial gas sector, which may not be the same people developing electrolyzer systems. Additionally, electrolyzers have the unique characteristic of relying on very thin membranes to separate hydrogen and oxygen. This presentation gives an overview of how to design for and manage some of the key risks in a typical integrated electrolyzer system, backed by a combination of process industry and electrolyzer-specific expertise. Important topics covered include avoiding hydrogen's wide flammability range, managing hydrogen releases (both intentional and not), assessing membrane failures, and detection in larger systems. Then, the presentation goes more in depth into risk assessments, functional safety, some recommendations, an example scenario, and oxygen safety.

Figure 2.18: Justin Cao

Bio Justin is a process engineer and project manager by background and is now fully focused on advancing the sustainable energy transition. He has been involved in several multi-megawatt green hydrogen projects around the world, in his past role representing Accelera by Cummins for the HyLYZER 1000 electrolyzer product. As the product's Lead Process Engineer, he was a key driver of the development toward standardization, compliance with global standards, improved manufacturability, and reduced cost. Now as a Hydrogen Engineering Consultant with Cratos Can Inc, Justin brings his experience to the broader industry to drive deployment of the solutions we need to secure a more sustainable future.

Effect of Catalyst-Ionomer Interactions on the Oxygen Evolution Reaction in Nickel-Based AEM Electrolyzers

Elena Baranova

Abstract The transition from fossil fuels to renewable energy sources demands clean, efficient energy vectors, among which hydrogen stands out as a key enabler. Water electrolysis offers a sustainable route for green hydrogen production, yet existing technologies face cost and performance limitations. Alkaline electrolysis is well-established but limited by porous separators and liquid electrolytes, preventing high current density and dynamic operation. Proton exchange membrane (PEM) electrolysis enables compact, high-performance systems but relies on costly platinum group metal (PGM) catalysts. Anion exchange membrane water electrolysis (AEMWE) is an emerging alternative that merges the benefits of alkaline and PEM systems, aiming to deliver high-efficiency hydrogen generation using solid-state anion exchange membranes and low- cost, non-PGM catalysts. Anion exchange ionomers (AEIs) serve both as membranes and catalyst binders, enabling hydroxide ion transport while preventing gas crossover. However, the interfacial structure and dynamics of AEI–catalyst interactions remain poorly understood and limit system performance. Nanostructured Ni-based catalysts have shown excellent promise for both the oxygen and hydrogen evolution reactions (OER/HER) in AEMWE due to their high activity, stability in alkaline media, and affordability. Their integration into 3D porous electrodes with AEI binders and gas-diffusion layers (GDLs) presents both opportunities and engineering challenges. In this presentation, we will give a brief overview of recent research activities led by Professor Baranova's group at Concordia University in the field of electrochemical engineering for the energy transition, with a focus on non-noble metal catalysts, ionomer–electrode interactions, and AEMWE system development for hydrogen production.

Figure 2.19: Elena Baranova

Bio Elena Baranova is a Professor in the Department of Chemical and Materials Engineering at the Gina Cody School of Engineering, Concordia University. Prior to joining Concordia, she was a Professor and Co- Director of the Nexus for Quantum Technologies (NexQT) Institute at the University of Ottawa. She previously held an NSERC Postdoctoral Fellowship and worked as a Research Associate at the National Research Council (NRC), before joining the uOttawa as a tenure-track Assistant Professor in 2008. She completed her Ph.D. at École Polytechnique Fédérale de Lausanne (EPFL). Her research focuses on electrochemical energy conversion and storage, water electrolysis, electrochemical promotion, and electrocatalysis.

indexgeneralnon-noble metal catalysts

Hydrogen Startups – Pitfalls and Key Strategies for Innovators

Paul Shenouda

Abstract Propolys is the technology entrepreneurship incubator at Polytechnique Montréal that provides comprehensive support services for business creation and fosters the development of entrepreneurial skills. It offers various entrepreneurial pathways tailored to Polytechnique students as well as sector-specific programs open to all Quebec residents, focusing on clean technologies, cybersecurity/digital equity, and medical technology. Polytechnique Montréal strongly promotes entrepreneurial spirit by assisting interested students through training, advisory services, competitions, and a wide range of complementary resources designed to meet diverse needs. Propolys plays a crucial role in empowering innovators and democratizing access to affordable and impactful technologies, contributing to the vibrant innovation ecosystem at Polytechnique Montréal.

Figure 2.20: Paul Shenouda

Bio Paul Shenouda (B.Eng., M.Eng.) is a CleanTech startup manager and senior advisor at the Propolys technology incubator (Polytechnique Montréal), as well as a university lecturer in technological entrepreneurship. With a background in engineering, innovation management, and industrial R&D—and over 10 years of experience as a foodtech entrepreneur—he offers pragmatic and hands-on guidance to emerging entrepreneurs.

Carbon Exel - Startup

Chris Panaritis

Abstract Despite the urgency for a sustainable future, energy derived from coal and fossil fuels are declining at a low rate. Replacing fossil fuel chemicals with sustainable sources such as e-fuel (i.e., fuel derived from renewable electricity) will counter or at least delay the effects of the climate crisis. While hydrogen (H_2) presents a viable alternative to fossil fuels, its adoption as a primary energy source depends on the continued development of supporting infrastructure. Instead, H_2 can reduce CO_2 emissions by producing e-fuels. The reverse water gas shift (RWGS) converts CO_2 and H_2 to CO, which is an intermediate to produce chemicals and fuels. The process then follows the Fischer–Tropsch synthesis (FTS) to manufacture jet fuel (C_8–C_{16}). H_2 reduces CO_2 and builds hydrocarbon chains in the RWGS and FTS, respectively. Cu and Ni nanoparticles activate H_2 in a dual catalyst configuration and provide a cheaper alternative to precious metals for both RWGS and FTS reactions. Here, we promote the catalytic activity of Co_3O_4 with Ni nanoparticles to convert 5% of CO_2 at 300°C. As for FTS, Cu doped on Co/Al_2O_3 increased the selectivity to C_5+ hydrocarbons. At Carbon Exel, we are developing a one-step process to transform H_2 and CO_2 into sustainable aviation fuel (SAF), leveraging our findings from the Ni/Co_3O_4 and Cu–Co/Al_2O_3 catalysts. Furthermore, we are integrating reaction and separation unit operations within a single reactor vessel to reduce energy consumption by 50%.

Figure 2.21: Chris Panaritis

Bio Chris Panaritis is the CEO of Carbon Exel and a postdoctoral fellow within the EPIC team led by Prof. Boffito at Polytechnique Montreal. His multidisciplinary expertise spans heterogeneous catalysis, nanotechnology, electrochemistry, process intensification, and theoretical DFT (Density Functional Theory) simulations. Chris led the research, development, and patenting of a novel catalyst enabling the direct conversion of carbon dioxide (CO_2) and green hydrogen (H_2) into sustainable fuels. Motivated by both the breakthroughs and challenges encountered during this work, he founded Carbon Exel to commercialize a single-step reactor system bypassing the traditional three-unit operation. This innovation significantly reduces emissions, costs, and space requirements, paving the way for more efficient and scalable carbon and hydrogen for sustainable fuel production.

Cycle Momentum - Opportunities for the creation and acceleration of Quebec-based hydrogen technology startups

Daniel Diez

Abstract Cycle Momentum is an international acceleration and innovation platform whose mission since 2015 has been to identify and support the development of cutting-edge technologies to address humanity's major ecological challenges. As a member of the Cycle Capital platform, Cycle Momentum offers acceleration and open innovation programs to support entrepreneurial growth, financing, and commercialization of climate technologies. We establish the necessary collaborations between industrial leaders and start-ups to accelerate the commercialization of their solutions. Cycle Momentum invests through Origo, an investment matching program supported by the Government of Quebec. Since 2023, Cycle Momentum, together with 2 Degres and other partners, has been developing the Lab-to-Startup, a program which aims to transform research-based innovations into impactful startups. By bringing together a multidisciplinary team around researchers, we validate the market, structure and finance the business project, and build a strong team to accelerate the transition from innovation to market. This is an opportunity for fast creation of startups in the field of hydrogen and other topics.

Figure 2.22: Patricio Gutierrez

Bio Patricio Gutierrez Mella has over 15 years of experience in entrepreneurship, innovation, and project management in both public and private sectors. In Chile, he worked with an incubator, led Ministry of Education entrepreneurship programs, and coordinated a Smart City program. He also mentors for Startup Chile and 3IE (UFSM). Since moving to Canada in 2017, he has worked in open innovation at Desjardins and is currently the Senior Coordinator of Acceleration and Open Innovation Programs at Cycle Momentum, a climate solutions startup accelerator. Patricio holds a bachelor's degree in business, a master's degree in economics and public policy (UAI, Chile), and a certificate in innovation management (HEC, Montreal).

Figure 2.23: Daniel

Daniel Diez is Project Manager - Clean Technology Consortium at Cycle Momentum. He brings a wealth of knowledge with his master's degree in renewable energy and experience as an international project development engineer. Daniel shares Amira's passion for clean technology and promoting innovation.

Multi-scale modelling and experimental validation of synergistic CO_2 and H_2O co-electrolysis for syngas production

Yanfa Zhuang

Abstract Carbon capture and utilization, which converts captured CO_2 into value-added chemicals and fuels, presents a promising pathway to mitigate energy crises and achieve carbon neutrality. The co- electrolysis of CO_2 and H_2O is an effective approach to convert greenhouse gases into valuable and sustainable products, such as syngas. Nevertheless, the coupled multi- physics transport–reaction phenomena within the device are complex and not directly quantifiable through experiments. To address these challenges and support industrial scalability, this study developed a multi-scale framework based on a 2D full-device model to predict reaction –transport mechanisms and subsequently validated the simulated co- electrolyzer experimentally using a lab-scale testing platform. By precisely controlling the H_2/CO ratio, the capture–conversion system enables downstream hydrocarbon and sustainable aviation fuel synthesis, thereby reducing the overall lifecycle carbon footprint.

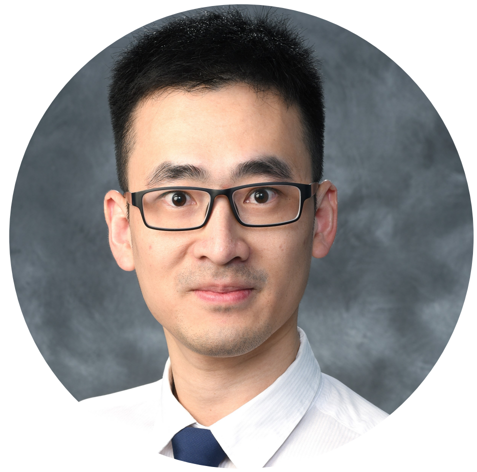

Figure 2.24: Yanfa Zhuang

Bio Yanfa Zhuang holds a Ph.D. in Chemical Engineering from Polytechnique Montréal. In 2023, he founded Hythermal Gas Inc., a Montreal-based company specializing in advanced carbon capture technologies using solid adsorbents. He leads the company's research and development efforts and is currently overseeing a 1,000-tonne-per-year pilot project for capturing industrial point-source flue gas. In addition to carbon capture, Hythermal is also advancing the development and commercialization of modular PSA hydrogen purification systems and CO_2–H_2O co-electrolysis technologies.

ClearWatt Startup

Arev Citak

Abstract ClearWatt is a startup in the domain of green hydrogen supply chains, originating from McGill University. ClearWatt facilitates the development of green hydrogen projects and connects suppliers and users on a single platform. In Québec, an annual surplus of 32 TWh of electricity is generated. This excess energy can be converted into green hydrogen, representing a significant opportunity for sustainable energy development. However, the restricted nature of the hydrogen network has the effect of hindering the scaling and utilisation of green hydrogen. ClearWatt has proposed a Power Purchase Agreement (PPA) and a gas cylinder marketplace that connects users and producers. The marketplace has the capacity to render data transparent, thereby creating the conditions for the emergence of new forms of service and business opportunity. ClearWatt's secondary function is to optimise the locations of electrolysers for hydrogen demand from various industries across different geographical locations. The hydrogen demand from the heavy transport industry in Québec demonstrates the potential for the optimisation of the site in the province. The software utilised by our team offers a comprehensive display of the impact of diverse metrics on the price, emission, and capacity of electrolysers. This facilitates the identification and comparison of the optimal locations for electrolysers and, by extension, hydrogen refuelling stations.

Figure 2.25: Arev Citak

Bio Arev Citak is the co-founder of ClearWatt. He is a final-year Bioresource Engineering student at McGill University. He founded ClearWatt with his McGill colleague in the summer of 2024. He has worked as a tutor and an undergraduate teaching assistant at McGill, as well as completing multiple summer internships during his studies. He is the president of the McGill Mac 3D Printing Club and a member of the McGill Robotics Club. In 2024, he won the Quebec Engineering Competition with his delegation, winning three prizes for his work on ClearWatt. He is currently an intern in Dr Patience's lab and will begin his PhD in Chemical Engineering next year.

On the path to decarbonization: integration of green hydrogen in pyrometallurgy

Jean-Philippe Harvey

Abstract Fossil fuels such as coke, petroleum and natural gas are used in a plethora of pyrometallurgical operations. These high temperature processes are designed to extract, reduce and purify metals originating from oxide-rich ores mined from the Earth's crust. They often involve the formation of a molten phase to thermodynamically and kinetically promote reducing and purifying reactions. Pyrometallurgical processes are essential for our industrialized world as they allow us to obtain commodity and critical metals. Carbon-based reactants are mostly used in these technologies as reducing agents and as fuels to generate the required heat to melt reactants and to maintain a high operating temperature. Carbon use efficiency is maximized by reacting with two oxygen atoms to produce gaseous CO_2, a critical greenhouse gas the pyrometallurgical sector is trying to avoid. One strategy to lower CO_2 gas emissions is to substitute carbon-based reactants with green hydrogen. This talk details how computational thermodynamics can be applied to predict the theoretical feasibility of using hydrogen as a reducing agent and as a fuel in various pyrometallurgical unit operations. Challenges associated with the endothermicity of H_2 reducing reactions, with the production of steam at high temperature, with the hydrogen solubility in molten metals and with hydrogen embrittlement will be discussed. Finally, a clear connection between computational thermodynamic simulations and life cycle inventories will be presented to strengthen current life cycle analysis strategies. The Midrex process as a potential candidate for the substitution of natural gas by hydrogen to produce iron will be analyzed.

Figure 2.26: Jean-Philippe Harvey

Bio Prof. Jean-Philippe Harvey started his appointment in the chemical engineering department at Polytechnique Montreal in 2016. He is classically trained in materials science and has been involved in projects related to earth and planetary sciences since his postdoctoral fellowship at Caltech back in 2013. His core research activities focused on the energetic and internal structure description of solid and liquid solutions that form during the extraction of metals and the elaboration process of alloys. He is a long-time contributor to the development of the FactSage computational thermodynamic package. This software is currently used by over 1000 universities and industrial sites around the world. Prof. Harvey uses atomistic simulations, computational thermodynamics, and process simulation tools to help in the design of new materials and greener pyrometallurgical processes. He recently held the Lecuyer philanthropic chair on recycling and has explored a variety of pyrometallurgical processes to valorize aluminum dross, electronic waste and lithium-ion batteries. Prof. Harvey is currently involved in NSERC-funded projects for the aluminum and steel industries supported by Rio Tinto, Alcoa, Constellium, Hydro-Aluminium, ArcelorMittal and Hydro- Quebec among others. He is also collaborating with CanmetENERGY and several NRC laboratories on a variety of projects related to steel production, LIBS analytical techniques, 3D metallic additive manufacturing and bio-sourced char valorization.

Mechanochemical synthesis of electrocatalyst for H2 production

Thomas Auvray

Abstract Thomas Auvray, Institut de Recherche sur l'Hydrogène et Département de Biochimie, Chimie, Physique et Science Forensique, Université du Québec à Trois-Rivières, Trois-Rivières (Québec) G8Z 4M3, Canada With more than 30 years of activity, the multidisciplinary team of the Hydrogen Research Institute has gained an international reputation for its expertise touching almost all aspect of the clean hydrogen value chain, from production to storage and its safe use and effective integration, especially in the context of low emission mobility. I will first introduce the breath of our activities, ranging from accelerated material discovery through combined theory/experiment approaches, to benchmarking of various electrolysis and fuel cell technologies, leading to advanced modeling and integration of renewable energy systems. In the second part of this presentation, I'll briefly illustrate our material expertise through a collaborative project on the development of 2D- chalcogenide materials used for the electrocatalytic production of hydrogen. Through mechanochemical treatments, we obtained materials with mixed composition (based on group 6 metals combined with S, Se or Te) and modified morphologies – exfoliation and phase change induced by strain introduction in the materials. These physico-chemical parameters are known to impact and potentially enhance catalytic activity. Indeed, testing the electrodes prepared by electrodeposition of the mechanochemically-treated materials showed lower overpotential, enhanced kinetics with moderate benefit on stability for water electrolysis.

Figure 2.27: Thomas Auvray

Bio Dr. Thomas Auvray is the co-director of the Institut de Recherche sur l'Hydrogène and assistant professor in Physical Chemistry of Materials at the Université du Québec à Trois-Rivières since November 2024. He obtained his B.Sc. (2012) and M.Sc. (2014) in Chemistry from Université Pierre et Marie Curie (Paris VI, France) before moving to Canada where he obtained his Ph.D. in 2020 at the Université de Montréal, focused on the development of supramolecular systems for artificial photosynthesis. After a year as postdoctoral research associate at the University of Rochester (NY, US) exploring the use polyoxometalates as ligands for actinide cations, he joined McGill University as a Fonds de Recherche du Québec – Nature et Technologies postdoctoral fellow (2021-2022) to explore the use of mechanochemistry for the synthesis of coordination compounds and sustainable methods for metal purification. In 2022, he became as senior research fellow at the University of Birmingham (UK), coordinating the group relocation while focusing his research on advancing mechanochemistry for the preparation of functional inorganic and organometallic materials and the use of spectroscopic in-situ methods for the study of mechanochemical processes. He was awarded the 2024 Nina McClelland Memorial Award by the Green Chemistry Institute of the American Chemical Society for his engagement in the development and diffusion of more sustainable laboratory practices.

The Challenges to Decarbonize Industrials Chemicals and Feedstock for Materials

Shaffiq Jaffer

Abstract The chemical industry today emits approximately 2 Gt/y CO_2 accounting for $\sim$5% of the global GHG emissions. Most chemicals contain carbon that are used in society today and hence this carbon will have to be sourced from biomass or CO_2 in the environment (Air/Water) in the long term. This will be the only way to achieve a full circularity for these products. A large challenge is the low density of these resources for sourcing carbon which brings additional cost and technical difficulty. Today, bioresources are limited when we try to achieve a sustainable approach to using this resource in addition to also not competing for land that can be used for food production. Consequently, long term a combined process to use CO_2 from the air/ water coupled conversion of it to chemicals leveraging vast amounts of renewable energy is the challenge. This presentation will try to show the challenges at the macro level and the potential path to try achieve the long term goal of full circularity of the chemicals industry.

Figure 2.28: Shaffiq Jaffer

Bio Shaffiq A Jaffer holds a BSc in Chemical Engineering from University of Alberta and a PhD from McMaster University (1998). He is a Fellow of Canadian Academy of Engineering (FCAE) and a Fellow of the Chemical Institute of Canada (FCIC). He joined TotalEnergies in 2009, as the VP Corporate Science and Technology Projects in North America. He initiates and oversees research collaborations with academia and government labs primarily in USA and Canada but has collaborations in Europe and Asia as well. He is focused on technologies and solutions that will facilitate sustainable energy meeting the NetZero ambition of TotalEnergies. Dr. Jaffer's research is focused on closing the carbon cycle, enabling seasonal energy storage and circularity of chemicals and materials. Research topics include Carbon Capture, Utilization and Storage (CCUS), Direct Air Capture, hydrogen generation, storage and use, electrification of refining chemicals manufacturing and Renewable Power (Solar, Wind, energy storage). Prior to TotalEnergies, he has worked for P &G and Koch-Glitsch in research and engineering roles. He has published across a broad array of scientific domains. A His work is dedicated to advancing technologies that support the company's Net Zero ambition and the broader transition to sustainable energy. His research focuses on closing the carbon cycle, enabling seasonal energy storage, and promoting the circularity of chemicals and materials. Key areas of interest include Carbon Capture, Utilization, and Storage (CCUS), Direct Air Capture, hydrogen production, electrification of refining and chemical manufacturing, and renewable energy systems including solar, wind, and energy storage.

CHARBONE Corporation

Daniel Charette

Abstract CHARBONE Corp is an integrated company specializing in Ultra High Purity (UHP) H_2 and the strategic distribution of industrial gases across North America (NA) and the Asia-Pacific region. The company is developing a modular network of green H_2 production facilities while partnering with industry leaders to supply He and other specialty gases without the need to build costly new plants. This disciplined strategy diversifies revenue streams, reduces risks, and enhances operational flexibility. CHARBONE is publicly listed on stock exchanges in both NA and Europe. The 'H' in CHARBONE represents two core principles: H_2, which the company produces in its own facilities, and Humanity, reflecting the company's commitment to its people as the heart of its operations and legacy for future generations. At the core of CHARBONE's identity lie 6 fundamental values that guide daily operations and underpin its ambition to become a leader in specialty gases: **Safety** is the foundation of CHARBONE's strategy and corporate culture. The company ensures the safety of its employees, stakeholders, and facilities through rigorous operational processes, including health, workplace safety, climate, and environmental considerations. **Responsibility** is embraced across all projects, with a commitment to the economic, social, and environmental impacts. CHARBONE takes ownership of protecting natural and human resources and strives for constructive and high-quality performance. **Agility** enables the company to respond quickly to market changes and seize new opportunities. CHARBONE fosters initiative, creativity, and adaptability to advance future technologies and continuously renew its expertise. **Respect and Humility** define the company's approach to diverse perspectives, honesty, transparency, integrity, and the maintenance of safe working conditions. **Passion** drives CHARBONE's dedication to developing renewable energy- supported gases, with a unified team pursuing solutions and excellence enthusiastically and professionally. **Collaboration and Consultation** emphasize partnerships based on shared ambitions and successes, promoting teamwork and open dialogue. Together, these values form the foundation of CHARBONE's strength, distinction, and sustainable growth in specialty gases.

Bio Daniel Charette is a seasoned entrepreneur with over 20 y of mechanical industrial manufacturing and industry services experience, and a veteran and pioneer of renewable energies in Canada and the US since 1998. He began his career in wind power by becoming, in 1998, the manufacturing manager of the first NAn wind turbine assembly plant. He established Canada's first regional wind turbine operation & maintenance center in Quebec for what was the largest wind farm in Canada (1999-2002). He was national sales director for Canada, including the merger of NEG Micon with Vestas (2002-2005). In 2005, he joined Brookfield Renewable where he became director of business development for the Americas renewable energy sector, covering the development of more than $1B of projects and first acted as project manager for the +$400M Prince 1 and 2 wind projects. He has been involved in several other companies in the field, including AAER, Pioneer Wind Energy Systems, NRG Systems/Oenko, Leader Resources, and Moventas. Since 2019, Daniel is the COO and a founding members of CHARBONE Hydrogen Corporation (TSXV). He is responsible to establish and deploy of Charbone's green H_2 production facility network in NA, value chain partnerships to build local ecosystems, and oversee all the renewable energy power purchase agreements. Daniel is the former president and VP of the "H_2 Quebec Association," a member of the "Mayor's Economic Transition Commission of the Great Lakes and Saint Lawrence Cities Initiative," a member of the "CUTRIC-CITRUC—Zero Emissions Bus Technologies & Energy Solutions Committee," one of the founders of the "Manitoba Green H_2 Round Table" and various boards including the Canadian Wind Energy Association, the Quebec Association of Renewable Energy Producers, the Latin American Wind Energy Association.

Hydrogène Québec

Steven Blaney

Abstract Hydrogène Québec is an independent, non-profit association dedicated to accelerating the emergence of a renewable and low-carbon hydrogen ecosystem in Québec. As the only organization in the province representing both public and private members across the entire hydrogen value chain — from production and distribution to applications and R&D — Hydrogène Québec plays a key role in shaping a sustainable hydrogen future. The association advocates for its members' interests, raising awareness among policymakers, industry stakeholders, and the general public about the strategic role hydrogen technologies can play in decarbonizing Québec's economy. Leveraging the collective expertise of its diverse network, Hydrogène Québec supports structured and impactful development of hydrogen projects, especially in sectors where decarbonization alternatives are limited. In the short and medium term, it prioritizes initiatives that contribute to Québec's energy transition and actively participates in the province's ongoing energy policy consultations to ensure the inclusion of supportive tools and policies that align with its vision.

Figure 2.29: Steven Blaney

Bio President and CEO, Hydrogène Québec. A man of action and innovation, Steven Blaney is committed to driving sustainable prosperity through creativity and initiative. An engineer and seasoned politician, Steven draws on his expertise in environmental engineering, urban infrastructure, water treatment, and energy optimization to accelerate Québec's energy transition. As Canada's first carbon-neutral Member of Parliament, he served in ministerial and parliamentary roles for over 15 years, championing strategic legislation and passionately supporting veterans and community initiatives. Notably, he swam across the St. Lawrence River seven times to raise awareness and funds for local organizations. Today, as President and CEO of Hydrogène Québec, Steven leads efforts to strengthen the province's green and low-carbon hydrogen ecosystem.

General Index

Author index