

HYDROGEN

for Clean Power and Mobility

WORKSHOP PROCEEDINGS
AND BOOK OF ABSTRACTS

28–29 MAY 2026

TRAKIA UNIVERSITY
STARA ZAGORA, BULGARIA



Co-funded by
the European Union



ПРОГРАМА
ОБРАЗОВАНИЕ
2021–2027



ПРОГРАМА
НАУЧНИ ИСЛЕДОВАНИЯ,
РАЗВИТИЕ И ДИФУЗИОННО-ТЕХНОЛОГИЧНА
ТРАНСФОРМАЦИЯ



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TRAKIA UNIVERSITY PRESS
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WORKSHOP PROGRAM

MAY 28-29, 2026

Augusta Trayana Hall

Trakia University - Stara Zagora, Bulgaria

DAY 1 **MAY 28**

HYDROGEN MASTERCLASS

08:30 - 09:00 WELCOME & REGISTRATION

OFFICIAL OPENING

9:00 - 9:10

Welcome Address

Prof. Miroslav Karabaliev | Rector of Trakia University, RRP Project Coordinator

9:10 - 9:35

[20 min+5 min Q&A]

Building the Future of Hydrogen in Stara Zagora: A Story of Growth, Vision, and Transformation

Prof. Daria Vladikova | Executive Director of H2START - Trakia University

HYDROGEN MASTERCLASS

State of the Art across the Hydrogen Value Chain: From Lab to Startup

9:35 - 10:30

[45 min+10 min Q&A]

Why hydrogen? ID Card and Some Stunning

Answers to Rarely Asked Questions

Alain THOREL | Trakia University / ICARE

10:30 - 10:50

COFFEE BREAK

10:50 - 11:45

[45 min+10 min Q&A]

Geogenic Hydrogen and Hydrogen Geological Storage

Orlando VASELLI | University of Florence

11:45 - 12:40

[45 min+10 min Q&A]

Hydrogen Production: Different Routes, Current Status, and Main Challenges

Julie MOUGIN | CEA

12:45 - 12:50

GROUP PHOTO

12:50 - 14:10

LUNCH & MEDIA BRIEFING

14:10 - 15:05

[45 min+10 min Q&A]

Hydrogen Storage and Transport Technologies: Principles, Development, and Recent Progress in China

LI Song | HUST/ICARE

15:05 - 16:00

[45 min+10 min Q&A]

General Uses of Hydrogen

Massimo SANTARELLI | Polito

16:00 - 16:25

COFFEE BREAK

16:25 - 17:20

[45 min+10 min Q&A]

Bridging the Valley of Death: The Role of Proof-of-Concept Programs in Science Valorization [online]

Emilio PAOLUCCI | Polito

TECHNICAL DEMONSTRATION

17:20 - 18:00

[30 min+10 min Q&A]

HyBOPS, a Modular and Turnkey Test Bench for Hydrogen Equipment - a Focus on PEM Fuel Cell System Testing

Loïc CAMENEN | HORIBA

18:00 - 19:00

POSTER SESSION

20:00

DINNER [Calista Spa Hotel]

The Hydrogen for Clean Power and Mobility Workshop is co-organized by the National Recovery and Resilience Plan – Development of Research and Innovation at Trakia University in the Service of Health and Sustainable Well-Being Project (No. BG-RRP-2.004-0006-C02), financed by the Program for Education 2021-2027 and Project H2START - Centre of Excellence for Hydrogen Technologies, financed by the European Union under Horizon Europe (GA 101136692) and the Programme for Research, Innovation, and Digitalisation for Smart Transformation 2021-2027.

DAY 2 MAY 29

HYDROGEN: BEYOND THE STATE OF THE ART

Session 1

GREEN POWER PRODUCTION

9:00 - 9:35

[30 min+5 min Q&A]

KEYNOTE LECTURE Beyond Technology:
Social Challenges in the Hydrogen Transition
Agatino NICITA | CNR

9:35 - 10:00

[20 min+5 min Q&A]

**Advancing PEM Water Electrolysis with
Low-Equivalent-Weight Aquivion® Membranes**
Fausta GIACOBELLO | CNR

10:00 - 10:25

[20 min+5 min Q&A]

PEM Electrolysis: The Catalyst Issue
Christian BEAUGER | Mines-Paris

10:25 - 10:45

COFFEE BREAK

10:45 - 11:10

[20 min+5 min Q&A]

**Biomass Valorization through Conversion
into Energy Carriers and High Value-Added-
Products** Vitaliano CHIODO | CNR

11:10 - 11:35

[20 min+5 min Q&A]

Hydrogen Production: Coupling to RES
Domenico FERRERO | POLITO

Session 2

HYDROGEN UTILIZATION

11:35 - 12:10

[30 min+5 min Q&A]

KEYNOTE LECTURE Hydrogen Fuel Cells for
Stationary and Quasi-Stationary Applications
Nikolaos BONANOS | Materials Science Consultant

12:10 - 12:35

[20 min+5 min Q&A]

**Proton Ceramic Cells as Pathfinders
in Green Chemistry**
Mariya E. IVANOVA | H2START-Trakia University

12:35 - 13:45

LUNCH

13:45 - 14:10

[20 min+5 min Q&A]

**Routes of Improvements for Air/Steam
Electrodes of Reversible Proton-Conducting
Ceramic Cells**

Asrar SHEIKH | H2START-Trakia University

14:10 - 14:35

[20 min+5 min Q&A]

**Hydrogen Transport and Distribution:
Insights from Simulation Activities of the
SHIMMER Project**
Marco CAVANA | Polito

Session 3

GREEN MOBILITY

14:35 - 15:10

[30 min+5 min Q&A]

KEYNOTE LECTURE Transport Sector
Decarbonization in Large Scale - Challenges
and Opportunities Blagoy BURDIN | IEES-BAS

15:10 - 15:35

[20 min+5 min Q&A]

**Hydrogen Mobility Beyond the Hype:
Applications, Evidence and Research
Challenges** Giuseppe NAPOLI | CNR

15:35 - 16:00

[20 min+5 min Q&A]

**Development of Solid-State Hydrogen
Storage: From Material Research to
Lab-Scale Tank Prototyping**
Rolando PEDICINI | CNR

16:00 - 16:20

COFFEE BREAK

16:20 - 17:10

[45 min+5 min Q&A]

**From Hydrogen Pioneer to HydroShunter:
Two Decades of Fuel Cell Innovation
for Railway Decarbonisation**
Stuart HILLMANSEN, University of Birmingham/
Vanguard Sustainable Transport Solutions

TECHNICAL DEMONSTRATIONS

17:10 - 17:35

[20 min+5 min Q&A]

**H2ICE: Italy's Innovation Hub for Hydrogen
Internal Combustion Engines** [online]
Francesco BITRAJ | Unione Industriali Torino

17:35 - 18:35

[60 min]

**Demonstrations with Hydrogen Fuel Cell
Electric Vehicle Hyundai Nexo**
Ivan IVANOV | IP Taxi

18:35

**CLOSING COCKTAIL WITH
POSTER SESSION AND H2 CAR TEST DRIVES**

HYDROGEN

for Clean Power and Mobility

WELCOME TO



TRAKIA UNIVERSITY
STARA ZAGORA



H2START

The worksop is organized under the patronage of the Rector of Trakia University, Prof. Miroslav Karabaliev



Prof. Miroslav Karabaliev

Rector

Trakia University – Stara Zagora

Prof. Miroslav Ivanov Karabaliev is a distinguished scholar in the field of biophysics and an experienced academic leader with more than 25 years of service in higher education. He graduated in Physics from Sofia University “St. Kliment Ohridski”, where he also obtained his PhD degree in Biophysics. Since joining Trakia University in 1996, he has played a key role in the development of medical physics and interdisciplinary scientific research.

His research activities focus on bionanotechnology, biosensors, spectroscopy, impedance-based cellular analysis, and the application of artificial intelligence in medical diagnostics. His scientific publications are indexed in internationally recognized databases, including Scopus and Web of Science.

As Rector of Trakia University, Prof. Karabaliev actively supports the modernization and internationalization of the institution. His leadership is focused on strengthening research capacity, expanding international academic partnerships, promoting digital transformation, and improving the quality of education through innovative technologies and contemporary learning platforms. He also contributes to national initiatives for the development of research universities and sustainable academic collaboration in Bulgaria.

WELCOME ADDRESS FROM THE RECTOR

Distinguished guests,
Dear colleagues,
Ladies and gentlemen,

It is my great pleasure, on behalf of Trakia University, to welcome you to Stara Zagora and to the workshop Hydrogen for Clean Power and Mobility. I warmly greet all participants, speakers, researchers, industrial representatives, institutional partners, students, and guests who have joined us for these days dedicated to scientific exchange, dialogue, and international cooperation.

This workshop represents much more than a scientific event. It reflects a shared vision for the future - a future in which knowledge, innovation, international cooperation, and responsible technological development contribute to the transition toward cleaner, more resilient, and more sustainable societies.

The global transition toward sustainable energy systems is among the defining challenges of our time. Achieving climate neutrality, ensuring energy security, and maintaining economic competitiveness require not only technological innovation, but also a coordinated effort between science, industry, institutions, and society.

In this context, hydrogen technologies are attracting growing international attention due to their broad potential in energy conversion, storage, transport, industrial applications, and the integration of renewable energy sources. Their advancement is opening new perspectives for sustainable development and accelerating innovation across multiple sectors.

Universities have an important role in this transformation. Beyond education and research, academic institutions are expected to

contribute actively to technological progress, innovation ecosystems, and the preparation of future generations of specialists capable of addressing increasingly complex global challenges.

At Trakia University, the development of hydrogen technologies has become an important strategic direction over the past years. Through a series of national and international projects, the university has continuously expanded its activities in the fields of electrochemical energy systems, hydrogen production and utilization technologies, advanced materials, and sustainable mobility solutions.

Today, Trakia University is among the pioneering institutions in Bulgaria in the field of hydrogen research and innovation. This position has been established through the dedication of leading scientists, active international collaboration, and the development of modern research capabilities and unique infrastructure supporting advanced experimental and applied research.

We are proud that our university is building an environment that combines scientific excellence, technological development, education, and international cooperation. Such efforts are essential not only for advancing science, but also for supporting regional development and creating new opportunities for young researchers and engineers.

This workshop reflects the interdisciplinary nature of modern energy research. The programme brings together topics ranging from advanced electrochemical materials and hydrogen technologies to mobility, infrastructure, sustainability, and system integration. Equally important is the opportunity for young researchers and students to engage directly with internationally recognized experts

and become part of a growing scientific community.

Meetings such as this create valuable opportunities for discussion, exchange of experience, and the establishment of future collaborations. Scientific progress increasingly depends on openness, partnership, and the ability to connect knowledge across disciplines and borders.

I would like to express my sincere appreciation to all organizers, speakers, contributors, and partners whose efforts made this event possible. I also acknowledge with gratitude the support of all institutions and programmes contributing to the advancement of research and innovation in the field of clean energy technologies.

Dear colleagues,

I am confident that the coming days will bring fruitful discussions, inspiring ideas, and new opportunities for cooperation.

I wish you a successful workshop and a pleasant stay in Stara Zagora.

Welcome to Trakia University.

Prof. Dr. Miroslav Karabaliev

Rector of Trakia University
Stara Zagora, Bulgaria

WELCOME ADDRESS FROM ORGANIZERS

It is a pleasure and an honour to welcome all participants to the Hydrogen for Clean Power and Mobility Workshop, jointly organised by the Research University project of Trakia University and the H2START Centre of Excellence project.

The workshop brings together researchers, academics, young scientists, and industry representatives to advance knowledge, innovation, and collaboration in hydrogen and fuel cell technologies. Through a carefully designed programme, it creates space for discussion, exchange of ideas, and new connections across disciplines and sectors.

We are especially pleased to highlight the participation of young scientists, whose poster presentations offer an opportunity to share their work, receive expert feedback, and join a growing clean energy research community.

The event also reflects the progress of the Bulgarian hydrogen research ecosystem. The first Working Group on Hydrogen in Stara Zagora helped spark interest and innovation within Trakia University, supporting the rapid development of the H2START Centre of Excellence in Hydrogen Technologies.

The Centre marks an important step towards transforming Stara Zagora into Bulgaria's first hydrogen hub and highlights the role of hydrogen in the transition to a sustainable, low-carbon future.

We thank all contributors, speakers, and participants for supporting this initiative and advancing hydrogen research and innovation.

Prof. Alain Thorel

Hydrogen and Fuel Cells Research
Group - Research University
Project, Trakia University

Prof. Daria Vladikova

Coordinator of the H2START
Centre of Excellence Project

EDITORIAL

Henry Louis Mencken (1880-1956) free-thinking journalist and writer, who was called the Sage of Baltimore, used to publish iconoclastic style and sharp wit quotations, a number of which would be totally appropriate to describe the today's politicians who put us in an unstable international situation. One of his quotes is fully relevant to describe the global warming and energy transition challenge that are ahead of us:

“For every complex problem there is always a simple and straightforward solution... which is wrong!”

Anyone proposing a simplistic solution to combat and control climate change is clearly making a mistake, a serious one. Climate change is a global and extremely complex problem with considerable and lasting inertia. And any global problem can only be solved by a global solution, which, in the case of climate change and the energy transition to a low-carbon society, implies international cooperation among stakeholders acting in concert.

This is precisely what we are doing here, in this international workshop where experts and students from different continents come together and exchange ideas for two days. The location, Stara Zagora and the University of Trakia, which blend 3,500 years of history with multidisciplinary university training, is also symbolic: the Thracians were fierce warrior tribes, but they are also renowned for their refined craftsmanship and their ability to create sumptuous jewelry and host lavish banquets. Let us draw inspiration from this fighting spirit against climate change and develop our goldsmithing skills to design effective conversion devices, while fully enjoying these shared moments.

The themes addressed, Hydrogen for Clean Power (H24CP) and Hy-

drogen for Clean Mobility (H24CM), are not only linked to the two projects funding the event, but also to the most urgent priority sectors. Indeed, these sectors (Energy and Mobility) are responsible for the largest CO2 emissions (35-40% and 20-25%, respectively). Therefore, this event is entirely relevant and legitimate, and efforts should be focused primarily on the sectors where the impact will be greatest.

The various facets of the value chains of these two sectors, H24CP and H24CM, from production to use, will be analyzed by addressing scientific, societal, technical and economic aspects. Discoveries likely to revolutionize the sector (such as white hydrogen) will be presented by specialists, as well as the financial viability of hydrogen, the different production processes, including those using biomass or electrolysis coupled with renewable energy sources, the different uses of hydrogen, primarily targeting electricity production and green mobility, storage technologies including LOHC (which is unfortunately understudied in Europe), and storage using divided matter.

Today, developing a technology requires more than simply ensuring the availability of necessary mineral resources; international tensions add another layer of difficulty in accessing these resources. Europe possesses a little bit of everything except rare earth elements, while other regions are rich in precious metals, rare earth elements, and other transition metals. The post-Covid crisis, followed by the war in Ukraine and now the war in Iran, have significantly impacted both resource prices and their accessibility. The price of certain precious metals, already scarce, has skyrocketed, even though they are essential to some of the technologies that will be presented and discussed here. Copper is under extreme pressure, and we have observed—and continue to observe—significant volatility in the prices of iron, nickel, cobalt, and aluminum. The project to exploit the vast lithium reserves in the Donbass region by the Australian company European Lithium has stalled. It is therefore clear that the issue of materials is of paramount importance, and all these instabilities have a considerable

impact on our plans for the energy transition. Mitigating risks requires a radical overhaul of our education system, which must prioritize materials science, with enriched chapters on catalysts, clean extractive metallurgy, high-throughput metal recycling, physical properties, substitute metals, ceramic sintering, etc. The issue of materials will also be addressed here.

Demonstrating the viability of a technology, even at an early stage, is essential for engaging stakeholders and understanding the challenges of implementing an emerging technology in a real-world setting. Demonstrators and prototypes have always played a crucial role in the development of innovative human societies; our workshop will host several demonstrations, ranging from a modular Balance of Plant for a power supply system to a hydrogen car, and including an example of retrofitting in the rail sector.

The workshop will unfold as follows: a day of general masterclasses on hydrogen, open to students, followed by a scientific day divided into three sessions: Green Power Production, Hydrogen Utilization, and Green Mobility. Poster sessions and Demonstrations will take place at the end of each of these two days.

This event, and the gathering of all these renowned experts, would not have been possible without the unwavering support of the Rector of Trakia University, Professor Miroslav Karabaliev, to whom we extend our sincerest thanks. But it is to Professor Daria Vladikova that we express our deepest gratitude and warmest thanks. Year after year, with unshakeable strength and motivation, she has, step by step, paved the way to the international projects that are giving rise, within Trakia University itself, to a unique center of excellence for hydrogen. I sincerely hope that her remarkable vision and determination will be the spark that ignites the future of hydrogen across Europe and beyond

Prof. Alain Thorel

Chairman of the Hydrogen for Clean Power and Mobility Workshop
Wuhan, China, April 26, 2026



Prof. Daria Vladikova

H2START – Trakia University, Stara Zagora

Daria Vladikova is Professor in Electrochemistry and Executive Director of the H2START Center of Excellence on Hydrogen Technologies towards Trakia University. She has a PhD in Solid State Chemistry and a D.Sc. in Electrochemistry. She is working in the field of fuel cells and batteries testing and diagnostics and deployment of hydrogen technologies. She is the author of more than 150 scientific publications with over 1000 citations. She has been awarded with Herman Göhr Award by the European Fuel Cell Forum.

Prof. Vladikova is founder of the Bulgarian Hydrogen, Fuel Cell and Energy Storage Association and Chairs its Scientific Committee. She is also a Member of the Clean Hydrogen Alliance (CHA) Round Table for Green Hydrogen Production and of the SET Plan Implementation Working Group (IWG) on Hydrogen.

BUILDING THE FUTURE OF HYDROGEN IN STARA ZAGORA

A Story of Growth, Vision, and Transformation



The Bulgarian team of H2START from Trakia University (March 2026)

The development of hydrogen research at Trakia University is a story of vision, persistence, and continuous growth, unfolding through two closely connected phases.

The journey began with the establishment of the first hydrogen research group at Trakia University, “Hydrogen and Fuel Cells”, created as a part of the National Project No. BG-RRP-2.004-0006-C02 “Development of Research and Innovation at Trakia University in Support of Health and Sustainable Well-being), aiming to increase the research in the higher education in Bulgaria.

We started with a small team collaborating between Sofia, Stara Zagora and Paris which reached a critical size with new researchers coming to Stara Zagora. With strong motivation, the team built the first research laboratory in Solid Oxide Cells. In parallel, initial experience in hydrogen electromobility inspired by the national project Eplus and realized with support and in collaboration with IEES-BAS, building the foundation of expertise, infrastructure, and confidence.

Driven by curiosity, dedication, and long-term vision, these early activities gradually created the knowledge base, technical skills, and confidence necessary for further expansion. They became the base for a more ambitious initiative: the H2START Centre of Excellence project.

Conceived as a lighthouse initiative, H2START aims to establish a research and innovation ecosystem in hydrogen technologies, transforming early enthusiasm into structured, sustainable, and internationally connected progress. What began as a single laboratory is now evolving into a network of seven specialized laboratories. Some are designed to go beyond the current state of

the art, while others are tailored to address the specific needs of the carbon-intensive Stara Zagora region. Equally remarkable is the growth of the research team itself, reflecting not only scientific advancement but also the creation of a vibrant, interdisciplinary, and committed community, attracting both young talents and senior researchers.

Today, H2START represents far more than a research project—it is a pathway toward sustainability and regional transformation. By combining advanced infrastructure, talent attraction, national and international collaboration, and long-term strategic vision, the initiative demonstrates how dedicated scientific efforts can evolve into a lasting innovation ecosystem.

H2START positions Trakia university as an emerging hydrogen center which inspires regional economic and societal transformation while contributing meaningfully to a cleaner and more sustainable energy future.

This journey shows that building excellence in hydrogen technologies is not only possible, but can also inspire.

Prof. Daria Vladikova

Coordinator of the H2START Centre of Excellence Project

Acknowledgements

Hydrogen and Fuel Cells research group foundation was supported by the Bulgarian Ministry of Education and Science under the Bulgarian National Recovery and Resilience Plan, Component “Innovative Bulgaria”, Project BG-RRP-2.004-0006-C02 “Development of research and innovation at Trakia University in service of health and sustainable well-being”. H2START has received funding from the European Union under Horizon Europe (GA 101136692) and the Programme for Research, Innovation, and Digitalisation for Smart Transformation 2021-2027.

DAY 1 ABSTRACTS

HYDROGEN MASTERCLASS

STATE OF THE ART ACROSS THE
HYDROGEN VALUE CHAIN
FROM LAB TO STARTUP





Prof. Alain Thorel

Trakia University / ICARE

Professor Alain Thorel is an engineer who earned his doctorate from Mines ParisTech in 1988 after a research fellowship at Lawrence Berkeley National Laboratory (UC Berkeley), where he remained Affiliate Scientist until 2013. He received his Habilitation à Diriger des Recherches (HDR) from the University of Paris in 2011. He spent his entire career at Mines-Paris, in the Materials Center, where he served as a research director and head of a research team.

He has taught at numerous institutions, notably at the China-EU Institute for

Clean and Renewable Energy (ICARE, Huazhong University of Science and Technology, Wuhan, China) since 2012. He became ICARE's European Coordinator in 2017 and was the director of the CARE International Master's program for Mines-Paris. He served as Secretary General of the French Society for Metallurgy and Materials (SF2M) from 2022 to 2024 and is a scientific expert accredited by the Ministry of Higher Education and Research (MESR). He has also been an Associate Professor at Trakia University, specializing in high-temperature fuel cells, since 2023.

He has participated in a number of European and international research programs. He holds nine patents in the fields of nanomaterials, fuel cells, and a device for combating COVID-19. He teaches at the undergraduate, master's, and doctoral levels and has supervised 30 doctoral students as well as numerous international master's students. His teaching areas include materials, metals and ceramics, manufacturing processes, and physical properties.

His research areas include the relationships between microstructure and properties, atomic structure (grains and grain boundaries), nanomaterials, ceramic processing, hydrogen, and high-temperature fuel cells (SOFCs and PCFCs, new concepts). He is a recognized expert in transmission electron microscopy (TEM).

He was awarded with the Prize RIST 1988 by SF2M, is the Laureate in 2012 and 2013 of the Prize for Innovation of the Ministry High Education and Research (MESR) and became Knight in the Order of Academic Palms in 2011 for his role in education.

Why hydrogen? ID Card and Some Stunning Answers to Rarely Asked Questions

A.Thorel^{1,2}

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Keywords: Hydrogen ID card, Origin of Hydrogen, Thermokinetics, Spin properties, Catalyst

Although hydrogen represents 75% of the known baryonic mass and 92% of all its atoms in the observable universe, fossil molecular hydrogen (H₂) no longer exists on Earth. Hydrogen is nevertheless widely present in more complex molecules, such as water and hydrocarbons, while non-fossil molecular hydrogen, produced by the interaction between groundwater and minerals, has recently been discovered worldwide, apparently in considerable quantities. In this evolving context, hydrogen, as an energy carrier or resource, will play a key role in the energy transition, particularly in the development of electrochemical devices such as fuel cells and electrolyzers.

The considerable interest in hydrogen in the context of the energy transition stems from its ubiquity and its high chemical bond energy, released during its oxidation, whether by combustion or electrochemical reaction in a fuel cell. This process is widely studied, used, and applied, and devices are commercially

available. However, certain fundamental questions, microscopic steps and mechanisms, despite their long-term academic and/or practical relevance, are largely overlooked outside specialized communities.

- When and how was hydrogen created?
- Why does fossil molecular hydrogen (H₂) no longer exist on Earth?
- Why is hydrogen so important in astrophysics?
- What is the relationship between hydrogen's spin properties and its storage capacity?
- Is hydrogen an ideal gas, and what are the consequences?
- What length or surface area of catalyst is needed to fix one mole of hydrogen?
- Are these values available in materials, for example, at the Triple Phase Boundaries of a fuel cell?

This conference will attempt to answer these questions.



Assoc. Prof. Orlando Vaselli

University of Florence

Associate professor in Geochemistry and Volcanology at the Department of Earth Sciences (University of Florence, Italy) and President of the Italian Society of Geochemistry since 2020. He has been and is responsible of national and international projects mainly dedicated to fluid geochemistry in geothermal and volcanic areas and in anthropogenic-polluted (industrial and mining) sites. He was consultant for the United Nations during the crisis of Nyiragongo volcano (Democratic Republic of Congo). In the same context he also acted as Rotating Volcanologist for the UN in September 2002. From 2009 to 2012, he was partner of European project dedicated to the CO₂ storage in the pilot site of Hontomin (Spain) in collaboration with Spanish Foundation “Ciudad de la Energia”. He has organized several national and international schools, workshops and congresses. He has been co-Chief Editor of the journal *Acta Vulcanologica* and he was/is in the editorial board of *Periodico di Mineralogia*, *Italian Journal of Geosciences*, *Journal of Geochemical Exploration*, *Processes*, *Geofluids*, *Frontiers*, *Pollution*, *Bulletin of the Mineral Research and Exploration* and *Heliyon*. He acted as reviewers for top-quality journals such as *J. Geophys. Res.*, *Chem. Geol.*, *Appl. Geochem.*, *Ophiolites*, *Sci. Tot. Environ.*, *Geoderma*, *Eur. J. Min.*, *J. Geochem. Expl.*, *Geochim. Cosmochim. Acta*, *J. Volcanol. Geotherm. Res.*, *Environ. Poll.*, *Environ. Res.* and so forth. He published more than 200 papers in international and national peer-reviewed journals.

Geogenic Hydrogen and Hydrogen Geological Storage

Orlando Vaselli^{1,2} and Enrico Pandeli¹

¹ Dept. Earth Sciences, University of Florence, Italy ² CNR-IGG, Institute of Geosciences and Earth Resource, Florence, Italy
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The increasing demand of energy impels to find new, alternative and green resources. In the last decades, hydrogen (H_2 ; the highest gravimetric energy density: 120kJ/g) has been considered an energetic priority. The role of geologists is of pivotal importance in i) finding H_2 -rich gas discharges from where it is separated to help the decarbonatization of the energy sector and ii) recognizing geological traps where H_2 can be stored.

Presently, few geological environments are found to be suitable for H_2 -production, being mostly limited to those areas where geochemical processes, involving water-rock interactions via serpentization, radiolysis of water, magma degassing

or mechanoradical reactions of water in faults zones, occur.

Hydrogen production from geological sources would difficulty achieve the target of >400 Mt of clean H_2 to satisfy the Zero Net Emissions by 2050. This target can be reached by engineered H_2 production (by splitting water according to various industrial processes). This presentation is aimed at investigating the origin and the geochemical reactions to produce geogenic H_2 . Additionally, the most promising geological lithologies to store industrial-produced H_2 are reviewed, also giving emphasis to geochemical tools to identify the presence of H_2 seepage and leakage.



Dr. Julie MOUGIN

CEA

Dr Julie MOUGIN is Deputy Director for Hydrogen Technologies at CEA, in charge of hydrogen production, storage and fuel cells. She is also Leader of the Technical Committee 1 on Hydrogen Production for Hydrogen Europe Research, Board member of France Hydrogene and Chair of OECD NEA H2-Val Working group.

Graduated from Grenoble Institute of Technology in Electrochemistry, she obtained a PhD in Materials Science and began her carrier in industry in the field of materials for energy and automotive. She joined CEA-Liten

in 2005 to head the SOFC/SOEC characterization group, later leading the Hydrogen Technologies Laboratory and Department (2010–2022), and supervising technoeconomic and life-cycle assessment activities for new energies technologies. She is coordinator of several EU projects, contributes to EU roadmaps, review of national hydrogen programs, and standards.

Julie Mougin is author/co-author of more than 65 peer-reviewed papers (180 in total), five book chapters and nine patents (H-index 26).

Publications: <https://orcid.org/0000-0002-3594-3506>

MASTERCLASS LECTURE

Hydrogen production: Different Routes, Current Status and Main Challenges

J. Mougin

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julie.mougin@cea.fr

Keywords: hydrogen production, different routes, electrolysis, status, challenges

In the context of reducing CO₂ emissions and a geopolitical need to cut dependence on fossil fuels and secure energy supplies, low-carbon hydrogen is emerging as a strategic energy vector widely recognized in EU policies [1] and national strategies.

MASTERCLASS LECTURE

Beyond its traditional uses in refining or fertilizers, hydrogen can “defossilize” hard-to-electrify sectors (e.g., steel production), provide long-term electricity storage, and enable heavy or long-distance transport where batteries are unsuitable (trucks, ships, aircraft via H_2 fuel cells/turbines or liquid fuels from low-carbon hydrogen such as e-kerosene or e-methanol (H_2 combined with CO_2), and e-ammonia).

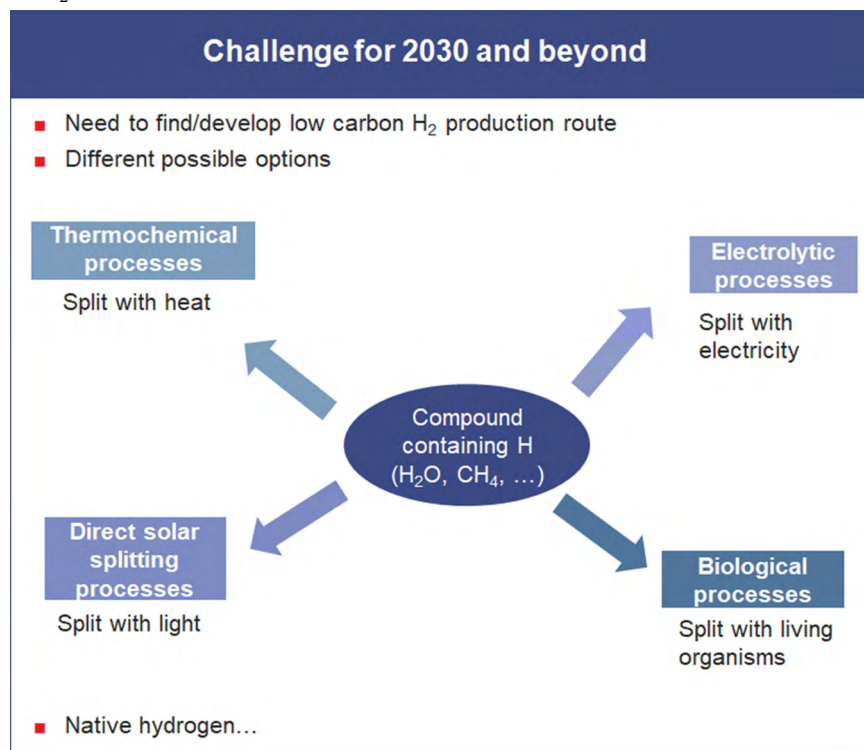


Figure 1. Different hydrogen production routes

Global hydrogen demand, already around 100 Mt in 2024, could grow significantly with these new uses, reaching 145 Mt by 2030 and up to 430 Mt by 2050 according to the IEA, with a major contribution from aviation and maritime sectors, which could account for 1/3 of low-carbon hydrogen consumption by 2050 [2].

Several technological routes exist to produce hydrogen. This talk will provide an overview of the options and compare them according to criteria (maturity, energy efficiency, cost, carbon footprint, water consumption, and critical raw material use). It will review current technology development and deployment, focusing on electrolysis technologies as a key option. Finally, it will present the challenges to reach multi-GW manufacturing and deployment capacities.

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Dr. Song Li

China-EU Institute for Clean and Renewable Energy (ICARE)

Dr. Song Li is currently an Associate Professor of China-EU Institute for Clean and Renewable Energy (ICARE) and School of Energy and Power Engineering at Huazhong University of Science and Technology (HUST) in Wuhan, China. She obtained her Ph.D. in Chemical Engineering from Vanderbilt University, USA, in 2014, and then work as a postdoctoral researcher at Northwestern University of USA until August, 2015. Her research focuses on hydrogen production, hydrogen storage, and the energy and

environmental applications of metal–organic frameworks by molecular simulation, machine learning, thermodynamics, and experimental approaches. Dr. Li has led multiple key research projects, including two National Natural Science Foundation of China grants, three sub-projects under the National Key R&D Program. She has received several distinguished awards, such as the Heritage Prize from the Li Foundation (USA), the Chutian Scholar Award from Hubei Province, the Distinguished Graduate Research Award from Vanderbilt University's Department of Chemical and Biomolecular Engineering. She has published more than 100 papers in high-impact journals, including Nature Communications, Advanced Energy Materials, Advanced Functional Materials, and ACS Nano. Her work has accumulated over 4,800 citations with an H-index of 35. She is the member of Sigma-Xi scientific society, IEEE and Chinese Chemistry, Chemical Engineering and Engineering Thermophysics Society.

Hydrogen Storage and Transport Technologies: Principles, Development, and Recent Progress in China

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Keywords: hydrogen storage, compressed hydrogen, hydrogen storage materials, chemical, physical

Hydrogen, a clean and efficient secondary energy, is vital for energy structure transformation and achieving carbon neutrality. Storage and transport are critical links in the hydrogen industrial chain. This talk covers common hydrogen storage technologies, classified into gaseous, liquid, and solid storage. High-pressure gaseous hydrogen storage is technologically mature, and the use of lightweight carbon fiber composite pressure vessels has promoted its development. Liquid hydrogen storage at -253 °C offers high volumetric density but suffers from significant energy consumption and evaporation loss. Solid-state hydrogen storage materials encompasses chemical absorption-based metal hydrides and liquid organic hydrogen carriers (LOHC), and physical adsorption-based porous carbon materials and metal-organic frameworks (MOFs). The principles, current development status, and practical applications of these technologies in China are discussed. A brief introduction to the main hydrogen transport methods including pipelines, pressurized tube trailers, and

cryogenic tankers will be given, together with the progress in China's hydrogen storage and transport enabled by supportive national policies.

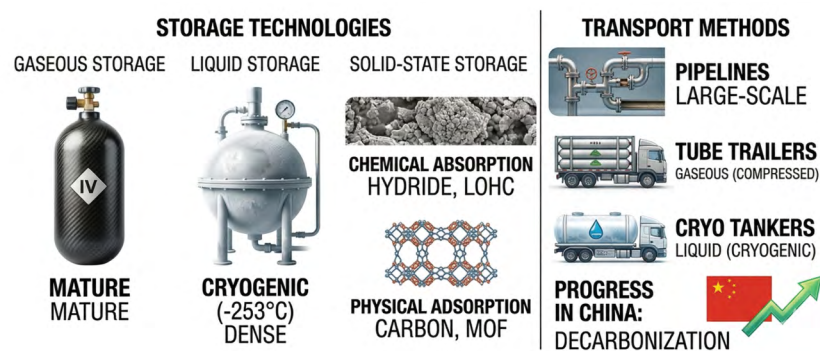


Figure 1. Summarized hydrogen storage and transport technologies

Acknowledgements

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Prof. Massimo Santarelli

Politecnico di Torino

Professor Massimo Santarelli, PhD in Thermodynamics and Heat Transfer, Full Professor at the Department of Energy at the Polytechnic of Turin. Affiliated with the Royal Polytechnic of Stockholm (KTH), the Polytechnic University of Barcelona (UPC) and the University of Illinois at Chicago (UIC).

Researcher at the Italian Institute of Technology (IIT) and the National Research Center (CNR).

Coordinator of the PhD School in Energy of Politecnico di Torino.

Author of around 360 articles in international journals and conferences (h-index = 66).

His main research activities focus on complex innovative systems (thermochemical and electrochemical processes and technologies) applied to the energy sector: energy-to-X paradigms and associated technologies.

Coordinator of the STEPS (Synergies of Thermo-chemical and Electro-chemical Power Systems) laboratory, the HySyLab (Hydrogen System Lab) and the CCL (CO₂ Circle Lab) laboratory of the Politecnico di Torino.

Coordinator of the European projects SOFCOM (FCH1-JU 2010 call), DEMOSOFC (FCH2-JU 2014 call) and REMOTE (FCH2-JU 2017 call), SUSTAN-ARCTIC (Horizon EU Call 2025)

Partner in European projects (ELECTROLIFE, H2START, H2SHIFT, IMAGHYNE, CRAVE-H2, HYACADEMY, GREENSKILLSFORH2, HYDRA, ECOLEFINS, TULIPS, BEST4Hy, SUBLIME, ICO2CHEM, COMSOS, TEACHY, ENEFIELD, ENFICA-FC, BRISK II, SELECT-CD, Explore Energy, Virtual Hub, MARS-EV), coordinator of several national projects and research projects with Companies.

Coordinator of the Erasmus+ HySET Master's degree "Hydrogen Systems and Enabling Technologies". Partner of the InnoEnergy SELECT master. Partner of the Erasmus+ DENSYS Master's degree. Member for Italy of ISO/TC 197 "Hydrogen technologies" and IEC-TC 105 "Fuel cells".

MASTERCLASS LECTURE

General Uses of Hydrogen

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Keywords: Hydrogen end-uses, industry, mobility, synthetic chemicals/fuels, energy storage

Renewable hydrogen is emerging as a key driver for future decarbonization thanks to its properties and its ability to integrate, as an energy vector or a chemical, across multiple economic sectors. Its current main application is the industrial sector, although it also has significant potential in mobility,

energy and maybe residential applications, where it can replace conventional high-carbon footprint technologies. While electrification is another major strategy for global decarbonization, it faces limitations in certain use cases where it is not technically or economically viable: in such scenarios, hydrogen could play a crucial role by enabling applications that other decarbonization technologies cannot achieve (hard-to-abate sectors).

Possible future applications of hydrogen and market of interest, where other solutions are not actually viable and where hydrogen can be used as a decarbonization solution, exploiting its role in the energy transition, are here analysed. The focus of the talk is on:

- industrial use
- mobility
- synthetic chemicals/fuels (e-chemicals and solar-chemicals)
- large-size long-term energy storage (power-to-power)

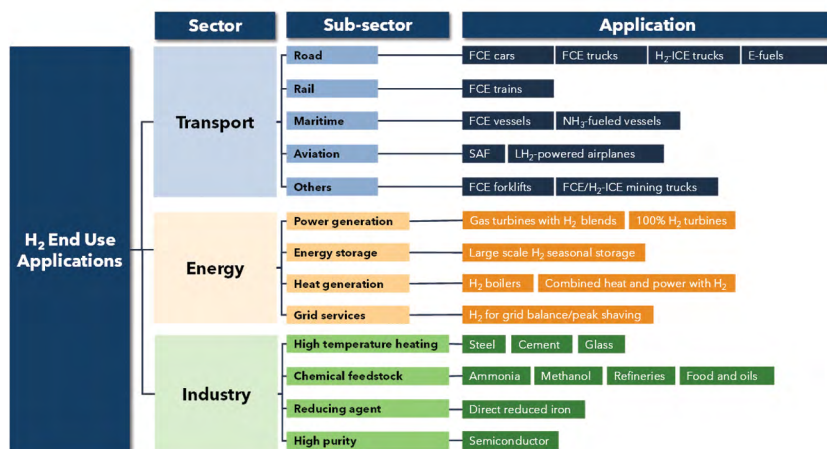


Figure 1. Possible end-uses of hydrogen



Prof. Emilio Paolucci

Politecnico di Torino

Emilio Paolucci is a full professor at the Polytechnic University of Turin, where he teaches Strategy and Entrepreneurship and scientific director of the EMBA program. He carries out research on the use of Artificial Intelligence in organizational choices and decision-making processes in companies, on the role of digital platforms in strategic choices, on Technology Transfer and entrepreneurship education in innovation processes in universities. In his research activity he has been responsible for national and

international research programs, carried out jointly with international universities, research centres and large companies. He has collaborated for over 10 years in the UCLA Global Access Program (<https://www.anderson.ucla.edu/programs-and-outreach/global-access-program>), with the aim of helping SMEs develop strategic plans for international growth.

He is the author of articles published in international peer-reviewed journals, such as Research Policy, Technovation, Strategic Management Journal, Strategic Entrepreneurship Journal, International Journal of Operations & Production Management, International Journal of Production Economics, Small Business Economics.

Bridging the Valley of Death: The Role of Proof-of-Concept Programs in Science Valorization

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Keywords: science valorization, proof-of-concept, technology transfer, valley of death, TRL scale

This work examines the role of science valorization in transforming academic research into societal and economic value, with a focus on the challenges associated with early-stage technologies (Perkmann et al., 2019; Wright, 2014). Despite increasing policy attention and the development of Technology Transfer Offices (TTOs), a significant gap - known as the “Valley of Death” - persists between basic research and market application. This gap is largely due to the high uncertainty, low maturity (TRL 1–5), and limited funding available for validation and development activities. Proof-of-Concept (PoC) programs are identified as a key instrument to bridge this gap. By supporting activities such as prototyping, intellectual property protection, and market analysis, PoCs help reduce technological and commercial uncertainty, enabling the advancement of research inventions toward higher TRLs and increasing their commercialization potential. The experience of Politecnico di Torino is discussed as a case study. Its PoC program combines

funding, mentoring, and networking to support researchers in developing entrepreneurial capabilities and engaging with external stakeholders. Evidence shows that PoCs enhance licensing opportunities, foster spin-off creation, and activate learning processes within research teams.

Overall, this work highlights that effective science valorization requires tailored, non-linear approaches depending on the nature of the underlying knowledge.

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Dr. Loïc Camenen

HORIBA

Loïc Camenen has built his career in the field of energy and scientific instrumentation, supported by a background in thermal systems and energy transfer. He graduated as an engineer before completing a PhD in Energetic Mechanics at the Université de Provence, focusing on modelling and physical processes in environmental systems.

He began his career in research at INRA, CNRS and CNES, working on modelling and instrumentation projects related to vegetation and fluorescence measurements. During this period, he

contributed to the definition and development of scientific instruments and initiated contacts with industrial partners such as HORIBA.

He then joined HORIBA France, where he progressively took on roles combining technical expertise, project management, and commercial support, particularly in fluorescence spectroscopy and scientific instrumentation.

He is currently Product Manager for hydrogen-based equipment testing benches, the HyBOPS, contributing to product definition, supporting commercial activities, and coordinating exchanges between customers, engineering teams, and international partners.

TECHNICAL DEMONSTRATION

HyBOPS, a Modular and Turnkey Test Bench for Hydrogen Equipment, for Evaluation at the Component Level up to Complete System Testing – a Focus on PEM Fuel Cell System Testing (H2 FCS)

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Keywords: testing bench, hydrogen, PEM, BOP, fuel cell system (FCS)

The presentation will introduce HyBOPS (Hydrogen Balance of Plant System), a turn-key hydrogen and fuel cell system testing bench developed by HORIBA to support the validation, optimization, and durability assessment of hydrogen-based equipment. Housed in secure and modular container(s), HyBOPS provides a fully integrated testing environment for fuel cell systems and their balance-of-plant (BoP) components under realistic operating conditions.

The presentation will cover the system architecture, key measurement and automation capabilities, and the embedded safety concept, including hydrogen detection and emergency shutdown functions.

We will focus on the HyBOPS configuration dedicated to PEM fuel cell system tests. Attention will be given to the flexibility of HyBOPS, ranging from component-level evaluation to full system testing, with scalable power capability and both indoor and

outdoor deployments.

The session will conclude by highlighting how HyBOPS accelerates hydrogen technology developments for the academic and industrial fields, while ensuring high safety, accuracy, and operational efficiency.

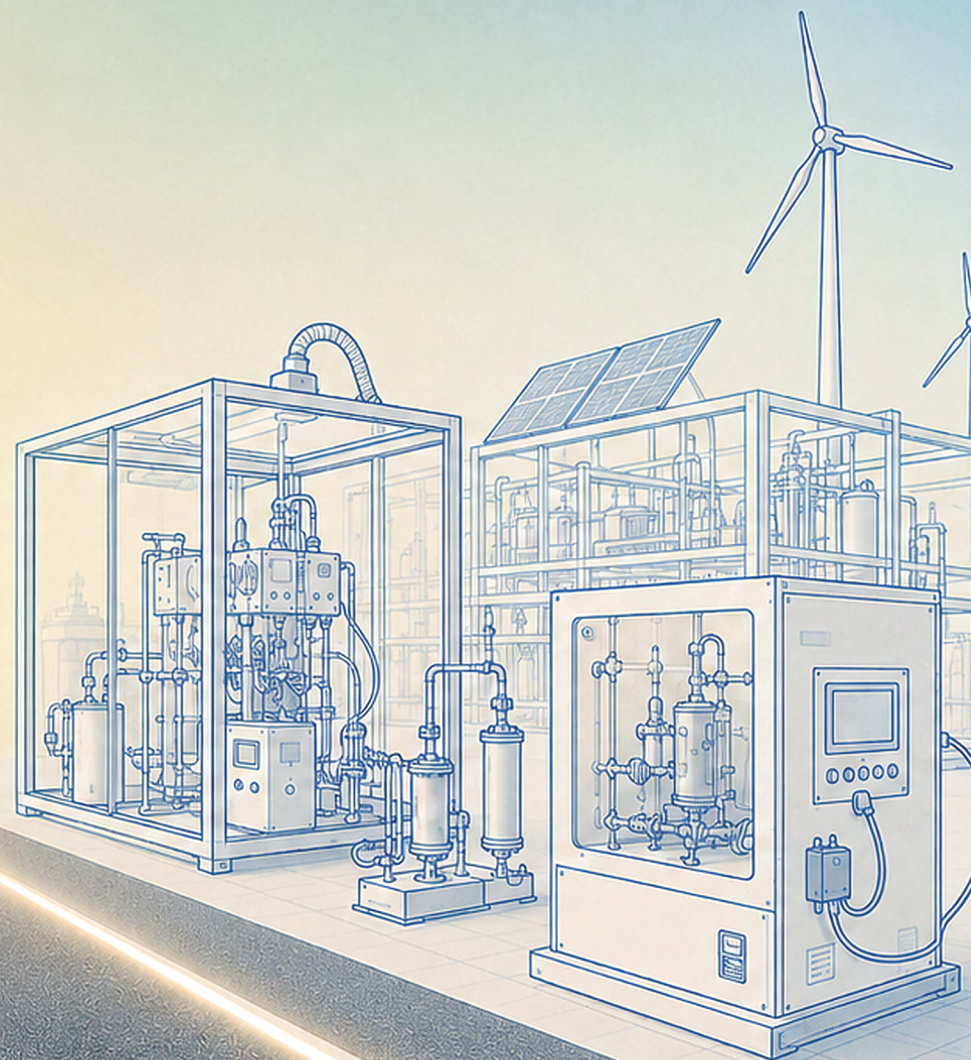


Figure 1. Example of HyBOPS testing bench for hydrogen PEM fuel cell

DAY 2 ABSTRACTS

SCIENTIFIC SESSIONS

HYDROGEN BEYOND
THE STATE OF THE ART:
UP-AND-COMING DEVELOPMENTS





Dr. Agatino Nicita

CNR - ITAE

Agatino Nicita is the coordinator of the “Evaluation of the Socio-Economic Impacts of Environmental and Energy Technologies” (VISTE) research group at the Istituto di Tecnologie Avanzate per l'Energia del Consiglio Nazionale delle Ricerche. He has developed extensive experience combining economic analysis, sociological perspectives on energy, and innovation studies focused on technological diffusion and adoption.

His research focuses on the evaluation of innovative energy technologies through integrated economic, financial,

and social perspectives, with the aim of supporting evidence-based decision-making for the energy transition.

In the field of energy economics, his expertise includes the economic and financial assessment of investments in emerging energy technologies, life-cycle cost analysis, and the analysis of sustainable and innovative business models.

Within the sociology of energy, he investigates socio-technical systems related to the energy transition, with particular attention to socio-economic impact assessment (including Social Life Cycle Assessment – SLCA), social and individual acceptance of new energy technologies, and participatory approaches such as co-creation and co-design processes.

A further core area of his work concerns the diffusion of innovation, analysing the social, institutional, and economic conditions influencing the adoption of renewable energy and hydrogen technologies.

Through his interdisciplinary approach, he aims to bridge technological innovation and societal needs, providing valuable insights for policymakers, researchers, industry, and civil society stakeholders engaged in the transition towards sustainable energy systems.

Beyond Technology: Social Challenges in the Hydrogen Transition

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Keywords: hydrogen economy; socio-technical transition; stakeholder engagement; public perception; social acceptance

Hydrogen is widely regarded by scientists and policymakers as a promising energy carrier for reducing climate-changing emissions and supporting the energy transition. Despite these expectations, its large scale deployment remains limited by several barriers [1]. These challenges span technical, economic, regulatory, and social dimensions and must be addressed to fully realize hydrogen's potential.

Evaluations of hydrogen technologies typically focus on costs and environmental impacts, such as carbon footprint indicators, while social aspects are often overlooked. However, interest in these dimensions is growing as hydrogen technologies move closer to widespread adoption. Social factors play a crucial role in shaping public acceptance, market development, and policy implementation.

A literature review by De León Almaraz et al. [2] identified ten key social aspects of the hydrogen economy, including accessibility, information, acceptability, policies and regulation, socio-political factors, stakeholders, externalities, socio-economic factors, hydrogen markets, and research and development. Similarly,

Gordon et al. [3] highlighted that the transition to a domestic hydrogen economy faces multiple cross sector barriers, particularly in achieving economies of scale and social acceptance. Addressing these challenges requires a comprehensive understanding of socio-technical factors across different scales. Therefore, future hydrogen strategies should integrate political, techno-economic, technical, market, and social dimensions. The purpose of this contribution is to present key social issues identified in the literature and emerging from the authors' research.

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Dr. Fausta Giacobello

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Fausta Giacobello obtained her master diploma in 'Chemical sciences' at the University of Messina / Italy in 2013 and received her PhD degree from the same University in 2017. Her research activity is focused on the development of innovative technologies for energy conversion through electrochemical processes powered by renewable sources. Dr. Giacobello mainly deals with the synthesis of materials used as catalysts in water electrolysis processes with proton and anion exchange membranes (PEMWE and AEMWE) and their electrochemical characterizations. She is involved in several national and international European projects (Horizon Europe – Clean Hydrogen JU).

ORAL PRESENTATION

Advancing PEM water electrolysis with low-equivalent-weight Aquivion® Membranes

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Keywords: water electrolysis, hydrogen, proton exchange membrane, radical scavenger, reinforced membrane

Hydrogen produced by water electrolysis is a key energy vector due to its high density, transport, and versatility across energy conversion and industry uses [1-2]. Among available technologies, proton exchange membrane (PEM) electrolysis offers major advantages, including high current density operation, fast response, and high purity hydrogen production. This study investigates the performance and durability of Aquivion® short side chain membranes for PEM water electrolysis. Bare cast membranes, radical scavenger polymers and reinforced membranes were evaluated in membrane–electrode assemblies by means of polarization curves, electrochemical impedance spectroscopy and 2000 hours durability tests. Advanced characterization techniques, including XRD, XRF, TEM and SEM were used to correlate membrane structure and ionomer dispersion with electrochemical behavior. Strong performance was achieved at 90 C, reaching 1.87 V at 5 A cm⁻² with a voltage efficiency of about 79%. Post operation analyses showed minimal

degradation of catalytic layers and no significant membrane thinning. These results demonstrate the potential of modified membranes for highly efficient, durable, and cost-effective PEM electrolyzers enabling reduced renewable energy consumption and lower green hydrogen production costs for clean energy use in future and sustainable growth globally.

Acknowledgements

The authors acknowledge the financial support from the ADVANCEPEM project. This project is supported by the Clean Hydrogen Partnership and its members including top-up funding by the UK Research and innovation under grant agreement No 101101318. This Joint Undertaking receives support from the European Union's Horizon Europe research and innovation programme, Hydrogen Europe and Hydrogen Europe Research.

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Prof. Christian Beauger

MINES Paris

Chemical engineer (Chimie Montpellier) and doctor in process engineering (Ecole des Mines de Saint-Etienne), Christian Beauger is working since 2000 in the field of hydrogen energy (PEM Fuel cells & hydrogen production). After 5 years as a research engineer at IMRA Europe, a private research center linked to TOYOTA, he joined MINES Paris in 2005.

Specialized in materials science, he mainly developed metal oxides-based aerogels (TiO₂ and SnO₂) as catalyst supports and photocatalysts, as well as composite polymer membranes, for

PEMFC and water (photo)electrolysis, in the framework of national projects (ANR) as coordinator and EU projects (FCH-JU) as scientific responsible for ARMINES.

Since 2013, he is the head of MATPRO group (Materials and Processes for energy) of PERSEE research center, involved in thematic dealing with buildings envelopes and superinsulating materials and electrochemical conversion (hydrogen energy and batteries). He is also coordinating a consortium gathering the experts from the Carnot M.I.N.E.S Institute working on Hydrogen for energy (H2MINES).

He is teaching Sol Gel processes, Fuel Cells and Hydrogen related matters in France at MINES Paris and PSL university and in China at HUST (Huazhong University of Science and Technology) in the framework of a Chinese-European institute (Institute for Clean And Renewable Energy).

ORAL PRESENTATION

PEM Electrolysis: the Catalyst Issue

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Keywords: electrolysis, platinum, iridium, supported catalyst

The energy transition we are currently experiencing requires the electrification of a large number of energy usages to move away from traditional energy conversion processes that are highly dependent on fossil fuels. In this context, hydrogen could emerge as

ORAL PRESENTATION

a key player, provided that progress is made in the field of water electrolysis, a process favoured at the European level to achieve the target in low-carbon hydrogen production by 2050. PEM (Proton Exchange Membrane) electrolysis offers several advantages over its competitors, including fast start-up time, high power density or high hydrogen pressure release. This competitive advantage makes it a prime candidate but will result in increasing the pressure on precious metals cost such as platinum and iridium [1], which are necessary for the electrochemical reactions at stake in this type of converters.

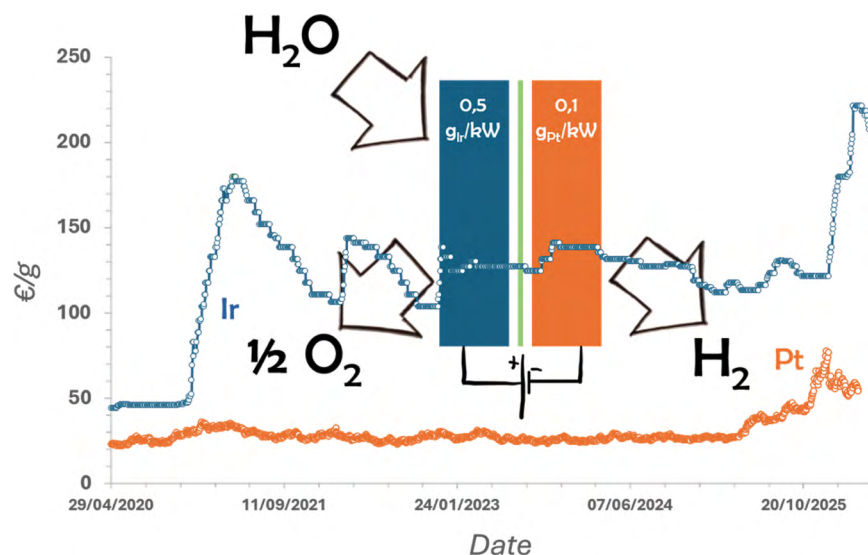


Figure 1. Pt and Ir, two precious metals to manage in order for PEM electrolyzers to confirm their expected worldwide deployment.

We will review global Pt and Ir available resources, comparing them with the needs related to the development of the hydrogen-energy sector, and will discuss the levers for action to make the deployment of the sector possible at an acceptable cost (precious metals loading, substitution, recycling...) [2]. As an example, we will discuss some of our results obtained on aerogel based supported Ir catalysts developed to increase mass activity in PEM electrolyzers.

Acknowledgements

This work was supported by the France 2030 government investment plan, managed by the French National Research Agency (ANR), under grant ANR-22-PEHY-0011 (MATHYLDE project).

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Dr. Vitaliano Chiodo

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Dr. Vitaliano Chiodo is a senior researcher at the CNR Institute for Advanced Energy Technologies “Nicola Giordano” in Messina (Italy), where he has been active since 2008. He graduated in Chemistry from the University of Messina where also obtained the Ph.D. in Materials Engineering.

Throughout his career at ITAE-CNR, he has held scientific roles, including serving as head of the research group “Syngas Production from Industrial By-Products (ByPC)” until 2013. Since 2014, he has led the research team

“Biomass Conversion Technologies (BCT)”, coordinating activities on the study and development of processes and materials for sustainable energy production from biomass.

His scientific background lies in the study, synthesis and chemical-physical characterization of solid catalytic materials for reforming technologies including Steam Reforming (SR), Partial Oxidation (POX), and Autothermal Reforming (ATR) aimed to syngas and hydrogen production from renewable and alternative carbon feedstocks such as bioethanol, biogas, glycerol, and organic exhausts solvents.

In recent years, his research is focused on thermo-chemical conversion processes, mainly gasification, applied to biomass and waste/residual feedstocks for the production of hydrogen rich syngas through development and testing of solid catalysts.

His broader research interests also include preparation and characterization of solid bio-materials, such as activated bio-carbons from biomass-derived biochar for different kind of applications, as well as CO₂ capture, adsorbent of metal ions from aqueous solutions and hydrogen storage.

ORAL PRESENTATION

Biomass Valorization through Conversion into Energy Carriers and High Value-Added Products

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Keywords: Steam gasification, Catalysts, Syngas, Pyrolysis, Biochar

The increasing demand for sustainable energy systems and circular economy solutions has intensified research on the valorization of biomass and residual materials, indeed it can be converted into energy carriers and high value added products, thus reducing dependence on fossil fuels and mitigating waste disposal issues.

Gasification process converts carbonaceous materials with assistance of an oxidant agent (such as air, oxygen, steam, CO₂) is a flexible technology to produce syngas from a wide range of feedstocks (biomass, coal, wastes, etc.). Hence, the activities carried out at CNR-ITAE mainly focused on study and upgrade of gasification process applied to different local waste feedstocks, among: Citrus peels (residues derived from orange fruits industries) and Posidonia Oceanica (Mediterranean sea plant) to produce hydrogen rich syngas. Experimental activities also include preparation and testing of solid catalysts suitable to increasing both inlet feedstock conversion and gasification efficiency, thus catalysts play a crucial role to promote tar

conversion into combustible gas via thermal cracking, hydro-cracking or water gas shift reactions.

In parallel, studies are addressed to pyrolysis process to produce biochar as high value added product. The whole cycle from preparation of biomasses-derived biochars to its upgrade to activated biocarbons is investigated to synthesize porous carbon materials with adjustable chemical-physical properties and suitable in different and advanced applications such as CO₂ capture, adsorbent of metal ions in aqueous solutions and hydrogen storage

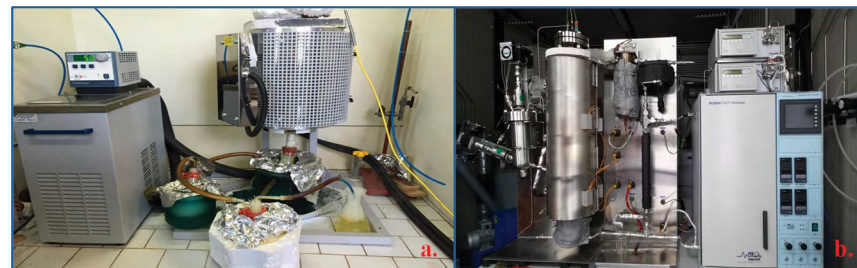


Figure 1. a. Bench-scale plants: a. Pyrolysis fixed bed reactor and b. Gasification fluidized bed reactor



Asst. Prof. Domenico Ferrero

Politecnico di Torino

Domenico Ferrero is Assistant Professor at the Energy Department of Politecnico di Torino, Energy and Nuclear Engineer, Ph.D. in Energetics.

Member of the STEPS group (Synergies of Electric Thermochemical and Electrochemical Systems) and of the CO2 Circle Lab of the Politecnico di Torino, his research activity is linked to the topic of electrochemical systems, electrolyzers and Power-to-Gas / Power systems and thermochemical cycles. He is academic collaborator in industrial consultancy contracts, speaker at numerous international conferences

and workshops, reviewer of international journals and editor of books.

He participates in European projects (ELECTROLIFE, ECOLEFINS, H2SHIFT, Green-Skills4H2), coordinated the island study REAL2.0 under the NESOI project (New Energy Solutions for Optimized Islands) and has been the unit responsible for the PRIN2022 project Multi-tool. He is the author of more than 50 publications in international journals and book chapters.

ORAL PRESENTATION

Hydrogen production: Coupling to RES. The Experience of the REMOTE Project for RES Integration by H₂-based Power-to-Power Systems

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Keywords: green hydrogen, remote areas, renewable energy integration, power-to-power systems, energy storage

The work presented examines the role of green hydrogen as a key enabler for the decarbonization of remote and off-grid areas. Remote communities, often characterized by limited grid access and reliance on diesel-based electricity generation, face high energy costs and significant carbon emissions. The study focuses on integrating renewable energy sources (RES), such as wind and solar, with hydrogen-based Power-to-Power

ORAL PRESENTATION

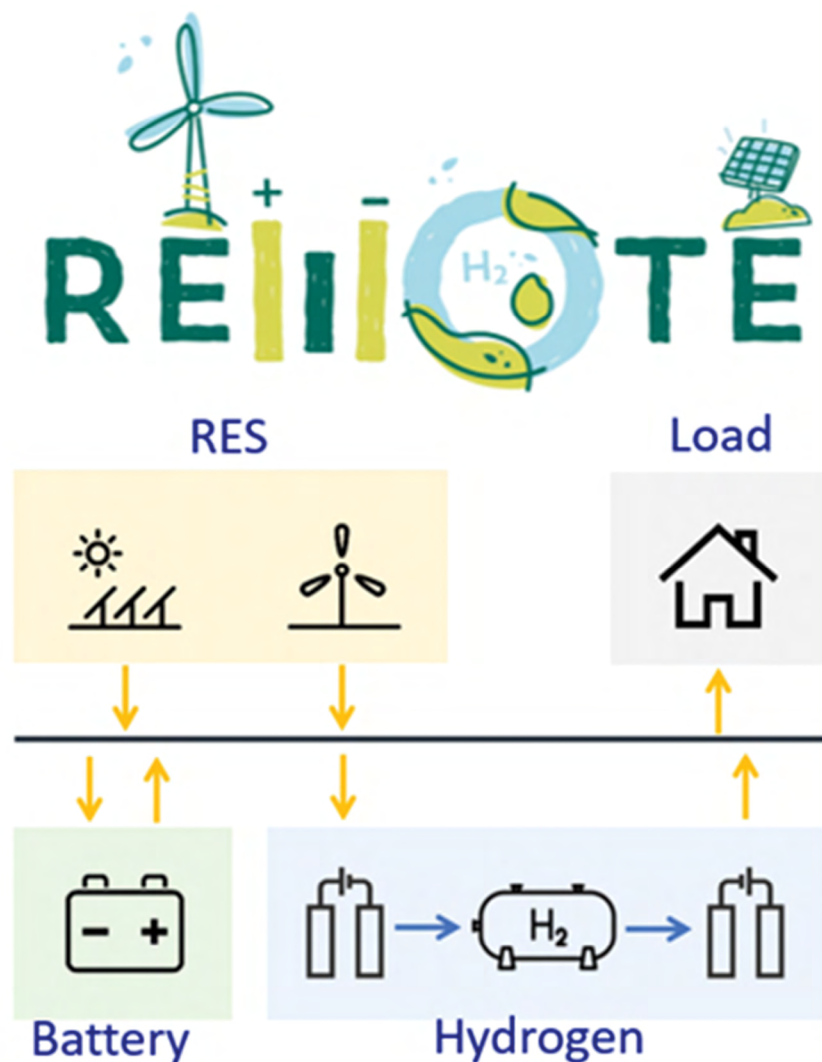


Figure 1. REMOTE project: Power-to-Power concept

(P2P) systems to provide reliable and sustainable energy.

Hydrogen is produced through electrolysis using excess renewable electricity, stored, and later reconverted into power via fuel cells. This approach enables long-term and seasonal energy storage, overcoming limitations of conventional battery systems. The work presented highlights the REMOTE project, which demonstrates hybrid hydrogen-battery systems in real-world case studies across Norway, Greece, and Spain. Results indicate substantial reductions in fossil fuel consumption (up to 95–100%) and CO₂ emissions, alongside improved energy autonomy and system reliability.

Despite challenges such as high costs and lower round-trip efficiency, hydrogen-based systems prove competitive in off-grid contexts with high fuel costs. The findings confirm that hybrid storage solutions combining batteries and hydrogen are effective for achieving sustainable, low-carbon energy systems in remote communities.

Acknowledgements

This project has received funding from the Fuel Cells and Hydrogen 2 Joint Undertaking under grant agreement No 779541. This Joint Undertaking receives support from the European Union's Horizon 2020 research and innovation program, Hydrogen Europe and Hydrogen Europe research.



Prof. Nikolaos Bonanos

Materials Science Consultant

Nikolaos (Nikos) Bonanos is a Materials Scientist specialising in the electrical and electro-chemical characterisation of materials. He has worked in university and industrial research. From 1993 to 2015 he was a member of the Fuel Cells Group at Risø National Laboratory Denmark, subsequently DTU Energy Conversion.

He has participated in projects including Advanced Ceramics for Protonics (NEDO), Next Generation Fuel Cell Materials (N INNER), and Innovative Dual Membrane Fuel Cell (EU). His later research has focussed

on materials for hydrogen permeation membranes and for protonic ceramic fuel cells (PCFC), and on techniques for the electrical characterisation of complex materials. He has also taught courses in Impedance Spectroscopy at DTU (2011–2015).

Since retiring at the end of 2015, Nikos has visited universities and research centres in Italy, Argentina, Turkey and Iran. Recently, he has set up a small facility for the characterisation of ceramics and polymers by impedance and dielectric spectroscopy. He is the co-author of 105 refereed papers and has contributed to the monograph *Impedance Spectroscopy*, Wiley (2018).

Publications (2015–2025)

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KEYNOTE LECTURE

Hydrogen Fuel Cells for Stationary and Quasi-Stationary Applications

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Keywords: Hydrogen, fuel cell, load cycle, ammonia, oxygenates

Hydrogen fuel cells are discussed in the context of stationary and quasi-stationary applications. Performance requirements are examined by means of examples ranging from a medium sized ship to a small mobility device and critical parameters for the fuel cell system are identified, including energy density, power density and load cycle capability. The feasibility of using hydrogen precursors such as ammonia and oxygenates is considered in the light of the above descriptors. Hydrogen fuel cell technologies under development are presented and their readiness levels discussed at the European and international level. The speaker's views are expressed regarding hydrogen fuel cells and their application in a Europe dominated by uncertainty of fuel supply.



Dr.-Ing. Mariya E. Ivanova

H2START - Trakia University

Dr.-Ing. Mariya E. Ivanova holds a Ph.D. in Materials Science and is currently responsible for Technology Development at the Center of Excellence for Hydrogen Technologies (H2Start), Trakia University, Bulgaria. Prior to this, she worked for over 15 years at Forschungszentrum Jülich GmbH, where she, together with her research group, contributed to the advancement of electrochemical energy systems, particularly ceramic membrane reactors and electrochemical devices, while actively engaging in international research, innovation activities, and project collaboration.

Her scientific work focuses on protonic ceramics and related electrochemical devices, with applications in hydrogen production, separation, and energy conversion. At H2Start, she leads the development of research and technology infrastructure and supports the planning and implementation of technology roadmaps as well as research and innovation activities across the hydrogen value chain.

Dr. Ivanova is a member of the Advisory Board of the Project “Development of Research and Innovation at Trakia University in Service of Health and Sustainable Well-Being” (BG-RRP-2.004-0006-C02) supported by the Bulgarian Ministry of Education and Science through the Bulgarian National Recovery and Resilience Plan, Component “Innovative Bulgaria”. Member of national and international Hydrogen Associations (BgH2A-Bulgaria, DWV-Germany); expert in European Commission hydrogen programs.

In addition, she is a Guest Professor at ICARE, Huazhong University of Science and Technology (Wuhan, China), where she contributes to teaching in the field of hydrogen technologies and materials science.

Dr. Ivanova is an advocate for voice equality and a committed ally against mobbing, discrimination, misogyny, and abuse of power in science. She is an active contributor to initiatives addressing workplace mobbing.

Presentation Acknowledgements

The support of the European Union under the Horizon Europe Programme, Project No. 101136692, H2START: Green Innovations in Hydrogen for a Sustainable Energy Transition is gratefully acknowledged.

ORAL PRESENTATION

Proton Ceramic Cells as Pathfinders in Green Chemistry

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Keywords: Proton ceramic cells (PCC); Electrosynthesis; Green chemistry; Hydrogen and CO₂ utilization

Proton ceramic cells (PCCs) emerge as promising platforms for advancing green chemistry and sustainable energy systems. This contribution presents PCC technologies as pathfinders, building on insights from solid oxide systems while extending their functionality toward integrated electrochemical–catalytic and electrosynthetic processes.

The presentation highlights the fundamental principles governing proton-conducting ceramics, including defect chemistry, transport mechanisms, and structure–property relationships, which enable efficient operation at intermediate temperatures (400–650 °C). Material design strategies, such as compositional tailoring and composite architectures, are discussed as key approaches to enhancing conductivity, stability, and device performance.

Application pathways are explored across energy and chemical sectors, including hydrogen production and purification, protonic ceramic fuel and electrolysis cells, CO₂ utilization, ammonia synthesis, and catalytic membrane reactors. In these systems, PCCs enable process intensification by coupling reaction and separation, offering new routes for efficient and low-emission

chemical transformations.

Although still at an early stage of technological maturity, proton ceramic cells demonstrate strong potential to bridge energy and chemical processes, positioning them as a versatile and impactful enabling technology for the transition toward sustainable, carbon-neutral systems.

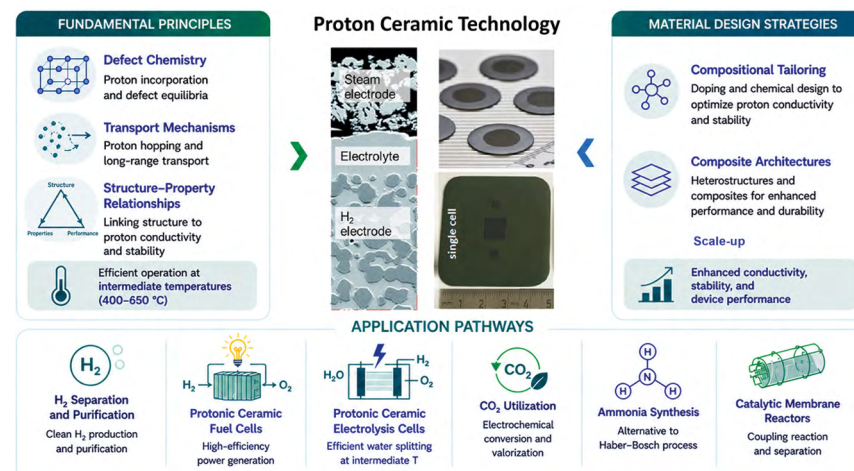


Figure 1. Proton ceramic technology for green chemistry and sustainable energy, linking fundamentals, material design, and applications.



Dr. Asrar Sheikh

H2START - Trakia University

Dr. Asrar A. Sheikh is currently working as a research associate in Trakia University where he is engaged in the activities for the establishment of high-tech research laboratories realized as a center of excellence (CoE) for hydrogen technologies. This work is being carried out under H2Start project funded by Horizon Europe/Clean hydrogen partnership and the Bulgarian ministry of Science and education. He is also involved in preparing a research plan for the synthesis, fabrication, and testing of high temperature ceramic cells under the supervision of Dr. Maria Ivanova – the technology development

manager (TDM) of the project.

Dr. Sheikh has an expertise on electrochemical testing of Solid oxide cells (SOCs) and performed an extensive experimental work on Electrochemical Impedance spectroscopy (EIS) and i-v curves for two European projects during his PhD and Master studies. Moreover, he has a teaching experience as senior lecturer in the Chemical Engineering departments of Baku Engineering University and Baku Higher Oil School, Azerbaijan.

Dr. sheikh has an objective to become a lead researcher by improving analytical, problem-solving, and leadership skills to drive innovation, mentor junior staff, and secure funding for impactful projects in his field. His role at TrU is to develop proton-conducting ceramic cells (PCCs) through the stages of synthesis and fabrication, electrochemical testing, and microstructural characterization. Also, his obligations include the preparation of educational material for training courses and conducting demonstrations for H2 fuel cells and electrolyzers.

ORAL PRESENTATION

Routes of Improvements for Air/Steam Electrodes of Reversible Proton-Conducting Ceramic Cells

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Keywords: reversible proton-conducting ceramic cell, air/steam electrode, corrugated interfaces

Proton conducting ceramic cell (PCC) offers solutions to the problems associated with the high temperature operation of Solid oxide cell (SOC) by providing the

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opportunities of using less expensive construction materials, improvements in efficiency, and longer system durability. However, the high activation polarization due to the sluggish kinetics at reduced temperature as well as reduction in the material ionic conductivity affect the overall cell performance. Therefore, it is a necessary to develop robust electrode materials with high electro-catalytic activity and electrolyte materials with sufficient ionic conductivity at comparatively lower PCC operating temperature. The air/steam electrode of a reversible PCC is a critical component that contributes to more than 80% of total cell over-potential and has been a major research subject in PCC development. In this work different problems associated with the PCC air/steam electrode are addressed and an overview of different scenarios as routes of improvements are presented and explained through the data obtained from literature. In this regard the use of corrugated interfaces can potentially be a viable solution in improving the polarization curve by reducing the activation polarization.

Acknowledgements

This work was supported by the Bulgarian National Recovery and Resilience Plan, Component “Innovative Bulgaria”, project BG-RRP-2.0040-0006-C02 “Development of research and innovation at Trakia University in service of health and sustainable well-being”, and by the H2Start project funded by Horizon Europe/Clean Hydrogen partnership, grant number 101136692, and the Bulgarian ministry of education and science.

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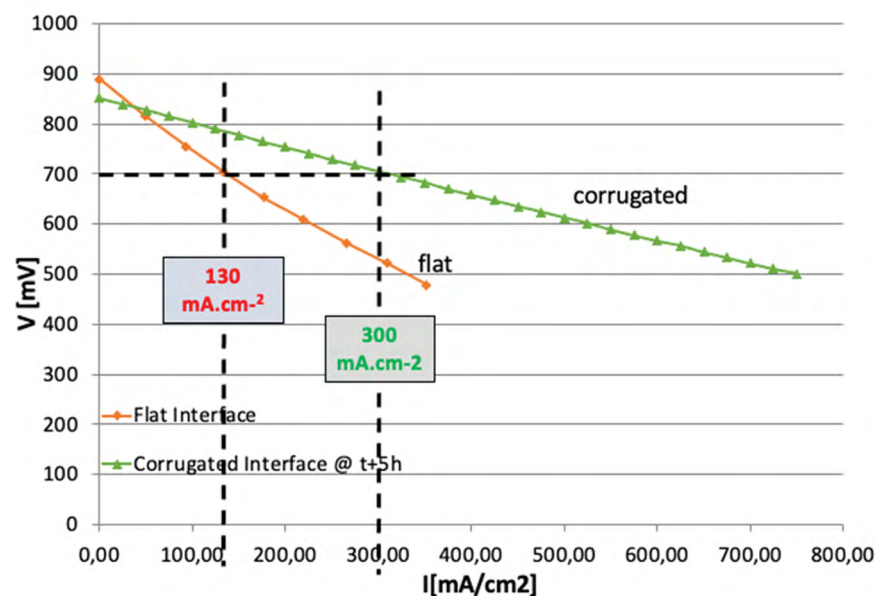


Figure 1. Comparison between the reference flat cell and the patterned cell



Marco Cavana

Politecnico di Torino

Marco CAVANA holds a master's degree in Energy and Nuclear Engineering and a PhD in Energetics from the Polytechnic University of Turin where he defended a thesis entitled “Gas network modelling for a multi-gas system” in 2020.

He is currently a Fixed-Term Researcher (RTD-A) in the Department of Energy at the Polytechnic University of Turin, where he assists with teaching on several courses, including “Energy Networks” (covering the section on gas infrastructure).

His work focuses on the modelling

and simulation of gas distribution and transmission networks in the framework of the integration of renewable gases (green hydrogen, biomethane and sNG) into the energy system through techno-economic models, the study of the regulatory framework and the development of business models associated with the commercial deployment of renewable. He has participated in various consultancy activities for major companies in the Italian gas sector in the fields of hydrogen production and grid blending, the assessment of the potential for biomethane production and integration into distribution infrastructure, and the evaluation of technological improvements to natural gas distribution infrastructure (installation of turbo-expanders, cogenerators serving pressure-reduction stations, systems to enable ‘reverse flow’, etc.). Recently, he has been involved in the European projects SHIMMER, the Irish Hydrogen Valley SH2AMROCK and H2START.

ORAL PRESENTATION

Hydrogen Transport and Distribution: Insights from Simulation Activities of SHIMMER Project

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Keywords: Gas Network, Hydrogen, Gas Quality Tracking, Hydrogen Blending, Hydrogen Infrastructure

The European Green Deal and the Fit-for-55 package require a rapid reduction of greenhouse gas emissions, promoting the uptake of renewable gases and hydrogen. The Hydrogen and Decarbonized Gas Market Package establishes the regulatory framework for future hydrogen infrastructures, enabling initiatives such as the European Hydrogen Backbone. However, hydrogen transport and distribution through existing gas networks pose challenges due to infrastructure constraints, renewable hydrogen variability, and the transitional coexistence of hydrogen and natural gas.

This work presents simulation activities developed within the EU project SHIMMER through SHIMMER++, an open-source fluid-dynamic gas network simulator with hydrogen quality tracking capabilities [1]. The tool supports transmission and distribution networks, steady-state and transient analyses, multi-component gas modelling, and hydrogen concentration tracking.

The simulator was applied to scenarios on the Italian gas network, including hydrogen injection from renewable energy sources,

gas quality propagation, and comparisons between blending and dedicated hydrogen backbone configurations. Results highlight the importance of transient effects and network topology on mixing behaviour and operational performance. Blending may support early hydrogen deployment, but can introduce hydraulic penalties and gas quality constraints, whereas dedicated hydrogen corridors provide higher transport capacity with lower natural gas transmission capability [2].

Acknowledgements

This work was supported by SHIMMER project financed by EU (ID 101111888) and NEST project financed by NRRP– NextGenerationEU (Project code PE0000021)

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Assoc. Prof. Blagoy Burdin

IEES-BAS

Blagoy Burdin is Assoc. Prof. in electrochemistry at the Institute of electrochemistry and energy systems – Bulgarian academy of sciences. He has a Master's Degree in Transport Mechanical Engineering from the Technical University - Sofia and PhD in the field of Hydrogen fuel cell electric vehicles at the same University. During his study he was a team leader of Technical University Sofia's team designed the first student's Bulgarian hydrogen fuel cell electric car for a student competition. Currently his main research interests are focused on the

Hydrogen implementation in transport sector, Electrochemical Impedance Spectroscopy and Solid Oxide Fuel Cells. He is co-author of more than 25 publications. Dr. Burdin is Head of field laboratory “Integrated energy systems” at CoC Hitmobil, where take place the first in Bulgaria hydrogen refueling station.

KEYNOTE LECTURE

Transport Sector Decarbonization in Large Scale - Challenges and Opportunities

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Keywords: FCEV, BEV, Hydrogen value chain, Synthetic fuels

The transport sector is responsible for a quarter of global CO₂ emissions [1]. Its decarbonization is a challenge due to large amounts of energy required and the specifics of transport – namely, the need for fast charging and long range. In addition to these issues, the usage of volatile renewable energy in the transport sector will pose significant challenges to energy systems. Currently, BEVs dominate due to the well-developed

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electricity grid and their high overall energy efficiency and thus reaches 20% of car market share in Europe. They are widely regarded as a key technology in passenger cars, while hydrogen and synthetic fuels are expected to play a major role in hard-to-abate sectors such as heavy-duty and maritime transport [2]. However, this still has low impact on renewable energy in the transport sector, with its share of only 11%. Moreover, a main part of this energy is based on biofuels. The increasing share of renewable energy in the transport sector calls for a more comprehensive analysis of how technologies such as batteries, hydrogen and synthetic fuels can be implemented effectively in large scale. The present work aims to adopt a system-level perspective on the transport sector as a whole and to enrich the analysis with real data from industrial-scale field experiments.

Acknowledgements

The study has been carried out by the financial support of Bulgarian Science Fund, Ministry of Education and Science of the Republic of Bulgaria, Contract № KII-06-H89/6/09.12.2024. Experiments were performed using the equipment of Project № BG16RFPR002-1.014-0009, “Development and Sustainability of the Center of Competence HITMOBIL–Technologies and Systems for Generation, Storage, and Consumption of Clean Energy,” funded by the Program “Research, Innovations and Digitalization for Smart Transformation”, 2021–2027.

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Dr. Giuseppe Napoli

CNR - ITAE

Giuseppe Napoli is a senior researcher at the Institute for Advanced Energy Technologies (ITAE) of the Italian National Research Council (CNR), based in Messina, Italy. His research focuses on energy systems for sustainable mobility, with particular emphasis on fuel cell and battery-electric vehicles, hybrid architectures, and hydrogen-based solutions. He works on mission-based modelling of transport systems, integrating vehicle design, logistics operations, and energy infrastructure planning. His activities also include the assessment

of environmental and economic performance of alternative powertrains and the development of digital tools for zero-emission transport. He coordinates and contributes to national and European research projects, collaborating with industry partners on applied innovation activities, including hydrogen retrofit solutions for heavy-duty vehicles.

ORAL PRESENTATION

Hydrogen Mobility Beyond the Hype: Applications, Evidence and Research Challenges

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Keywords: Hydrogen mobility, FCEV, transport decarbonisation, sustainable logistics, mission-based analysis

Hydrogen is increasingly considered a key energy carrier for transport decarbonisation, particularly in applications where battery-electric solutions may face operational limitations. However, technology assessment cannot be reduced to a binary comparison, as performance depends on both mission profiles and system-level conditions. A mission-based framework is adopted to evaluate the suitability of different energy carriers in

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logistics operations, focusing on key variables such as range and utilisation. There are no fixed boundaries between technologies: suitability shifts continuously as operating conditions vary (Fig.1). Battery-electric vehicles are generally effective for short- and medium-range missions, while fuel cell solutions enable extended range and continuous operation in high-utilisation scenarios. However, for low utilisation levels, battery-electric vehicles may also cover longer distances, whereas fuel cell systems can be viable in shorter-range applications when high operational continuity is required.

Beyond vehicle-level performance, infrastructure availability, energy supply chains, and economic factors play a crucial role in shaping technology adoption. In this context, hybrid architectures

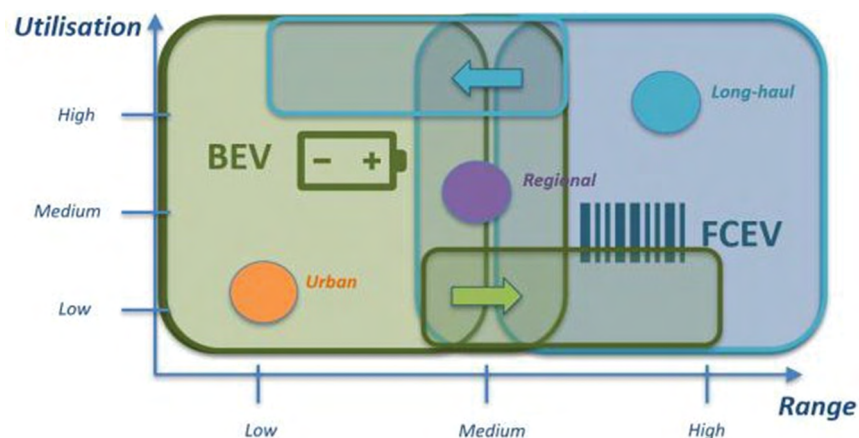


Figure 1. Technology suitability depends on transport missions and on the operating ecosystem

combining batteries and hydrogen emerge as a promising approach to integrate efficiency and operational flexibility. Retrofit solutions for heavy- duty vehicles further support this transition by enabling the reuse of existing platforms. Overall, the results support a systemic perspective in which hydrogen complements, rather than replaces, other technologies.

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Dr. Rolando Pedicini

CNR - ITAE

Dr. Rolando Pedicini is a senior researcher at the National Research Council of Italy (CNR-ITAE) in Messina, with over twenty years of experience in the development of advanced materials and technologies for the energy transition, with a particular focus on hydrogen as a sustainable energy carrier. He obtained his PhD in Materials Science and Technology from the University of Calabria, specializing in the development of innovative systems for solid-state hydrogen storage.

His scientific activity lies at the

intersection of materials science and energy systems engineering, with a strong application-oriented approach. His main research interests include the development and characterization of materials for polymer electrolyte fuel cells (PEFC), metal hydrides, and advanced composite materials for hydrogen storage, as well as the design and development of prototype storage systems integrated with electrochemical devices. His work has contributed to improving performance, safety, and sustainability of hydrogen-based systems, with applications in both transportation and stationary energy sectors.

He is currently responsible for the module “Hydrogen storage: materials and applications” at CNR-ITAE and holds leading scientific roles in several national and European research projects (including PRIN, PNRR, MOST, and NEST), actively contributing to the development of key technologies for decarbonization and energy transition.

Dr. Pedicini is the author of over 160 scientific publications in international journals and conference proceedings, 2 book chapters, and more than 60 scientific technical reports, a reviewer for high-impact journals in the fields of energy and materials, and a member of scientific and organizing committees of international conferences. He has also served as a lecturer and visiting professor in international academic contexts, contributing to the training of young researchers and fostering global scientific collaborations.

ORAL PRESENTATION

Development of Solid-State Hydrogen Storage: From Material Research to Lab-Scale Tank Prototyping

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Keywords: Solid-state hydrogen storage, Metal hydrides, Hydrogen sorption performance, Sustainable materials

One of the main challenges to be addressed for hydrogen to become the energy carrier of the future is its safe and efficient storage and transportation. Among the currently available storage technologies, solid-state hydrogen storage is gaining increasing importance. In this context, the primary objective of current research is the development of materials capable of storing hydrogen in gaseous form under moderate operating conditions ($T < 100\text{ }^{\circ}\text{C}$, $P < 50\text{ bar}$), with a storage capacity of at least 3–3.5 wt%. The activities carried out at ITAE are focused on the synthesis and characterization of several classes of advanced materials, many of which have been developed within European and national research projects. Among these, particular attention is devoted to composite materials consisting of metal oxides anchored onto functionalized aromatic polymer matrices. These materials have been used to develop and test a 20 L prototype storage tank integrated with a fuel cell (fig.1).

In parallel, other advanced materials are under investigation, including: activated carbons derived from biomass waste (such as algae, wood, coffee grounds, and banana peels), subsequently functionalized with suitable metal catalysts; MgFe-based bimetallic alloys, where the presence of Fe reduces the Mg–H bond energy,

enabling operation at lower temperatures; TiFe alloys obtained from recycled materials after appropriate purification; high-entropy alloys such as TiVZrHfNb, whose high storage capacity is offset by the cost and criticality of some constituent elements, thus motivating ongoing efforts to partially substitute them while preserving performance. Additional research activities include the synthesis of graphene from recycled PET via pyrolysis and the development of thin polymeric films to protect sensitive metal hydrides (e.g., NaAlH_4) from surface passivation. A key aspect of this research is the comprehensive characterization of materials, including their morphological and crystallographic properties, as well as their hydrogen absorption and desorption performance, to assess their suitability for practical applications.



Fig. 1- Prototype tank for H₂ storage



Prof. Stuart Hillmansen

University of Birmingham
Vanguard STS

Stuart Hillmansen is a UK-based academic and engineering professional specialising in railway traction systems, energy modelling, and sustainable transport. He is a Professor at the University of Birmingham, where he has developed advanced longitudinal train simulation tools used extensively in the analysis of freight performance, energy consumption, and decarbonisation strategies. His work spans battery-assisted rail operations, discontinuous electrification, and hybrid propulsion systems, contributing to major industry studies and policy discussions.

Alongside his academic role, Stuart is a founder and director of Vanguard Sustainable Transport Solutions, a company focused on delivering innovative engineering solutions in low-carbon mobility, including hydrogen and hybrid rail technologies. He plays a key role in bridging research and industry application, leading technical studies, supporting product development, and contributing to international collaborations in clean transport. His work combines rigorous engineering analysis with practical deployment, supporting the transition to more sustainable and efficient rail systems.

ORAL PRESENTATION

From Hydrogen Pioneer to HydroShunter: Two Decades of Fuel Cell Innovation for Railway Decarbonisation

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Keywords: Hydrogen traction, fuel cell hybrid systems, rail decarbonisation, shunting locomotives, energy storage integration

This paper presents the evolution of hydrogen propulsion for rail through the development activities of Vanguard Sustainable Transport Solutions, tracing two decades of innovation from early concept to operational deployment. Initial work in 2005 explored the application of fuel cell technology to railway traction, motivated by emerging concerns over diesel availability, air quality, and long-term decarbonisation requirements.

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Subsequent development led to the creation of the narrow-gauge Hydrogen Pioneer demonstrator, now recognised within the UK National Railway Museum's Railway Futures programme. Building on this foundation, Vanguard partnered with Porterbrook in 2019 to deliver the UK's first mainline-capable hydrogen train. Following full certification in 2020, the HydroFLEX platform has since accumulated several thousand operational miles on the GB mainline network, demonstrating the technical readiness of hydrogen traction for wider deployment.

More recently, the HydroShunter project has addressed freight



Figure 1. HydroShunter hydrogen-battery hybrid locomotive developed by Vanguard, demonstrating high-efficiency operation for shunting duties through integration of fuel cell technology and onboard energy storage, enabling significant reductions in emissions, noise, and fuel consumption.

yard and shunting applications, where legacy diesel locomotives exhibit inefficient duty cycles. A hybrid architecture combining a modest fuel cell system with battery storage offers significant reductions in emissions, noise, and fuel consumption, while improving whole-life cost performance. The paper highlights how such solutions can support scalable hydrogen adoption, particularly when integrated with localised production and refuelling infrastructure, positioning hydrogen as a viable pathway for rail decarbonisation.

Acknowledgements

This work was supported by Innovate UK through the First of a Kind (FOAK) programme, with delivery led by Vanguard Sustainable Transport Solutions in collaboration with the University of Birmingham and Porterbrook. Additional development has been supported through private investment by Vanguard.

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Francesco Bitraj

Unione Industriali Torino

Francesco Bitraj works at the intersection of technological innovation, industrial sustainability, and business strategy. He currently serves as Innovation Manager at the Technology, Innovation and Research department of Unione Industriali Torino, where he coordinates technology ecosystems focused on sustainable mobility and energy, supporting SMEs in their digital and green transition through Industry 4.0 frameworks and European/PNRR funding access.

Holding a degree in Industrial Chemistry from the University of

Turin and an advanced specialization in Industry 4.0 from CIM 4.0 Academy, Francesco leads the H2 ICE cluster — Italy's Innovation Hub for Hydrogen Internal Combustion Engines — bringing together leading automotive companies, research centers, and top universities around the challenge of hydrogen propulsion. He has represented high-value technology projects at major international congresses across Europe and the USA, promoting innovative solutions for heavy-duty, marine, and off-road sustainable mobility.

TECHNICAL DEMONSTRATION

H2ICE: Italy's Innovation Hub for Hydrogen Internal Combustion Engines

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Keywords: hydrogen, internal combustion engine, technology cluster, sustainable mobility, decarbonization

H2ICE is a cutting-edge technology cluster that brings together Italy's leading automotive companies to develop highly efficient hydrogen-fueled internal combustion engines. Leveraging the vast technological expertise of Turin — one of Europe's capitals of ICE innovation — the cluster unites industry leaders, research centers, and top universities to drive the future of sustainable mobility. The mission is to bridge the gap between traditional powertrains and zero-emission solutions, using hydrogen to achieve carbon-neutral propulsion without compromising on power and durability. By fostering collaboration and technological advancements, H2 ICE contributes to the decarbonization of transport sectors such as heavy-duty, marine, and off-road applications, promoting synergies across Italy's industrial and academic ecosystem.

Acknowledgements

This work is supported by Unione Industriali Torino within the framework of the H2ICE cluster activities.

TECHNICAL DEMONSTRATION

Demonstrations with Hydrogen Fuel Cell Electric Vehicle Hyundai Nexo

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Keywords: FCEV, Hydrogen refueling stations

The demonstration includes a presentation of the Hyundai Nexo fuel cell electric vehicle, its main systems and specifications, and experience from using the car in real operating conditions.



Figure 1. Demonstration's vehicle – Hyundai Nexo

Participants, who wish, will have the opportunity to test drive the car (a valid driver's license must be shown) or take a ride in the car with a driver provided by the event. There will be an opportunity to ask questions related to the hydrogen vehicles and hydrogen technologies for mobility application.

Acknowledgements

Demonstrations were performed with the support of the H2START project, co-funded by the European Union under Horizon Europe (GA 101136692) and the Programme for Research, Innovation, and Digitalisation for Smart Transformation 2021-2027.

ABSTRACTS

POSTER SESSIONS



Towards the Scaling-up of Protonic Ceramic Electrolysis Cells: Design and Development of Sealing Materials and Steam Electrodes

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Keywords: Protonic ceramic cell, Scaling-up, Glass sealants, Steam electrode

Protonic ceramic electrolysis cells (PCECs) are a next-generation solid-oxide electrolysis technology whose proton-transport mechanism enables efficient operation at 400–600 °C (vs. 700–900 °C for SOECs), mitigating high-temperature corrosion and delivering high-purity H₂ at the fuel electrode side. However, scale-up and stack integration remain the principal challenges [1,2]. This study investigates integration of 30-mm-diameter BaZr_{0.44}Ce_{0.36}Y_{0.2}O_{3-δ}/SrZr_{0.5}Ce_{0.4}Y_{0.1}O_{3-δ} – NiO half-cells with AISI 441 ferritic stainless-steel interconnects. Two glass-based sealants were designed and characterized, with emphasis on chemical compatibility and thermo- mechanical stability at 600 °C under steam-rich conditions. Screen-printed green tapes of the selected glasses were fabricated and used to optimize cell-to-metal joining, targeting maximum hermeticity and precise control of joint geometry. In parallel, a composite steam electrode, La_{0.6}Sr_{0.4}Co_{0.2}Fe_{0.8}O_{3-δ}/BaZr_{0.8}Y_{0.2}O_{3-δ}, was developed. Starting

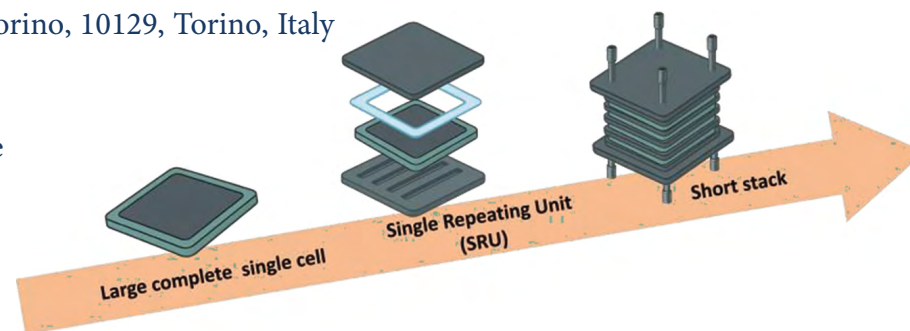


Figure 1. Schematic of the required upscaling steps for PCECs

powders were engineered to yield screen-printable inks with controlled dispersion, stability, and rheology, enabling uniform deposition and subsequent optimization of microstructure and adhesion. Finally, electrochemical performance of the deposited electrodes was assessed by electrochemical impedance spectroscopy.

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POSTER PRESENTATION

Cost-Oriented Modeling and Optimization of Balance of Plant for AEM Electrolyzer Systems: Design Trade-offs and Comparison with PEM

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Keywords: AEM electrolysis, PEM electrolysis, Balance of Plant, hydrogen production, system modeling

The deployment of cost-effective green hydrogen systems requires careful design of the Balance of Plant (BoP), particularly for emerging Anion Exchange Membrane (AEM) electrolyzers. This work presents a system-level methodology for the selection, modeling, and optimization of BoP components, with a focus on minimizing auxiliary energy consumption while ensuring stable operation under dynamic conditions. A lumped dynamic model integrating electrochemical and thermal behavior was developed to simulate an AEM electrolyzer coupled with key BoP elements, including pumps, heat exchanger, and condenser. Multiple BoP configurations were assessed, ranging from minimal layouts to fully monitored systems, highlighting trade-offs between capital cost, controllability, and performance.

Results show that BoP design strongly influences system efficiency and thermal stability, with recirculation flowrate and heat

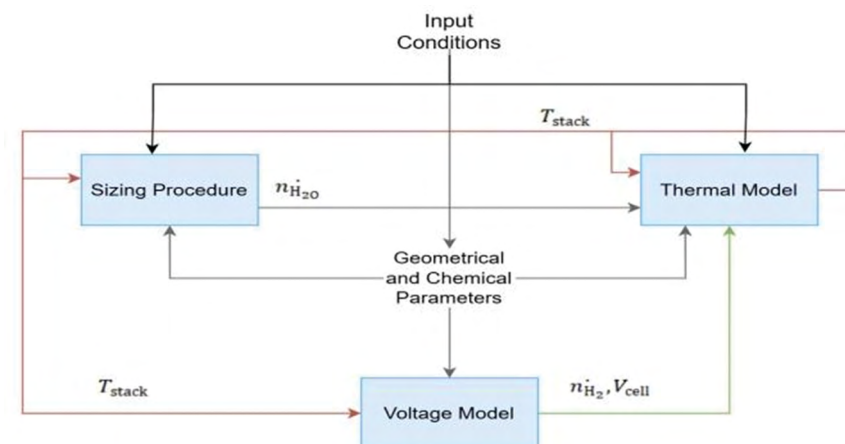


Figure 1. Block diagram of the dynamic system model for the electrochemical performance, thermal management, and sizing procedure

management strategies playing a dominant role in component sizing and energy consumption. An optimal operating point was identified that balances hydrogen production, thermal

loads, and auxiliary power demand. Compared to PEM systems, AEM technology enables reduced material costs through non-noble catalysts but introduces additional challenges in water management and thermal control, making BoP optimization critical. This work provides design guidelines for scalable, decentralized hydrogen systems and supports the development of simplified, cost-effective electrolyzer architectures suitable for renewable integration.

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POSTER PRESENTATION

Multiphysics Model for Protonic Ceramic Electrolysis Cells and Olefins Electrochemical Production

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Keywords: PCEC, Hydrogen, Electrochemical Modeling, Olefins, Co-ionic membrane

In this work a comprehensive model for a protonic ceramic electrolysis cell (PCEC) and for the electrochemical production of olefins is presented. A 3D numerical model has been developed for a planar single repeating units (SRUs) and stacks. This model integrates thermal-fluid-dynamics, electrochemical processes and structural analysis, accounting for the transport of protons, electrons holes and oxygen vacancies through the membrane, typical for barium-based zirconate perovskites commonly employed in this technology and considered in this model. A key objective of this study is to quantify the impact of several parameters on hydrogen production, establishing the negative effect of the electronic leakage on the transference number. Additionally, structural effects on the SRU components resulting from operational conditions, especially temperature gradient induced thermal stresses, are examined for their impact

on structural integrity and durability. The analysis explored structural parameters and operational parameters, such as interconnectors' configuration, operating temperature and streams compositions and flow rate. The parameters that most impact performance and structural integrity are identified and quantified providing insights into configurations that could improve hydrogen production and durability of the PCECs.

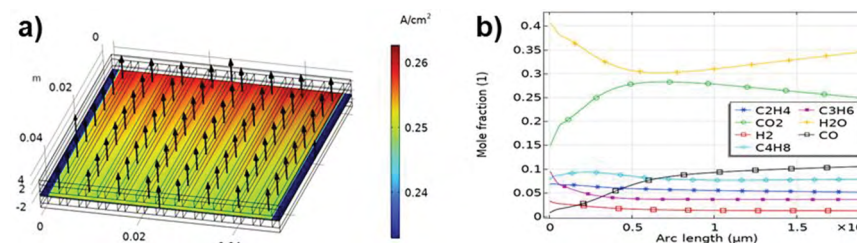


Figure 1. (a) hydrogen ions current density and (b) olefins distribution along tubular cell

POSTER PRESENTATION

Integration of Innovative Redox Materials in Multiphysics Models of Two-Steps Thermochemical Cycles

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Keywords: Multiphysics reactor modeling, Two-step solar thermochemical cycles, Redox material modeling

Perovskites materials represent a promising candidate for two-steps solar thermochemical cycles, thanks to their higher reduction extent at moderate temperatures with respect to ceria. In this work, a modelling framework to estimate the reduction extent of a generic redox material by means of its thermodynamic properties is presented. By coupling it with a 1D time-dependent multiphysics model, the performance on a complete redox cycle of ceria and a perovskite material ($\text{SrTi}_{0.5}\text{Mn}_{0.5}\text{O}_3$) have been compared. The perovskite resulted in higher oxygen release capacity during the reduction step ($0.5141 \text{ mmol}\cdot\text{g}^{-1}$, $0.0642 \text{ mmol}\cdot\text{g}^{-1}$ for ceria), while higher steam flow rates are required to re-oxidize it. The specific hydrogen production per moles of steam provided indicates lower production with respect to ceria. In addition, the STM55 resulted in much lower production rates (peaks of $\text{SrTi}_{0.5}\text{Mn}_{0.5}\text{O}_3$ and ceria respectively: $\sim 0.03 \text{ mL}\cdot\text{min}^{-1}\cdot\text{g}^{-1}$ and $\sim 0.2 \text{ mL}\cdot\text{min}^{-1}\cdot\text{g}^{-1}$), leading to longer oxidation steps.

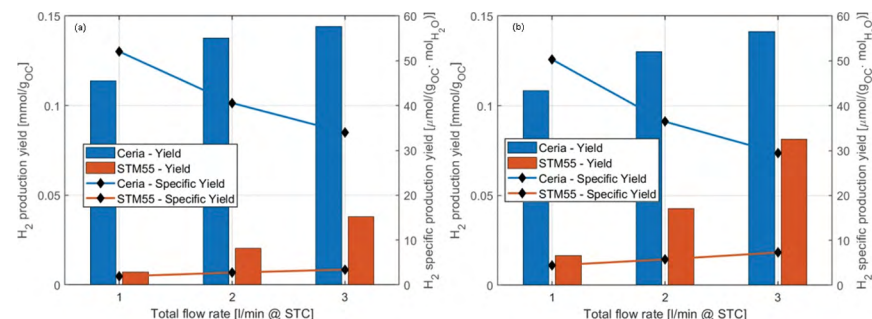


Figure 1. Hydrogen production yield for the two materials considered with different operating conditions: (a) $x_{\text{H}_2\text{O},\text{in}} = 0.5$; (b) $x_{\text{H}_2\text{O},\text{in}} = 0.9$

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POSTER PRESENTATION

Conceptual Design and Feasibility Study of an Autonomous Equalization Complex (AEC) Based on Electrolysis Hydrogen

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Keywords: Autonomous Equalization Complex (AEC), Electrolysis Hydrogen, Modular Industrial Design, NPP Energy Integration

Purpose and Scope

The project details the conceptual design and feasibility of an Autonomous Equalization Complex (AEC) based on electrolysis hydrogen. Designed as an innovative industrial enterprise, the AEC is intended for deployment on flat terrain in safe proximity to a Nuclear Power Plant (NPP) to optimize infrastructure costs and engineering connections. The project adheres to current Bulgarian and international regulatory standards, specifically following the Horizon 2020 research program framework.

Methodology

The study utilizes analysis and synthesis methods to develop a modular design. Two technological variants are explored to determine optimal area, volume, and planning solutions:

- **Variant 1:** AEC utilizing Proton Exchange Membrane (PEM) electricity production.

- **Variant 2:** AEC utilizing Molten Carbonate Fuel Cell (MCFC) electricity production.

Technical Description

The AEC consists of four primary technological blocks:

- **Electrolyzer Complex:** For both variants, five containerized PEM electrolyzer modules (equivalent to GINER S400, 2.1 MW each) are planned. These produce 400 Nm³/h of hydrogen with a purity > 99.9%.
- **Hydrogen Storage:** The facility is designed to store 100,000 m³ of gaseous hydrogen. Variant 1 utilizes 68 horizontal tanks (50 m³ at 4.0 MPa), while Variant 2 utilizes 28 bottle trailers (20 m³ at 20.0 MPa).
- **Electricity Production:** * PEM Variant: Five 1 MW modules with > 50% electrical efficiency and zero pollutants.
 - o MCFC Variant: Two modules with a total output of 3,700 kW,

60% efficiency, and capabilities for heat recycling.

- **Electrical Distribution:** Systems are designed for an outgoing capacity of up to 5 MW.

Facilities and Infrastructure

The site includes comprehensive auxiliary infrastructure, including pumping stations for deionized and fire-fighting water, a nitrogen generation facility for emergency shutdowns, and a centralized management building for process control. The design integrates internal site communications and underground engineering networks to ensure a fully functional industrial ecosystem.

POSTER PRESENTATION

Building a Supplementary Real-Time Data Pipeline for Hydrogen Infrastructure Monitoring

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Keywords: Software Engineering, Data Pipeline, Sensor monitoring, Hydrogen safety, Early warning

Safety is a top priority for hydrogen facilities, so instead of reacting to failures, I want to build a proactive software solution. My proposal focuses on developing a low-latency data pipeline for real-time sensor monitoring.

I plan to use lightweight messaging protocols like MQTT to collect raw telemetry—such as pressure, temperature, and gas concentration—directly from the hardware. This data will be ingested into a time-series database optimized for fast, continuous querying. The core of the project involves writing anomaly detection logic that evaluates incoming data streams against safe

baseline thresholds. If the code detects early signs of a micro-leak or valve degradation, it will trigger automated alerts. Finally, I will build a frontend dashboard to visualize the hardware's health in real-time.

Crucially, this project is designed as a supplementary diagnostic layer and is not intended to replace the primary hardware safety systems. Its main purpose is to assist operators by providing an early-warning tool, allowing them to catch issues before they escalate, which adds an extra level of security and prevents costly downtime.

POSTER PRESENTATION

Sustainable Energy Materials: Bacterial Nanocellulose in Fuel Cells and Supercapacitors

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Keywords: Bacterial nanocellulose, symmetric supercapacitor, fuel cell, electrochemical tests

Bacterial nanocellulose (BNC) is a novel nanomaterial produced by various aerobic bacterial species, exhibiting unique physicochemical properties and a highly porous three-dimensional structure. Its flexibility and mechanical strength make BNC an excellent matrix for the design of functional nanomaterials for energy applications. In hydrogen-based systems, BNC has shown potential as a durable biopolymer for ion-exchange membranes and electrodes in fuel cells and electrolyzers. Surface modification and functionalization enhance its ionic conductivity and chemical stability, enabling efficient proton or hydroxide transport in electrochemical energy conversion.

Beyond hydrogen technologies, BNC has also been explored as a separator material in supercapacitors. Supercapacitors incorporating BNC membranes demonstrated high specific capacitance and excellent cycling stability, maintaining performance over 10,000 charge-discharge cycles.

The objective of this study is to assess the broader applicability of BNC and to improve its performance in electrochemical energy systems. The electrochemical behavior of BNC-based materials was evaluated using cyclic voltammetry, galvanostatic charge-discharge tests, long-term cycling, and Electrochemical Impedance Spectroscopy (EIS). This study highlights the potential of BNC-based materials as sustainable energy components for hydrogen storage and supercapacitor applications.

Acknowledgements

Part of equipment used in this research is provided by the National Roadmap for Research Infrastructure 2020–2027 "Energy storage and hydrogen energetics (ESHER)", approved by DCM No 354/29.08.2017 and updated by D01-349/13.12.2023 under Grant Agreement D01-160/28.08.2018.

The financial support under project No. BG16RFPR002-1.014-0009 "DEVELOPMENT AND SUSTAINABILITY OF THE HITMOBIL COMPETENCE CENTER", financed by the "Research, Innovation and Digitalization for Smart Transformation" Program 2021-2027, co-financed by the European Union through the European Regional Development Fund is appreciated.

POSTER PRESENTATION

Artificial Electrochemical Aging: A Redox-Cycling Approach for SOFCs

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Keywords: Impedance Spectroscopy, Solid Oxide Cells, Accelerated Stress Tests, Artificial Aging, Redox Cycling

The commercialization of Solid Oxide Cells (SOCs) is hindered by the requirement for long-term durability tests, often exceeding 80,000 hours. Within the framework of the FCH JU2 Project AD ASTRA, this study presents a novel Accelerated Stress Test (AST) protocols based on artificial aging of the fuel electrode via controlled redox-cycling [1]. To overcome the risk of irreversible mechanical damage, such as anode/electrolyte cracking and delamination, a specialized procedure was developed. The methodology employs a unique impedance-based monitoring technique to measure Ni-network resistance changes in real-time, allowing for a precise "mild" oxidation level that mimics natural Ni-coarsening and migration. Comparative analysis using Current-voltage (i-V) curves, Electrochemical Impedance Spectroscopy (EIS) and SEM characterization validates the approach in a fuel cell mode. Results demonstrate that 20 redox cycles, performed within only 60 working hours, induce degradation equivalent to

over 4,000 hours of nominal operation (Fig. 1).

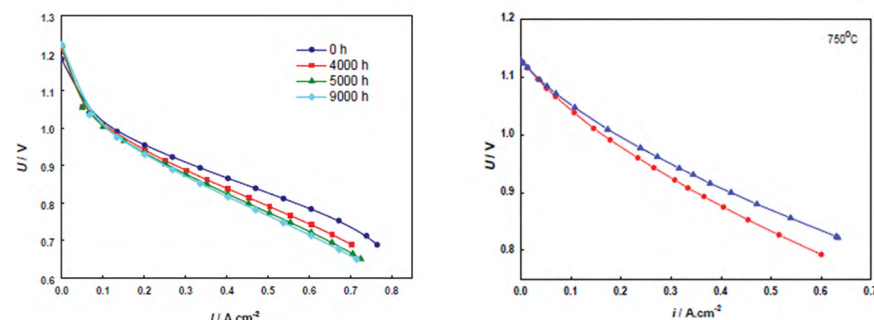


Figure 1. Current- voltage (i-V) curves: a) of calendar aged cell operated for 9000 h and b) artificially aged cell before redox cycling ($\blacktriangle$) and after 20 redox cycles ($\bullet$)

This yields an Acceleration Factor (AF) of approximately 60, offering a highly reproducible and time-efficient tool for assessing SOC lifetime. This protocols significantly reduces the bottleneck of long-term testing. The advanced data analysis technique of

the Differential Impedance Analysis (DIA) is further applied for deeper insight in the degradation mechanisms.

Acknowledgements

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POSTER PRESENTATION

Hydrogen-to-X applications: Converter Topologies and Control Strategies for Fuel Cell-Based Energy Systems

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Keywords: Fuel cell, Power supply system, Power electronic converter, DC/DC converters topology

Hydrogen production, storage, transportation, and utilization face significant challenges, and the lack of coordinated infrastructure limits integration across the hydrogen industry chain. Developing a clean, low-carbon, and efficient green hydrogen energy system,

as shown in Figure 1, is essential for advancing hydrogen technologies. In general, fuel cell power generation devices require improvements in materials, structure, and control strategies to enhance power quality and broaden their application. High costs, driven by performance and durability, remain a major barrier, prompting efforts to automate production and develop low-cost fuel cell packages and optimized balance-of-plant components including auxiliary system components and power electronics, such as inverters and converters for conditioning electricity for grid or user applications. DC–DC converters play a critical role in regulating fuel cell output, ensuring stable and efficient integration with electrical systems. Innovation arises from exploring new converter topologies and algorithms to optimize fuel cell operation, which are analyzed in this paper.

Acknowledgements

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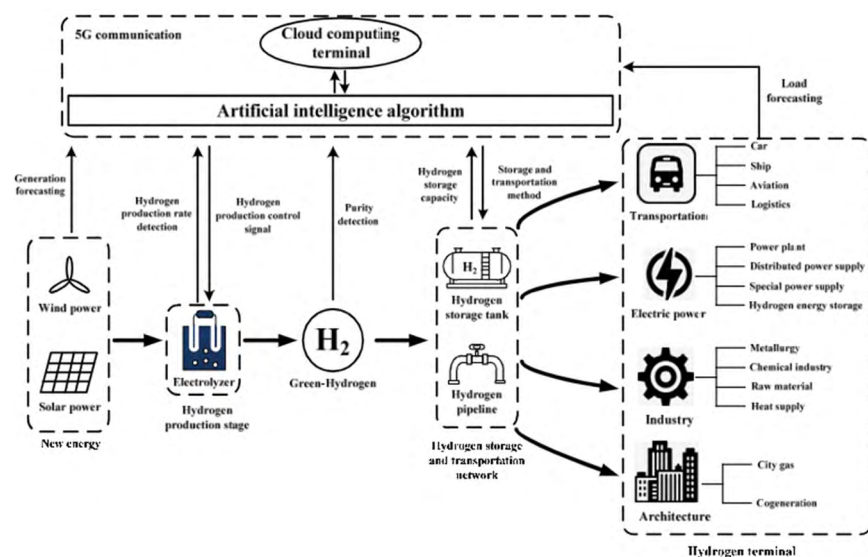


Figure 1. Hydrogen production and distribution flowchart

POSTER PRESENTATION

The Hydrogen Value Chain and the Question of Mineral Resources: A Shared Vision Between Europe and China

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Keywords: Mineral resources, Hydrogen Value Chain, Europe and China, International tensions, Education

The hydrogen value chain is inherently linked to renewable energy (RE) technologies—such as photovoltaics or wind turbines—that power electrolyzers. All such technologies require large quantities of materials, which are largely similar and can be grouped into four families: (i) structural and coating materials [e.g., Ni, Cr, Zn, Al], (ii) catalysts [PMGs], (iii) core materials [e.g., Co, Ni, Li, rare earths] and (iv) connecting materials [Cu].

However, mineral resources are unevenly distributed. Copper and platinum-group metals (PMGs) already face supply constraints, and international tensions can block access, causing extreme price volatility. The storage, transport, and use of hydrogen will also require significant material inputs. To address these challenges in the current international context, it is essential to: (i) secure international supply chains for mineral resources; (ii) consider

reopening mines that were previously unprofitable; (iii) recycle materials at every stage of the value chain; (iv) explore alternative materials; (v) optimize the profitability of value chain ecosystems. This necessarily calls for a major transformation in research and training, with a focus on materials science and economics.

China and Europe differ greatly in history, culture, society, and resources, yet they share the same climate and energy transition goals. This poster shows that mutually beneficial cooperation is possible despite these differences—especially through shared educational commitments to train the skilled professionals needed for the energy transition.

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POSTER PRESENTATION

Retrofitting as a solution for heavy-duty, rail and maritime transport decarbonisation

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Keywords: Retrofitting, Heavy-duty vehicles decarbonisation, rail, maritime.

The decarbonization of heavy-duty road, rail and maritime transport is a serious challenge due to large amounts of energy required and the specifics of transport – requirements for fast charging, fuel and drive systems with high energy density and respectively long range. Another challenge, especially in the rail and maritime sectors, is that these vehicles/vessels are not produced uniformly on an assembly line. Each one is a unique combination of components covering specific requirements. In



Figure 1. Ikarus trolleybus used for exploring modernization process – before modernization (left) and planned design after (right)

addition, the long design life of 30+ years predetermines the moral and physical obsolescence of their systems and subsystems. The modernization approach (so-called retrofitting in recent years) has been adopted for them as normal procedure under which old onboard systems are replaced by modern technological solutions. This work explores the possibilities for synergy between the need for modernization in these machineries with the implementation of new technologies such as hydrogen, fuel cells and batteries. An Ikarus trolleybus at the end of its life cycle was used as the object of modernization. Lessons learned, advantages and disadvantages during the modernization process are presented.

Acknowledgements

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POSTER PRESENTATION

Predictive Energy Management for Hydrogen Fuel Cell Hybrid Trains

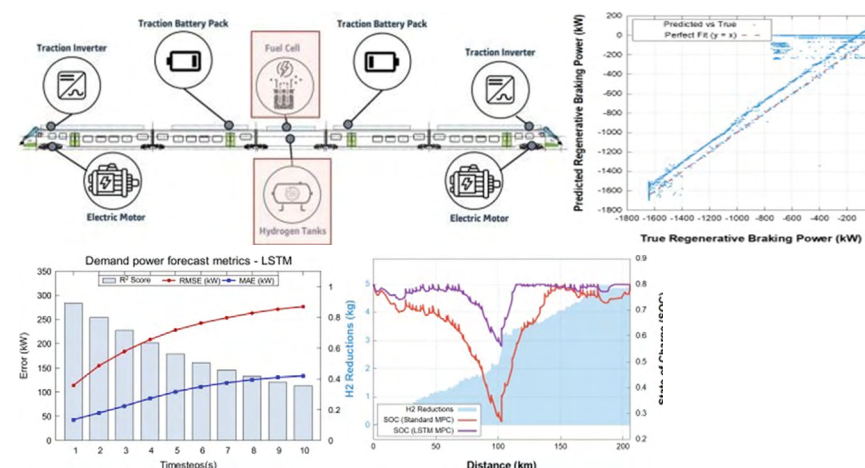
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Keywords: Hydrogen Fuel Cell, Hybrid Multiple Unit Train (HMU), Energy Management System (EMS), Model Predictive Control (MPC), Machine Learning

Fuel cell-battery hybrid trains are promising for clean heavy-duty transport, but need proper modeling for widespread adoption. This study presents machine learning solutions for simulation, regenerative energy, and total power demand prediction to improve EMS, with a focus on ALSTOM's hydrogen train on Italy's Brescia-Iseo-Edolo line. The EMS uses model predictive control (MPC) for power splitting, based on SOC and operational constraints. Machine learning methods include a two-stage ensemble predictor for regenerative power and a long short-term memory (LSTM) for total power demand forecasting, using train kinematics as features. The ensemble and LSTM achieve R^2 values of 0.99 and 0.89, respectively. The EMS gains were evaluated at balanced-weight settings for the MPC, which minimized the objective function. After running a round-trip simulation, LSTM-predicted assisted MPC achieves up to 7% reduction in hydrogen consumption compared to standard MPC. From the fuel cell lifetime perspective, the cumulative power fluctuation was assessed at 57.9 MW with LSTM-MPC, 2 MW lower than in standard MPC. The enhanced MPC maintained SOC more



precisely over the round trip, supporting optimal battery power rate of change and operating range while ensuring charge-sustaining mode.

Acknowledgements

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POSTER PRESENTATION

Electric Drivetrain Analysis and Adaptations for Fuel Cell Retrofitted Vehicle

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Keywords: FCEV, Vehicle Retrofitting, Electric drivetrain, Motor dynamics

The transport sector generates about 25% of global CO₂ emissions [1]. Heavy-duty transport and machinery are among the vehicles that are difficult to decarbonise. Modernisation (so-called retrofitting) is one option for introducing new low-emission technologies into these vehicles. When retrofitting, although there is usually an electric traction motor, it is often morally and physically obsolete and should be replaced with a new one. Modern drive systems provide significantly higher efficiency, and help to improve the characteristics of the vehicle. However, this replacement is also associated with challenges that must be considered in the design process of the new traction motor and drivetrain.

The presented work focuses on simulating the implementation of a new traction motor during the vehicle retrofitting process. Traction motor dynamics [2] are influenced by the new suspension and traction force dynamics, as well as their dependence on chassis-frame behaviour, represented by modal values [3]. This simulation analysis uses the GNU Octave software package and its instrumentation. These complex influence

paths are analysed with software tools to develop an algorithmic methodology, enabling further data logging and analysis of the physical values and phenomena affecting the real electrical hybrid hydrogen fuel cell–battery vehicle. A system-level approach is also included in the presented work.

Acknowledgements

This work is supported by the project “Development of research and innovation at Trakia University in service of health and sustainable well-being” (No. BG-RRP-2.0040-0006-C02).

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POSTER PRESENTATION

Development of a Multifunctional Textile Using the Solution Blow Spinning Technique

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Keywords: Solution Blow Spinning, PLA nanofibers, ZnO nanoparticles, oil/water separation, functional textiles

Oil spills and oily effluents pose a growing threat to freshwater and marine environments and are of increasing concern to both industry and academia [1]. Extensive research efforts have focused on the development of absorbent materials optimized for high-efficiency oil adsorption or for the effective separation of oil from water (and vice versa) through precise control of surface wettability and contact angles. Porous materials that exhibit super water-repellent (hydrophobic) behavior (superhydrophobicity) together with super oil-attracting (oleophilic) properties (superoleophilicity) are considered ideal absorbent candidates due to their high selectivity and their ability to facilitate fluid transport through interconnected pores (permeability) [1].

Significant advancements have been achieved in the production

and application of superhydrophobic coatings; however, their practical implementation remains limited by insufficient durability, particularly under large-scale and long-term operating conditions [2]. To address this limitation, the present article describes the development of a multifunctional nanofibrous membrane fabricated using Solution Blow Spinning (SBS), a novel coating technique developed by the researchers. A polylactic acid (PLA) solution dissolved in dichloromethane (DCM) and containing zinc oxide (ZnO) nanoparticles was prepared. This composite solution was atomized and deposited onto a cotton fabric substrate, forming a membrane with a roughened surface and hierarchical porosity. Preliminary test results demonstrate that the resulting membrane exhibits excellent oil/water

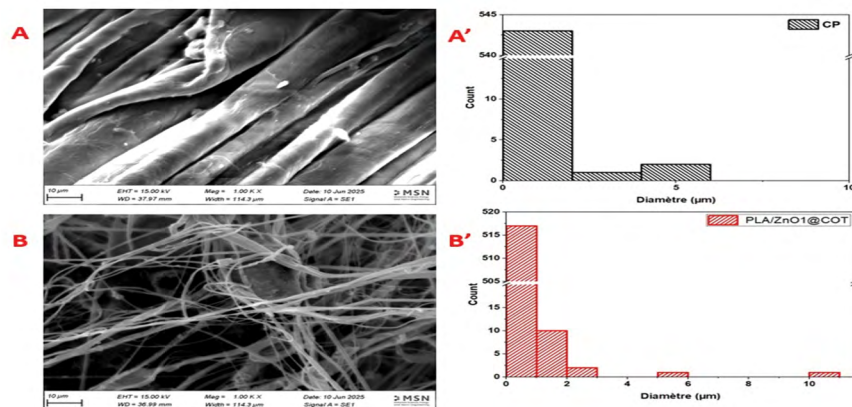


Figure 1. SEM analysis and fiber distribution of (A, A') C.P and (B, B') PLA/ZnO1@cot samples

separation performance, with a water contact angle of 150° and a separation efficiency exceeding 99%.

The incorporation of PLA as a raw material for membrane fabrication also provides an environmentally sustainable option, as PLA is a biodegradable polyester that naturally degrades through microbial activity. Consequently, the use of PLA for membrane production offers an innovative and environmentally friendly solution for oil/water separation in the industrial treatment of oily wastewater.

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POSTER PRESENTATION

Dielectric Impedance Spectroscopy of Cow and Plant Milks

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Keywords: Cow milk, Plant milk, Dielectric Impedance Spectroscopy

This work presents an investigation of milks (with different composition and origin) with respect to their physical behavior and electrical properties changes under application of low-frequency AC signal (Fig. 1). The method, known as Dielectric Impedance Spectroscopy (DIS) is a valuable experimental tool for fundamental scientific research and contributes significantly to understanding the structure and microdynamics of dielectrics. Dielectric spectroscopy, depending on the frequency range used, could be applied to a wide range of systems, as gases, liquids and solid objects. For first time DIS is performed for evaluation of milk, which presents a complex colloid system composed of a polar matrix with dissolved nonpolar fluid. Different milks (plant based and animal originated) were investigated in a specially designed experimental cell, which consists of two coaxial stainless-steel cylindrical electrodes with coplanar working surface. The results presented in this paper indicates that DIS can be used as a quick test to determine the different ingredients and environments.

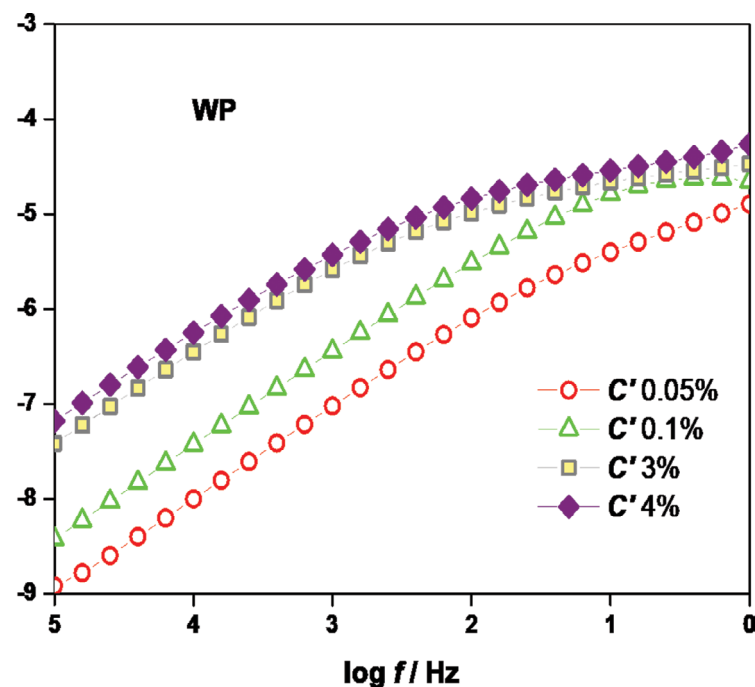


Figure 1. Permittivity measurements samples of WP protein

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POSTER PRESENTATION

Molecular Hydrogen: A Bridge Between Clean Energy and Biomedical Innovation

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Keywords: molecular hydrogen, oxidative stress, inflammation, metabolic health

Molecular hydrogen (H₂) is best known as a promising energy carrier for low-carbon technologies, but it has also attracted growing interest in biomedicine. Beyond its role in clean power and mobility, H₂ has been explored for its potential antioxidant, anti-inflammatory, and cytoprotective effects in experimental and early clinical settings. The available evidence suggests that molecular hydrogen may help modulate oxidative stress and inflammatory signaling, with possible relevance to metabolic disorders, cardiovascular disease, and other conditions linked to cellular damage. At the same time, the field is still developing: delivery methods, dose standardization, and the strength of clinical evidence remain open questions. Molecular hydrogen is thus presented as a compelling example of how an energy technology can extend into the biomedical field, illustrating the growing intersection between clean energy research and pharmacological innovation.

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HYDROGEN FOR CLEAN POWER AND MOBILITY WORKSHOP PROCEEDINGS AND BOOK OF ABSTRACTS

This volume contains abstracts submitted for the Hydrogen for Clean Power and Mobility Workshop, held on 28–29 May 2026 at Trakia University, Stara Zagora, Bulgaria, compiled by the Workshop Organizing Committee. The abstracts are published as submitted and have not undergone formal peer review or language editing. Responsibility for the content of each abstract rests with its respective author(s).

The Hydrogen for Clean Power and Mobility Workshop is co-organized by the National Recovery and Resilience Plan – Development of Research and Innovation at Trakia University in the Service of Health and Sustainable Well-Being Project (No. BG-RRP-2.004-0006-C02), financed by the Program for Education 2021-2027 and Project H2START - Centre of Excellence for Hydrogen Technologies, co-financed by the European Union under Horizon Europe (GA 101136692) and the Programme for Research, Innovation, and Digitalisation for Smart Transformation 2021-2027.



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HYDROGEN AT TRAKIA UNIVERSITY

Hydrogen technologies are increasingly recognized as a key link in the clean energy transition, connecting renewable energy, industrial decarbonisation, energy storage, transport, and sustainable regional development. At Trakia University, this field has become a strategic direction, bringing together scientific expertise, education, applied research, and international cooperation. The establishment of the “Hydrogen and Fuel Cells” research group under the national project Development of Research and Innovation at Trakia University in Support of Health and Sustainable Well-being laid the foundation for new knowledge, technical capacity, and experimental work in electrochemical energy systems, advanced materials, hydrogen production and utilization, and clean mobility.

The Hydrogen for Clean Power and Mobility Workshop marks an important milestone in this process. It reflects the combined progress of the national project, which initiated and strengthened hydrogen research at Trakia University, and H2START – Centre of Excellence for Hydrogen Technologies, which is expanding this momentum into an internationally connected research and innovation ecosystem. Through specialized laboratories, interdisciplinary teams, and partnerships with leading experts, Trakia University is positioning itself as one of Bulgaria’s pioneering academic centres in hydrogen technologies, while creating new opportunities for young researchers, engineers, and the sustainable transformation of the Stara Zagora region.

The Hydrogen for Clean Power and Mobility Workshop is co-organized by the National Recovery and Resilience Plan – Development of Research and Innovation at Trakia University in the Service of Health and Sustainable Well-Being Project (No. BG-RRP-2.004-0006-C02), financed by the Program for Education 2021-2027 and Project H2START - Centre of Excellence for Hydrogen Technologies, co-financed by the European Union under Horizon Europe (GA 101136692) and the Programme for Research, Innovation, and Digitalisation for Smart Transformation 2021-2027.



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