BIO energy & economy INTERNATIONAL Conference (IBBC2025)

Abstract Book

ISEC Lisboa, Lisbon, Portugal

December 03-05, 2025 Daily Sessions: 09:00 AM

Presented in Partnership with

iseclisboa INSTITUTO SUPERIOR DE EDUCAÇÃO E CIÊNCIAS

Industrial Energy-Related Technologies and Systems iets

Task XI: Industry-based biorefineries towards sustainability

IBBC 2025 – Abstract Book Index

#IBBC2025 Foreword

IBBC has been initiated with a steadfast commitment to empower the global bioenergy and bioeconomy community through a series of premier international conferences held annually.

With immense joy and excitement that we extend our warmest welcome to all participants joining us for our inaugural edition **IBBC 2025**, taking place from **December 3rd to 5th, 2025**, in the vibrant and historic city of Lisbon, Portugal. We are truly delighted to have this opportunity to gather once again and explore the transformative advancements shaping the fields of bioenergy, bioeconomy, and sustainable innovation.

Our conference venue, **ISEC Lisboa**, offers an excellent academic environment that fosters meaningful dialogue, collaboration, and inspiration. It provides the perfect setting for knowledge exchange and multidisciplinary engagement among researchers, industry leaders, innovators, and policymakers from around the world.

With **IBBC 2025**, our aim is to create an inclusive and dynamic forum that encourages open discussion, innovative thinking, and impactful scientific exchange. Participants will have the opportunity to delve into diverse aspects of bioenergy systems, circular bioeconomy models, sustainable technologies, and environmental solutions while forging new collaborations and expanding professional networks. The conference promises to be a platform where cutting-edge ideas are shared, and new horizons are explored.

Our heartfelt gratitude goes out to all the Honourable Guests, Speakers, Distinguished Researchers, Partners, and Sponsors who have accepted our invitation and chosen to be part of IBBC 2025. Your presence and contributions are invaluable in shaping a successful and inspiring event.

We also extend our sincere appreciation to the Conference Chairs, Local Organizing Committee, and International Advisory Board for their dedication, hard work, and unwavering support. Your efforts in curating a rich, thought-provoking agenda and steering **IBBC 2025** forward are truly commendable.

As we look forward to this exceptional gathering, let us embrace the spirit of collaboration, the excitement of discovery, and the collective pursuit of knowledge. Together, we will contribute to advancing global sustainability and driving innovation in bioenergy and the bioeconomy—paving the way for a greener and more resilient future.

Yours sincerely,

Organizing Committee

IBBC 2025

#IBBC2025 Conference Organization

Honorable Chair

Jorge Costa, Coordinator of the Degree in Renewable Energies and Environment.
ISEC Lisboa - Instituto Superior de Educação e Ciências, Portugal

National Advisory Board

- **Helena Nadais,** University of Aveiro, Portugal
- **Helder Viana,** Polytechnic University of Viseu, Portugal
- **José Carlos Pires,** University of Porto, Portugal
- **João Miranda,** Portalegre Polytechnic University, Portugal
- **Henrique Matos,** Instituto Superior Técnico, Portugal
- **Isabel Cabrita,** CERENA/IST, Portugal
- **Florbela Carvalheiro,** National Laboratory for Energy and Geology, Portugal
- **Ana Luísa Fernando,** Universidade Nova de Lisboa, Portugal
- **Edmundo Marques,** Polytechnic Institute of Viseu, Portugal
- **Alberto Reis,** National Laboratory for Energy and Geology, Portugal

International Advisory Board

- **Antonis Kokossis,** National Technical University of Athens, Greece
- **Marzouk Benali,** Natural Resources Canada, Canada
- **Paul Stuart,** Polytechnique Montréal, Canada
- **Petros Samaras,** International Hellenic University, Greece
- **Walter Haslinger,** BEST - Bioenergy and Sustainable Technologies, Austria
- **Cemil Koyunoğlu,** Yalova University - Energy Systems Engineering Department, Turkey
- **Herminia Domínguez,** University of Vigo, Spain
- **Encarnación Ruiz,** University of Jaén, Spain
- **Arun Goyal,** Indian Institute of Technology Guwahati, India
- **Léa Vilcocq,** CP2M, CNRS, France

Industrial Advisory Board

- **David Apollus,** Across Atlantic, United Kingdom
- **Luís Gil,** Directorate-General for Energy and Geology (DGEG), Portugal
- **Christoph Brunner,** AEE INTEC, Austria
- **Irshad Ahmed,** Avalon Energy Group LLC and MIT, USA

Scientific Committee

- **Maria das Graças Felipe,** The University of Sao Paulo, Brazil
- **Eulogio Castro,** University of Jaén, Spain
- **Paulo Brito,** Polytechnic Institute of Portalagre, Portugal
- **Raúl Muñoz,** University of Valladolid, Spain
- **Francesco Zimbardi,** ENEA, Italy
- **Margarida Gonçalves,** NOVA University Lisbon, Portugal
- **Clemente Pedro Nunes,** Instituto Superior Técnico – University of Lisbon, Portugal
- **Ana Paula Oliveira,** ISEC Lisboa, Portugal
- **Ana Filipa Ferreira,** Instituto Superior Técnico, University of Lisbon, Portugal
- **Bruno Barbosa,** Instituto Superior de Educação e Ciências (ISEC Lisboa), Portugal
- **Luis C. Duarte,** National Laboratory for Energy and Geology (LNEG), Portugal

Sponsors and Organizing Institutions

- **ISEC Lisboa – Instituto Superior de Educação e Ciências, Portugal**

Sponsored and Endorsed By

- **IEA IETS – Task XI: Industry-Based Biorefineries**

Associated Partners

We proudly recognize the **IEA IETS – Task XI: Industry-Based Biorefineries and ISEC Lisboa – Instituto Superior de Educação e Ciências, Portugal** for their valuable partnership in advancing the global transition toward sustainable and circular industrial systems.

IEA IETS – Task XI focuses on the transformation of industrial energy, technologies, and systems accelerating decarbonization, climate resilience, and circular bioeconomy pathways. Through its multidisciplinary work across decision support systems, technology innovation for net-zero/negative emission biorefineries, and biomass-oriented industrial symbiosis, Task XI drives cutting-edge international cooperation between industry, government, and academia. Their continuous efforts since 2008 have strengthened global knowledge exchange, fostered R&D collaboration, and advanced policy relevant science for optimized, integrated biorefinery solutions.

ISEC Lisboa, our host and academic partner, plays a pivotal role in bridging education, applied research, and industrial innovation. As a key contributor to Task XI — notably leading Subtask 3 on Circular Bioeconomy and Biomass Oriented Industrial Symbiosis ISEC supports systems-level methodologies that enable carbon circular industrial ecosystems and enhance technology deployment.

Together, these partners bring scientific depth, strategic insight, and international collaboration to #IBBC2025 ensuring a dynamic platform for knowledge sharing, policy development, and sustainable industrial transformation in Lisbon and beyond.

#IBBC2025 Program at a Glance

Location	Wednesday Day 1. December 3rd, 2025	Thursday Day 2, December 4th, 2025	Location	Friday Day 3, December 5th, 2025
Main Hall (L, J)	REGISTRATION (08:00-08:50)	REGISTRATION (08:00-08:50)	Main Hall (L, J)	Workshop on Decision Support Systems and Scenario Analysis for Biorefinery Development Organizer:- Marzouk Benali (9:00-10:30)
	Inaugural Session (09:00-09:30)	Plenary: Philippe Tanguy (09:00-09:35)		
	Plenary: François Maréchal (09:30-10:05)	Plenary: Mohammed Hassan Abdullahi (09:35-10:10)		
MC	**Coffee Break (10:05-10:35)**	**Coffee Break (10:10-10:40)**	**MC**	**Coffee Break (10:30-11:00)**
Location	Parallel Sessions Session: 1&2	Parallel Sessions Session: 2 & Task XI Special Session	**Main Hall (L, J)**	Workshop on 'Management of Biomass Supply Chains: Stakeholders, Risks, and Value Creation Organizer:- Sebnem Yilmaz Balaman (11:00-12:30)
D4	Session Duration(10:45-13:00)	Session Duration(10:50-12:50)		
	Session-1	Session-2		
D5	Session Duration(10:45-13:00)	Session Duration(10:50-13:05)		Closing Keynotes 12:30-13:00
	Session-2	Task XI Special Session		
MC	**Lunch Break (13:00-13:50)**	**Lunch Break (12:50-13:40)**	**MC**	Lunch Break (13:00-14:00)
Main Hall	Plenary: Andrea Ramirez Ramirez (14:00-14:35)	Plenary: Paul Stuart (13:50-14:20)	**Technical Tour to Navigator Company 15:00-17:00**	
Location	Parallel Sessions Session: 1, 3, 4,	Parallel Sessions Session: 5,6, 7 & Task-XXIV Session		
D4	Session Duration(14:45-17:45)	Session Duration(14:30-17:40)		
	Session-1, 3	Session-5, 6		
MC	**Coffee Break (16:05-16:35)**	**Coffee Break Timings For Parallel Sessions (15:40-16:10:D4; 15:50-16:20: Main Hall; 16:00-16:30:D5)**		
D5	Session Duration(14:45-17:55)	Session Duration(14:30-17:15)		
	Session-4	Task-XXIV, Session-7		
Main Hall		Session Duration(14:30-17:10)		
		Session-8		
MC		Poster Competition 17:45-18:45 (P1-P30)		
City Tour (18:00 Onwards)		Social Dinner and Networking 19:30-21:30@Museu da Cerveja		

Session Codes:

Session 1: Bioenergy Production, Value Chain and End-use
Session 2: Sustainable Biorefineries in a Circular Economy
Session 3: Sustainable feedstock Supply and integration
Session 4: Pathways to Net-Zero and Negative Emissions, and Climate Change Mitigation Strategies
Session 5: Advanced Biofuels and Platform Chemicals for Industry Sectors
Session 6: Hydrogen Value Chain
Session 7: Digital Transformation in Biorefinery, Decision Support Systems and Scenario Analysis
Session 8: Project financing options

Special Sessions:

Task XI: Decision Support Tools for a Feasible Bio-economy
Task XXIV: Process Integration for Industry Decarbonization

#IBBC2025 Contribution List

Puck Wammes, TNO Energy Transition Studies, Netherlands	Oral	103
Katerin Julieth Paez Moreno, IMT Atlantique, France	Poster	105
Eliana Lozano, Aalborg University, Denmark	Poster	106
Guilherme Henrique da Silva, LNEG, Portugal	Poster	107
Francisco Espínola, University of Jaén, Spain	Poster	108
Francisco Díaz, University of Vigo, Spain	Poster	109
Miguel Nogueira, University of Lisbon, Portugal	Poster	110
Manuel Francisco Blanco Roldán, CIEMAT, Spain	Poster	111
María Dolores Torres Pérez, University of Vigo, Spain	Poster	112
Nataliia Antoniuk, National Academy of Management, Ukraine	Poster	113-114
María Ángeles Martín-Lara, University of Granada, Spain	Poster	115
Mónica Calero, University of Granada, Spain	Poster	116
Anderson Correa, Federal University of Uberlândia, Brazil	Poster	117
Marianna Shevchenko, University of Aveiro, Portugal	Poster	118
Fanny Machado Jofre, USP, Brazil	Poster	119
Pedro L. Martins, LNEG, Portugal	Poster	120
Luis C. Duarte, LNEG, Portugal	Poster	121
Florbela Carvalheiro, LNEG, Portugal	Poster	122-123
Luis C. Duarte, LNEG, Portugal	Poster	124
Iván Costa Trigo, LNEG, Portugal	Poster	125
Helder Viana, Polytechnic Institute of Viseu, Portugal	Poster	126
Avni Gupta, Liverpool John Moores University, UK	Poster	127
Ana Catarina Faria, Fraunhofer Portugal AWAM, Portugal	Poster	128
Alonso Israel Arroyo Escoto, CEBAL, Portugal	Poster	129

Day-1

Keynote Presentation

Overview of Bioenergy in the Energy Transition: Biomass for the Net-Zero Energy Transition: From Cascading Use to Negative Emissions by System Integration

François Marechal

Industrial Process and Energy Systems Engineering EPFL Valais-Wallis, Switzerland

Photosynthesis is nature's original renewable energy and circular economy solution. It converts solar energy into biomass while directly capturing atmospheric carbon. This biomass, a carbon hydrate ($C(H_2O)_nH_{2z}$), serves primarily as food with an energy content of around 20 MJ/kg. Beyond its role as human energy and nutrients supply, biomass offers material and energy solutions to the society, enabling negative emissions and supporting society defossilization.

Although being part of a natural circular economy principle, the biomass resource is limited by its land usage and will have an impact via the human management activities (e.g. cropping) or the eco-services (e.g. carbon sequestration) it provides. For the energy system, the biomass resource is part of a cascaded usage. It is typically the by-product of a higher value usage like food supply, construction or fiber materials. It therefore appears as a waste. Its potential extends beyond stored energy: biomass also provides a source of captured atmospheric carbon known as biogenic carbon, enabling negative emissions if sequestrated and renewable energy storage.

This presentation explores biomass as an element integrated in the energy system linking harvesting, conversion, and storage through supply chains. Harvesting depends on land or water use, while the supply chain must address challenges like moisture content and degree of oxidation, which affects its energy transportation costs.

Conversion processes can be thermal, chemical, or bio-chemical. They are tailored to biomass composition (C, H, O content), energy content, and moisture, with a focus on energy density and biogenic carbon utilization. The conversion efficiency needs to be considered with its heat integration prospecting considering heating service supply to the industry and the house heating/cooling in addition to energy transport and storage. Key metrics for assessing conversion chains should therefore include both energy and carbon efficiency

Central to this discussion is the biorefinery concept, analogous to petrochemical refineries but designed for biogenic feed-stocks. Biorefineries fractionates biomass into high-value products, platform chemicals, plastics, and fuels, including the key fraction of Sustainable Aviation Fuels (SAF). Innovative approaches emphasize lignin extraction, direct product transformation, and the integration of electrolysis/co-electrolysis to match the hydrogen, carbon, and oxygen composition of products and minimise the release of biogenic carbon as CO_2 in the atmosphere.

Given its limited availability, the talk examines biomass's systemic role in balancing energy and products supply and demand, seasonally storing renewable energy, and generating negative emissions, it is therefore a direct competitor to the direct air capture technology. By prioritizing material use and leveraging biogenic carbon, biomass emerges as a critical enabler of the net-zero transition, bridging decarbonisation of energy usage, efficiency, renewable energy storage, sustainable chemical production, and carbon sequestration for negative emissions.

Biography:

Prof. François Maréchal is an Adjunct Professor at EPFL and a leading expert in computer-aided process and energy systems engineering. His work focuses on process integration, exergy analysis, thermo-economic optimization, and the design of sustainable energy conversion systems. Holding a PhD in Chemical Engineering from the University of Liège, he has contributed extensively to methodologies that improve the efficiency and sustainability of industrial processes. Prof. Maréchal has led major research and industry collaborations in biofuels, utility system optimization, waste-to-energy, desalination, and urban energy systems, advancing innovative solutions that support the transition toward cleaner and more efficient energy futures.

~ Go to Contribution List

Day-1

Session-01 - Bioenergy Production, Value Chain and End-use

Invited Presentations

Renewable Natural Gas (RNG) Will Replace Fossil Natural Gas (LNG) – Let Me Show You How ?

Ben Pluke

CEO, Co-Founder, RAFT Energy, United Kingdom

The RNG and Biogas industry has enormous potential, but it suffers from a PR problem when compared to Wind, Solar and Hydrogen. Green Gas / RNG is the "Big Green battery" that we need in Europe and it solves the three issues that every government faces a) Clean power to meet Net Zero b) Energy Security c) Cost. Ben, will discuss his own journey into Biogas, how his invention came about and the wider opportunities for the RNG community to replace LNG for good.

Biography:

Ben Pluke is CEO, Co-Founder of RAFT Energy which has a goal of becoming the largest supplier of activated biochar in the world. He is the inventor of our flagship product ActiCH4R which is an activated biochar product used by Biogas plants to increase methane yield and improve plant efficiency.

~ Go to Contribution List

A New First-of-Its-Kind Commercial Plant in Spain Which Will Produce Renewable Fuels and Circular Materials From Waste That Would Otherwise Be Destined for Landfill

Ana Filipa Almeida[1] and Dalia García Franco[2]

[1]Gasification Expert, Primary Conversion Senior Scientist, Repsol, Spain
[2]Senior Project Manager, Gasification Expert Repsol, Spain

The Ecoplanta Project represents a pioneering initiative in the field of waste-to-renewable technologies, leveraging advanced gasification to transform municipal solid waste (MSW) into valuable circular products.

This presentation introduces gasification as a key enabling technology for the chemical recycling of non-recyclable waste, facilitating the production of renewable fuels and circular materials.

Ecoplanta stands as an international benchmark for the application of MSW gasification, producing bio-methanol and circular methanol, contributing to climate neutrality and resource efficiency. The project exemplifies how innovation in waste management can drive the transition toward a circular economy and sustainable industrial transformation.

Biography:

Ana Filipa Almeida, Gasification Expert, Primary Conversion Senior Scientist, Repsol, Spain

Ana Filipa Almeida holds a PhD in Engineering and is an expert in thermochemical conversion processes. Since 2013, she has dedicated her career to the valorisation of residues through pyrolysis and gasification technologies. She has held positions in both the public and private sectors, including as a Scientific Researcher in the public sector, Head of Research and Development at a biomass pyrolysis company and, since 2022, as a Senior Scientist focusing on gasification. She currently belongs to the Primary Conversion team within the Industrial Transformation unit of the Technology and Corporate Venturing Division of Repsol, S.A.

Dalia García Franco, Senior Project Manager, Gasification Expert Repsol, Spain

Dalia García Franco is a Chemical engineer with a solid professional background at Repsol since 2008, having held various roles in planning, control, strategy, business development, and project management. For more than 11 years, she worked in Repsol Química, identifying collaboration opportunities with strategic partners, assessing initiatives from both technical and economic perspectives, and actively participating in negotiations and the integration of new businesses and joint ventures. Since 2018, her career has focused on developing waste valorization opportunities, initially within Repsol Química and, from 2022 onwards, in the Renewable Fuels area. She currently serves as Senior Project Manager in this area, focusing on waste transformation projects, particularly in pyrolysis and gasification technologies such as Ecoplanta. Her professional path combines technical, strategic perspectives, contributing to the advancement of innovative energy solutions aligned with the company's decarbonization goals.

~ Go to Contribution List

Energy Transition in Portugal: The Role of Bioenergy

Jaime Braga

APPB, Secretary General, Portugal

It presents the evolution of final energy consumption in Portugal between 1990 and 2023, in terms of both total amounts and greenhouse gas emission levels.

Portugal also faces the obligation to reduce its emissions to 55% of the 1990 level, with electrification set as the main priority.

The country faces the challenge of decarbonizing the transport sector and the “hard-to-abate” industrial processes.

However, it is impossible to overlook the imperative of ensuring energy competitiveness and a socially just transition.

The pace of transition and investment expenditure must be socially and economically sustainable. Relying on a single form of energy presents an unacceptable vulnerability.

Bioenergy—through biofuels and renewable gases—represents a limited but indispensable complement, due to its high level of circularity in resource utilization and its associated emission reductions.

Bioenergy provides biofuels, an essential component of the low-carbon fuels needed to decarbonize transport, as well as biomethane. Industry requires fuels, and in several of its sectors, electrification is not a feasible solution. Biomethane, being compatible with existing gas networks, offers a highly effective pathway for a fair and non-discriminatory decarbonization of industrial processes. It also provides excellent conditions for the development of a new and promising energy market while minimizing transition investment costs.

Biography:

A Mechanical Engineer from IST, he has dedicated nearly 50 years to professional activity, with more than half in the industrial sector. From 1997 to 2011, he served as a university professor at ISCTE and co-authored the book Environmental Guide – Companies, Competitiveness and Sustainable Development (2011). Throughout his career, he has actively contributed to several national bodies and commissions, including the National Council for the Environment and Sustainable Development (CNADS) and the Advisory Boards of the Energy Services Regulatory Authority (ERSE) and the Water and Waste Services Regulatory Authority (ERSAR). Currently, he is an Advisor to the Board of the Portuguese Business Confederation (CIP), a Technician at the Federation of Vegetable Oil, Derivatives and Similar Industries (FIOVDE), and Secretary-General of the Portuguese Association of Biofuel Producers (APPB). His expertise spans industrial operations, sustainability, energy, and regulatory affairs, with a strong commitment to advancing Portugal’s energy transition and bioeconomy.

~ Go to Contribution List

Thermochemical Conversion of Biomass and Wastes: Pyrolysis and Gasification

Luís António da Cruz Tarelho

Associate Professor, Universidade de Aveiro, Portugal

Thermochemical conversion of biomass to energy vectors and organic products will be analysed in this presentation. The process and technology of pyrolysis and gasification are analysed with focus on main technologies and most relevant products and some of their applications. Biomass pyrolysis for biochar, bio-oil and gas production and gasification for producer gas production will be addressed. The technology of fluidized bed reactors for combustion and gasification and auger reactors for pyrolysis processes will be analysed. The analysis is supported also with examples of extended research topics that have been developed at University of Aveiro, Portugal.

Biography:

Licentiate in Environment Engineering, and Associate Professor at Department of Environment and Planning, University of Aveiro, Portugal.

Coordinator of the Research Cluster Circular Economy, Resources and Energy Optimization at the Associate Laboratory Centre for Environmental and Marine Studies (CESAM) at University of Aveiro.

Main research expertise in biomass to energy and valorisation (material and energetic) of solid wastes and alternative gaseous fuels. Expertise in developing and optimization of thermochemical (combustion, gasification, and pyrolysis) processes and technologies for energetic conversion of biomass (including sewage sludge and solid wastes) to energy vectors and bio-products and its integration in industrial processes, and related measures to mitigate environmental impacts. Expertise in developing bench-scale facilities for processes characterisation and optimization, and prototypes and pilot-scale facilities for demonstration of the technology of thermochemical conversion of biomass to energy. Expertise in bubbling fluidised bed reactors. Collaboration with industrial partners in optimization of thermochemical conversion technology at industrial scale, and also collaboration with international R&D partners, e.g., in Sweden, Brazil, Spain.

Bioenergy Contribution to the Targets of the National Energy System and 2050 National Carbon Neutrality

Paulo Martins

Division Head for Energy Studies and Sustainability, Directorate-General for Energy and Geology (DGEG), Portugal

Portugal aims to increase the share of renewable energy to 51% in final energy consumption by 2030. Bioenergy will play a key role in achieving this target, through the deployment of advanced biofuels, sustainable aviation and maritime fuels, efficient cogeneration using biomass, and the production of biogas and biomethane from urban and agro-industrial organic waste. The efficient use and recovery of forest, agricultural, and urban biomass residues is also a strategic priority.

National energy and climate objectives are aligned with European commitments and the National Roadmap for Carbon Neutrality 2050, which identifies biomass as a critical driver of a sustainable energy transition. As an endogenous resource, biomass contributes to reducing dependence on fossil fuels and energy imports, particularly in hard-to-electrify sectors such as industry and heavy transport. Optimizing biomass harvesting and recovery operations is essential to reduce fossil carbon emissions and ensure the long-term sustainability and resilience of the national energy system.

Biography:

Paulo Martins is a Senior Technical Officer at the Direção-Geral de Energia e Geologia (DGEG) within the Division of Studies, Research and Renewables, where he contributes to national policy and analysis on sustainable energy systems. With a degree in Technological Chemistry, his research spans life-cycle thinking, carbon footprinting, and energy-economy integration. He is currently engaged in the INTAS – Industrial and Tertiary Product Testing and Application of Standards project, reflecting his focus on aligning industrial product standards with renewable energy and circular-economy goals. His recent publications include the hydrogen roadmap for Portugal and an energy-emissions modelling tool supporting the country's decarbonisation pathways. Having authored over 11 publications with more than 3,000 reads, Paulo brings both quantitative modelling expertise and policy insight to the energy-transition agenda.

~ Go to Contribution List

Day-1

Session-02 - Sustainable Biorefineries in a Circular Economy

Invited Presentations

Molecular Microbiology Contributions to Bioenergy Production and Residue Valorization

Jorge H. Leitão

University of Lisbon, Portugal

Molecular Microbiology can be defined as the study of microorganisms at the molecular level. Due to recent advances in Omics sciences, including genomics, proteomics, and others, together with the development of powerful bioinformatics tools, an amazing level of detail has been achieved concerning the metabolites, biochemical reactions, biochemical pathways, regulatory mechanisms of gene expression and of biochemical pathways within a given microorganism and populations of microorganisms. This same knowledge is starting to be exploited to design more robust and greener processes for bioenergy production and residue valorization in a circular economy context. General tools available to engineer more robust microbes towards the valorization of residues of agricultural or industrial origin will be presented. A few examples of how the knowledge of microbial population composition can be used to design more robust bioenergy production processes, both for biogas or bioelectricity production will be presented and discussed.

Biography:

Jorge Leitão received his PhD degree in Biotechnology in 1996 from Technical University of Lisbon (now University of Lisbon), Portugal. J.H. Leitão is Associate Professor of the Department of Bioengineering, Instituto Superior Técnico (University of Lisbon), Portugal, in the scientific area of Biological Sciences. Research interests are focused on Molecular Microbiology. Topics of interest include post-transcription regulation of bacterial gene expression and the roles played by small non-coding regulatory RNAs and RNA chaperones on the biology and pathogenesis of bacteria of the Burkholderia cepacia complex, exopolysacharide biosynthesis by Gram-negative bacteria, resistance to antimicrobials and development of novel antimicrobials, and the molecular characterization of microbial populations of ecological, industrial or health interest.

Biochar: From By-Product to Strategic Driver of the Bioeconomy and Carbon Sequestration

Paulo Correia

Ibero Forest Mass, Portugal

Biochar represents one of the most versatile and promising solutions at the intersection of bioenergy, agriculture, and decarbonization. Produced through slow pyrolysis of biomass, this material combines unique properties: it locks carbon in a stable form for hundreds of years, enhances soil fertility, and can substitute fossil fuels in various applications.

The experience of Ibero Massa Florestal demonstrates how the industrialization of biochar can transform environmental challenges into economic opportunities. Through innovation in production processes and international certification (ISO, EBC, DIN Plus, Global C-Sink), the company ensures traceability, quality, and measurable impact.

This presentation will explore three key dimensions:

1. Technology and quality – the role of pyrolysis, standardization, and certification in building trust in the biochar market.
2. Impactful applications – practical examples of agricultural, forestry, and energy uses, highlighting its regenerative potential and capacity to substitute fossil carbon.
3. Strategy and future outlook – biochar as a Carbon Dioxide Removal (CDR) tool, integrated into the voluntary carbon market and as a cornerstone of the circular bioeconomy.

More than a product, biochar should be understood as a strategic driver, capable of generating sustainable economic value, building climate resilience, and opening new value chains on a global scale. The challenge ahead is how to accelerate its adoption, aligning public policies, industrial innovation, and private investment to make biochar a key element of the energy transition and the bioeconomy.

Biography:

Paulo Correia has been General Director of Ibero Massa Florestal since 2023, a pioneering Portuguese company in biochar production since 2010 and in the development of solutions for bioenergy and the circular bioeconomy. With over 25 years of experience in industrial management, he holds an MBA in Business Management and a Lean Six Sigma Black Belt certification, with a focus on efficiency and innovation. At Ibero Massa Florestal, he leads the strategy for sustainable growth, integrating ESG practices and positioning the company as a European reference in Biochar Carbon Removal (BCR). Under his leadership, the company has expanded biochar applications from domestic use to regenerative agriculture and ecosystem restoration. An advocate for energy and climate transition, he has been actively engaged in promoting biochar as a strategic solution for decarbonization, soil resilience, and the creation of economic value through the bioeconomy.

~ Go to Contribution List

Fueling the Future: How Regenerative Agriculture Can Power Biogas and Circular Economies

Katja Lyons

Technical Sales Director, Bioenergy Group, Australia

Australia is uniquely positioned to harness regenerative agriculture and biogas as twin pillars of a circular economy. This presentation explores how integrating anaerobic digestion with regenerative farming creates scalable pathways for renewable energy, soil restoration, and emission reduction.

Regenerative practices, diverse rotations, reduced synthetic inputs, and improved soil health, provide sustainable feedstock while enhancing biodiversity and farm resilience. Biogas systems transform agricultural residues and organic waste into renewable gas and nutrient-rich digestate, closing loops between energy and food production.

Case studies highlight economic, environmental, and social co-benefits: lowering input costs, creating regional jobs, improving soil fertility, and reducing greenhouse gases. A roadmap for scaling this model in Australia will be outlined, addressing policy, investment, and collaboration opportunities.

Attendees will gain insight into how regenerative agriculture can power biogas development and position Australia at the forefront of sustainable circular economies.

Biography:

Katja Lyons is an Environmental Engineer with dual Master's degrees in Environmental Engineering and Sinology. With more than a decade of international experience across Europe, Asia, Africa, and the Pacific, she specialises in biogas and biomethane project development, circular economy solutions, and regenerative agriculture. At BIOGEST and Bioenergy Group, she leads initiatives that integrate anaerobic digestion with sustainable farming practices, creating scalable models for renewable energy, carbon reduction, and soil restoration.

~ Go to Contribution List

Integrated Biorefinery Approaches for the Sustainable Valorization of Olive-Derived Biomass

Eulogio Castro

Dpt. Chemical, Environmental and Materials Engineering, Institute of Biorefineries Research, Universidad de Jaén, Spain

Background: Olive cultivation and olive oil production generate large amounts of lignocellulosic residues and agro-industrial by-products that remain underexploited, despite their high potential as renewable feedstocks. Developing integrated biorefineries based on olive-derived biomass offers a unique opportunity to produce biofuels, biochemicals, and bioactive compounds while supporting the transition toward a circular bioeconomy in Mediterranean regions.

Objectives: This work aims to assess the technical, economic, and environmental feasibility of valorizing olive pruning, leaves, stones, and pomace through biorefinery strategies, with a focus on multiproduct systems that enhance resource efficiency and mitigate greenhouse gas emissions.

Methods: A combination of experimental approaches—including advanced pretreatments (e.g., organosolv, eutectic solvents, microwave- and ultrasound-assisted extraction) and downstream conversion processes—was integrated with process simulation, techno-economic analysis, and life cycle assessment to evaluate multiple valorization pathways.

Results: The results demonstrate the potential of olive residues to produce biofuels (ethanol, lactic acid, furfural), bioproducts (xylitol, biopolymers), and high-value antioxidants (hydroxytyrosol, triterpenes, polyphenols). Multiproduct configurations improved process efficiency, reduced energy demand, and enabled carbon-negative outcomes when combined with carbon capture strategies.

Conclusions: Olive biomass-based biorefineries represent a viable and sustainable route to transform agro-industrial residues into energy, materials, and bioactive compounds. Beyond their environmental benefits, such systems can foster rural development, strengthen Mediterranean bioeconomy, and contribute to climate action at regional and global scales.

Biography:

Eulogio Castro has a Ph.D. in Chemical Engineering from the University of Granada, where he also worked as a professor in undergraduate and postgraduate studies in Chemistry and Chemical Engineering. Since the founding of the University of Jaén (1993) he has served as a professor and researcher and is currently Professor of Chemical Engineering. I was also Invited Researcher at the École Nationale Supérieure de Chimie de Toulouse, France, and visiting assistant professor at the University of Florida, United States. His main research interests center on the conversion of biomass into biofuels and other value-added products and on technological and environmental aspects related to the development of the biorefinery concept.

~ Go to Contribution List

Multi-Platform Modern Biorefineries: Influence of Complexity on Sustainability

Carlos Ariel Cardona[1], Juan Felipe Hernández[2]

[1]Departamento de Ingeniería Química. Instituto de Biotecnología y Agroindustria, Colombia
[2]Universidad Nacional de Colombia sede Manizales, Colombia

In the past only Biofuels and Biomaterials were the driving force of Biorefineries based mainly on sugary platforms from Biomass. Today, several platforms are recognized as the future in new biorefineries addressing new products required in the market. So, sugar (C5,C6) from first biopolymers can be used together with lignin derivatives, oils esters, glycerol, biogas-based products, syngas products, biochar, carbon dioxide and Hydrogen as well as extractives in complex factories. The expected products like common biofuels, biomaterials and organic acids can be complemented with fertilizers, vaccines, cosmetics, antioxidants and other added value molecules. However, as the complexity of the biorefinery increases the limits imposed by the market as well as the internal competition between different valorizations possibilities stand like a barrier and the sustainability can decrease. A model example is shown in detail with sustainability characterization depending on the complexity. The results show a very interesting limits in contradiction to the well-known advantages of multi-platform and multi-product Biorefineries.

Biography:

Carlos A. Cardona is a Full Professor in the Department of Chemical Engineering at the Universidad Nacional de Colombia at Manizales, where he has served since 1995. He earned his B.Sc., M.Sc., and Ph.D. degrees in Chemical Engineering from the Moscow State Academy of Fine Chemical Technology (M.V. Lomonosov). His research focuses on non-conventional separation processes, thermodynamics, process integration, biorefineries, and sustainability analysis. Prof. Cardona has led numerous national and international projects on biofuels development and the sustainable utilization of agro-industrial wastes from Colombia, South America, and Europe. He has authored over 290 peer-reviewed publications, 19 books, and 88 book chapters, and has presented more than 300 papers at scientific conferences. Currently, he leads the Research Group on Chemical, Catalytic, and Biotechnological Processes (PQCB) and heads the Industrial Biotechnology, Biorefineries, and Sustainability research lines at the Institute of Biotechnology and Agribusiness in Manizales.

~ Go to Contribution List

Day-1

Session-04 - Pathways to Net-Zero and Negative Emissions, and Climate Change Mitigation Strategies

Invited Presentations

Biochar: from Agricultural Residues to Value

Jack Van Batenburg

Carbo Culture, Netherlands

Carbo Culture is a project developer with proprietary climate technology, building a rapidly scalable biochar removal solution. Our Northstar mission is to remove 1 billion tons of carbon dioxide from the atmosphere. With our patented Carbolysis™ reactors we convert biomass into high quality biochar, locking carbon safely away for centuries and generating renewable energy in the process. The technology combines the best of traditional pyrolysis with the best of gasification, producing a good amount of high quality biochar together with a high amount of energy. The biochar can be used in high tech horticulture to finally end up in open soil or in the steel industry to produce 'green steel' by replacing coal. The energy can be used to produce heat in boilers or combined heat and electricity in CHP's. In our third generation test facility close to Helsinki, Finland, we optimize our technology and we test all kinds of feedstock. In our vertical reactors, the feedstock is not moving. This results in coarse, stable and durable biochar with excellent properties for growing media. The ongoing flow of syngass delivers 11,7 mW energy constantly. The first commercial unit is going to be build in the hart of the Dutch Horticulture, after which we plan to scale up rapidly.

Biography:

My name is Jack van Batenburg, living in The Netherlands and working for Carbo Culture since the beginning of 2025. After studying 'horticulture' at the University of Applied Science in Den Bosch, The Netherlands, I started my career as a consultant and after that selling young plants for cut-roses. Prior to joining Carbo Culture I worked 25 years in the growing media business, focussing on coir from India and Sri Lanka. This gave me a vast experience in product development, sourcing raw materials and international B2Bsales. Within Carbo Culture I'm responsible for building the supply chain for feedstock and I'm involved in the marketing of biochar.

~ Go to Contribution List

Study of Low-Carbon Fuels in Portugal: Perspectives for 2030

Marco Marques[1], Luis Manuel Ventura Serrano[2]

[1]Polytechnic Institute of Setúbal, Portugal
[2]Polytechnic Institute of Leiria/ ADAI, Portugal

Nuno Lapa, Inês Matos, Maria Bernardo, Márcia Ventura, Marco António Ludovico Marques, Maria de Fátima Nunes Serralha, Natália Maria Ferreira Rebelo de Melo Osório, Raquel Alexandra Galamba Duarte, Paulo Miguel Marques Fontes, Luís Serrano, Helder Santos, Diogo Silva, Ricardo Almeida, Nuno António

The transport sector accounts for around 26% of Greenhouse Gas Emissions in the European Union and around 25% in Portugal, 80% of which still depends on petroleum products.

Low-Carbon Fuels produced from non-fossil and renewable raw materials (including biodiesel, Hydrotreated Vegetable Oil, Renewable Fuels of Non-Biological Origin, and biomethane) – complement electrification and are indispensable for achieving decarbonization in the transport sector.

Although Portugal has an installed value of biofuel production capacity of 770,000 m³ in 2022, actual production was only 35-40% of that value, due to dependence on imported raw materials: Used Cooking Oils, Animal Fats and oils from residues.

Between 2021 and 2024, 76–90% of national production from bio-waste and advanced biofuels showed a progressive alignment with the requirements of European Directive RED III.

Ongoing projects to develop the production of Hydrotreated Vegetable Oil and Sustainable Aviation Fuels, will be crucial to meeting the minimum quota of 5.5% for advanced biofuels and Renewable Fuels of Non-Biological Origin by 2030.

Cautious, Moderate, and Ambitious were the three scenarios that were assessed for integrating renewable energy into transportation, representing, respectively, 21.2%, 26.9%, and 39.5%. Only the latter can guarantee an achievement of the required target of 29%.

With an average age of 15.5 years in 2023, heavy vehicles—which rely almost entirely on diesel—are particularly affected by the aging of the country's fleet. It is anticipated that liquid fuel usage would rise by 2030.

Portugal has the technical conditions and endogenous resources to meet the European targets for 2030. However, the success of the transition will depend on firm political decisions capable of mobilizing investment, ensuring regulatory predictability, and promoting a balanced strategy between electrification, advanced biofuels, and Renewable Fuels of Non-Biological Origin.

Biography:

Luís Manuel Ventura Serrano holds a PhD in Mechanical Engineering from the University of Coimbra, where he also completed his Master's and Bachelor's degrees in Thermodynamics and Fluids. His research focuses on fuels and combustion, particularly biofuels such as biodiesel and biomethane, as well as LPG, natural gas, and fuel additives. A researcher at ADAI since 1995, he has also served as Assistant and Adjunct Professor at the Polytechnic Institutes of Viseu and Leiria. He coordinated automotive engineering programs, led ADAI's Leiria research unit, and presided over the Pedagogical Council (2021–2023). He has authored over 50 publications, two book chapters, and holds one patent.

Day-1

Session-01 - Bioenergy Production, Value Chain and End-use

Oral Presentations

Variations in the Pyrolytic Devolatilization Kinetics of Rice Husks and Oak Wood Sawdust in Response to Particle Size

Timothy Namaswa[1,2,3,4*], David F.R.P. Burslem[1,2], Jo Smith[1], Roberto Volpe[5], Afzal Waheed[4]

[1]School of Biological Sciences, University of Aberdeen St Machar Drive, Aberdeen, Scotland, UK AB24 3UU.
[2]Interdisciplinary Institute, University of Aberdeen, King's College, Aberdeen, Scotland, UK AB24 3FX
[3]National Forest Products Research Programme, Kenya Forestry Research Institute, P. O. Box 64636 – 00620, Nairobi, Kenya.
[4]School of Engineering, University of Aberdeen, Fraser Noble Building, Aberdeen, Scotland, UK AB24 3UE
[5]School of Engineering and Materials Science, Queen Mary University of London, Mile End Road London, E1 4NS.

Under optimal conditions, pyrolysis kilns in Sub-Saharan Africa can achieve over 50% yield, but actual pyrolysis yield is in the range of 10 to 30%. Designing simple, efficient and affordable pyrolysis kilns for use in this region requires information about devolatilization kinetics of biomass materials for process simulation. Therefore, this study determined the true pyrolytic devolatilization kinetics of biomass feedstock for simulation purposes. Rice husks and sawdust with particle sizes of <0.12, 0.12-0.25, 0.25- 0.35 and mm were pyrolyzed at five heating rates (4, 10, 20, 30 and 40°C min^{-1}), to three setpoint pyrolysis temperatures (500, 600 and 700°C), in a thermogravimetric analyser under a 60 ml min^{-1} nitrogen gas flow. Thermal behaviours were analysed using the maximum rate of mass loss and peak temperatures. The maximum rate of mass loss ranged from -0.06 to -0.55% s^{-1} for rice husk and -0.07 to -0.65% s^{-1} for. The pyrolytic peak temperatures of rice husks and black oak wood sawdust increased significantly in response to heating rate and particle size. The Friedman model gave an activation energy range of 150 to 202 kJ mol^{-1} for rice husk and 145 to 198 kJ mol^{-1} for sawdust at conversions of 0.2 to 0.8, with the Vyazovkin model giving statistically identical results. There were statistically significant effects of particle sizes on the activation energy. However, Tukey's hsd test showed the pyrolytic activation energy of rice husks and sawdust of particle sizes of <0.12 and 0.12-0.25 mm were not significantly different. Particle size had no significant effect on the pre-exponetial factors of rice husks and sawdust. We therefore, the activation energy of rice husks (150 -163 kJ mol^{-1}) and sawdust (145-159 kJ mol^{-1}) at conversions of 0.2 to 0.8 are true for simulation biomass of pyrolysis kilns

Biography:

Timothy (Wekesa) Namaswa is a doctoral student in Plant Sciences at the University of Aberdeen, Scotland, specializing in biochar production and fuel briquetting. With over six years of experience as a Research Scientist at the Kenya Forestry Research Institute, he focuses on the sustainable utilization of organic residues to produce biochar and clean fuel briquettes aimed at mitigating climate change and improving resilience to climate shocks. He holds a Master's degree in Bioenergy and Environment from the University of Eldoret and is actively engaged in research on renewable energy, biomass valorization, and low-carbon energy solutions.

~ Go to Contribution List

Production and Chemical Characterization of Biocrude Oil from Hydrothermal Liquefaction (HTL) of Sludge Anaerobic Digestates

David Gbenga Oke[1,2], Giovanni Manente[1], Giuseppe Mele[1]

[1]Department of Engineering for Innovation, University of Salento, Lecce, Italy.
[2]Industrial Chemistry Programme, Department of Agriculture, Engineering and Science, Bowen University, Iwo, Nigeria.

Global urbanization and population growth present several issues, among which is the disposal of sewage. Anaerobic digestion (AD) is one of the most important measures of sewage valorization, yet it results in significant production of digestate that is commonly sent to landfill. Accordingly, a hybrid conversion process composed by AD and hydrothermal liquefaction (HTL) in sequence has been proposed by some researchers.

This research is aimed at the production and chemical characterization of biocrude oil from sewage sludge digestate using a 500 mL PARR chemical reactor. The sludge digestate collected from a local wastewater facility in the south Apulia region with a 15% solid loading (digestate to water percentage) is fed into the bench scale reactor carrying out several tests, where temperatures, reaction times and solid loading are varied to achieve maximum biocrude yield. Ethyl acetate is used for the separation of biocrude from hydrochar and the products are characterised with FTIR, GCMS and ^{1}H and ^{13}C NMR.

The results showed that HTL at 300°C at 30 minutes residence time produced the highest biocrude yield of 24 wt.%. The results of the chemical characterization highlight the conditions with the highest quality of biocrude when hydrotreatment is considered as a further upgrading technique.

Biography:

Dr. David Gbenga Oke is a dedicated teacher and researcher, currently serving as a Postdoctoral Research Fellow at the University of Salento, Lecce, Italy. With a PhD in Natural Product and Synthetic Chemistry, he brings extensive expertise in analytical and environmental chemistry. Dr. Oke has been a Chemistry Lecturer at Bowen University, Nigeria, since 2013 and previously worked as a researcher, teacher, trainer, and administrative officer across various institutions. His work focuses on sustainability, environmental pollution, and natural product chemistry. Known for his commitment, leadership, and multilingual abilities, he strives for excellence in all his academic and professional endeavors.

~ Go to Contribution List

Co-Pyrolysis of Orange Peels with Renewable Agro-Wastes for Sustainable Biofuel Synthesis

Emna Fassatoui[1,2,3], Khaled Loubar[1], Sana Kordoghli[3,4], Jean François Largeau[1,5], Fethi Zagrouba[3]

[1]*IMT Atlantique, GEPEA UMR CNRS 6144, Nantes, France*
[2]*National school of Engineering of Monastir, University of Monastir, Tunisia*
[3]*Research Laboratory for Sciences and Technologies of Environment LR16ES09, University of Carthage, Tunisia*
[4]*National School of Advanced Sciences and Technologies, ENSTA- Borj Cedria, University of Carthage,Tunisia*
[5]*Icam Ouest, 35 rue du Champ de Manœuvres, 44470 Carquefou, France*

This study investigates the pyrolysis and co-pyrolysis of orange peels alongside typical agro-biomass residues, such as peanut shells and coffee grounds. Based on their equal

weight percentage, the selected samples were combined with orange peels in a 50:50 wt% ratio. Two technological configurations were employed: a batch and a semi-batch setup, both at the laboratory scale. Comparative analysis was then performed to evaluate the technology impact in term of yields and characteristics of the by-products retrieved after pyrolysis. With the experiments progressing from batch to semi-batch configuration, the volatile byproduct yield, including bio-oil and syngas, exhibited a notable increase, averaging a maximum of 79% for orange-peanuts mixture. The semi-batch technology demonstrated an enhanced conversion efficiency for both condensable and noncondensable fractions by promoting more extensive cracking reactions. Subsequently, emphasis was placed on the semi-batch configuration due to its ability to ensure high-quality syngas production. As regards to pure biomass pyrolysis, orange peels generated the largest gas fraction (38.83 wt%) owing to their high volatile content. The co-pyrolysis outcomes further indicated that the combination of orange peels with the other residues had a significant impact on the thermochemical behavior, resulting in an increased syngas yield. Namely, gas fractions reached 48.90 wt% for the orange-coffee mixture and 54.20 wt% for the orange-peanuts blending. Particularly, the incorporation of orange peels produced innovative mixtures that achieved maximum hydrogen production earlier than the individual biomass processing. Regarding bio-oil composition, the established blends yielded higher hydrocarbon concentrations. For instance, the orange-coffee blend promoted alcohol formation, which are scarce in pure coffee grounds. Similarly, the orange–peanut mixture showed a significantly increased acid content (31.86%) compared to separate peanuts. These findings highlight the synergistic potential of co-pyrolysis as an innovative strategy for sustainable biofuel synthesis.

Biography:

Emna Fassatoui is a PhD candidate in Process Engineering at IMT Atlantique, specializing in energy systems, clean technologies, and sustainable biomass valorization. Her research focuses on thermochemical conversion processes, particularly pyrolysis and co-pyrolysis of agro-wastes for the production of hydrogen-rich syngas, bio-oil, and biochar. With strong expertise in renewable energy, process optimization, and advanced reactor design, Emna has contributed to multiple scientific publications and international conferences. She has prior experience in biomass hydrogen generation, petroleum distribution systems, and electronic design internships. Passionate about sustainable innovation, she aims to advance efficient, low-carbon energy solutions for a circular and resilient bioeconomy.

~ Go to Contribution List

Fuel Properties of Diesel and Gasoline Blends with Olive Pomace-Derived Bio-Oil for Partial Fossil Fuel Substitution

Catarina Marques[1], Nídia Caetano[2,3], Luís Tarelho[1], Maria Isabel Nunes[1*]

[1]Centre for Environmental and Marine Studies (CESAM), Department of Environment and Planning (DAO), University of Aveiro, Aveiro, Portugal
[2]Laboratory for Process Engineering, Environment, Biotechnology and Energy (LEPABE), Faculty of Engineering, University of Porto, Porto, Portugal
[3]Centre of Innovation on Engineering and Industrial Technology/IPP-ISEP (CIETI), Faculty of Engineering, University of Porto, Porto, Portugal

The search for sustainable energy alternatives has driven interest in converting residual biomass into usable fuels. Olive pomace, an abundant agro-industrial waste in Mediterranean countries, represents a promising feedstock for bio-oil production through pyrolysis. This study aims to evaluate the technical feasibility of incorporating olive-pomace-derived bio-oil into conventional fossil fuels at a 5 wt.% blending ratio and to determine how different condensation strategies for recovering bio-oil fractions affect compatibility. Two bio-oil fractions were obtained through pyrolysis at 550 °C and recovered using different condensation strategies: (i) a single-temperature system (SBO), and (ii) a fractional system with four decreasing temperatures, with fraction collected at the highest temperature selected for testing (FBO). The resulting blends were analyzed for density, kinematic viscosity, copper strip corrosion, flash point, and cold filter plugging point (CFPP), and results were compared against European standards.

Results showed greater compatibility between the bio-oils and gasoline, with effective incorporation exceeding 4 wt.%. In contrast, diesel blends experienced phase separation, particularly with FBO, which reduced the miscible fraction to only 1.77 wt.%. All blends exhibited a modest increase in density but remained within regulatory limits. Viscosity changes were minimal in gasoline blends but more pronounced in diesel blends, though still compliant with standards. The addition of bio-oil increased the flash point by 5–6 °C, which can be considered beneficial for handling safety. However, the CFPP of diesel blends worsened considerably, compromising their cold-weather performance. Corrosion testing revealed compatibility issues, with only the gasoline blended with SBO bio-oil meeting the required specifications.

Overall, the gasoline blend with SBO showed the most promising performance across all evaluated parameters, suggesting its potential as a viable option for partial fossil fuel substitution. However, further studies are needed to fully characterize its fuel properties and

International Conference on Bioenergy and Bioeconomy to assess engine performance and associated environmental impacts before practical implementation can be considered.

Biography:

Catarina Marques is an experienced researcher specializing in biomaterials, tissue engineering, and marine biotechnology. She holds a PhD in Materials Science and Engineering from the University of Aveiro, where she developed calcium phosphate scaffolds using robocasting for bone regeneration. At the 3B's Research Group, University of Minho, she has focused on creating innovative 3D-printed composite biomaterials derived from marine resources and biopolymers for regenerative medicine. Her work includes supervising MSc students, contributing to international research projects, and organizing scientific events. With over 25 publications and an h-index of 12, Catarina brings strong expertise in biomaterials innovation and cross-disciplinary collaboration.

~ Go to Contribution List

Evaluating the Interdependence of Solid Biofuels Properties: A Comparative Data-Based Analysis Across Five Fuel Types

André Pires[1], Elsa Cancela[2], Neuza Alves[2], Teresa Almeida[1], Sónia Figo[1], Luís Gil[3]

[1]Unidade de Biomassa, Centro da Biomassa para a Energia, Miranda do Corvo, Portugal
[2]Laboratório de Ensaios, Centro da Biomassa para a Energia, Miranda do Corvo, Portugal
[3]Direção-Geral de Energia e Geologia, Lisboa, Portugal

Understanding the interrelationships between the physicochemical properties of solid biofuels is essential for optimizing their use in energy recovery systems. This study presents a comprehensive statistical analysis of correlations between key fuel parameters — including ash content, carbon and hydrogen content, moisture content, lower heating value (LHV), bulk density, and particle size — across five common biomass fuels: forest residues, wood chips, wood pellets, wood briquettes, and sawdust. Drawing from an extensive dataset generated through laboratory analyses conducted by the Biomass Centre for Energy (CBE), linear and polynomial regression models were applied, and the strength of correlations was evaluated using the coefficient of determination (R^2) and significance level ($p < 0.05$).

The results reveal consistently strong correlations between moisture content and LHV (as received basis) in all biomass types, confirming moisture as a critical factor affecting energy performance. Similarly, the sum of carbon and hydrogen contents showed high predictive power for LHV (dry basis), particularly in forest residues. In contrast, other relationships, such as ash content versus LHV (dry basis), bulk density or particle size, were not consistent across all fuels. Notably, in wood chips, certain non-linear relationships yielded stronger fits, suggesting that second- or third-degree polynomial models may be more appropriate for some property interactions.

This analysis offers valuable insights for the bioenergy sector, highlighting which properties are most interdependent and therefore most relevant for quality control, fuel selection, and standard development.

Biography:

André Pires is a Biologist and Environmental Engineer committed to advancing sustainability and the circular bioeconomy. He works at the Biomass Center for Energy, contributing to European projects that promote the sustainable valorization of natural resources, with a particular focus on rural regions. Alongside his professional work, he recently completed a second degree in Biology at the University of Coimbra, driven by his passion for understanding living systems and their relevance to today's environmental challenges. With strengths in scientific analysis, project management, communication, and interdisciplinary collaboration, André strives to develop innovative, regenerative solutions that support a more sustainable and nature-aligned society.

Re-Feed: Renewable Energy Production at Farm Level for Energy Efficiency and Defossilization

Rita Fragoso[1*], Miguel Nogueira[1], João Bastos[2], Paulo Brito[3], Olga Moreira[4], E. Duarte[1]

[1]LEAF- Linking Landscape, Environment, Agriculture and Food Research Center, Associate Laboratory TERRA, Instituto Superior de Agronomia, Universidade de Lisboa, Tapada da Ajuda, 1349-017 Lisboa, Portugal
[2]Federação Portuguesa de Associações de Suinicultores (FPAS), Montijo, Portugal
[3]VALORIZA - Centro de Investigação para a Valorização de Recursos Endógenos, Instituto Politécnico de Portalegre.
[4]Pólo de Inovação da Fonte Boa, Instituto Nacional de Investigação Agrária e Veterinária, Quinta da Fonte Boa, 2005-048, Portugal

Agricultural activities generate substantial organic waste, including crop residues, animal manure or slurry, and food processing by-products. Transforming these materials into bioenergy is essential for minimizing waste and generating renewable energy. Utilizing biomass for energy helps decrease dependence on fossil fuels, lowers operational costs, and reduces carbon emissions, supporting climate goals at both national and international levels.

Integrating bioenergy solutions into agriculture by utilising residual biomass is an essential strategy for combating climate change. The pig sector holds significant economic value and is vital for food self-sufficiency. Moreover, the pig sector has considerable energy needs and generates large quantities of pig slurry, which require efficient management.

The RE-FEED project addresses these challenges by: (i)Promoting energy efficiency through audits and tailored measures at pig farms, (ii) Developing strategies to convert pig slurry into energy and safe organic fertilizer, and (iii) Demonstrating farm-scale anaerobic codigestion of pig slurry and agri-food biomass.

RE-FEED also seeks to empower farmers by supporting the development of energy communities and promoting renewable technologies such as biogas and solar power. These solutions provide sustainable energy, reduce costs, and create opportunities for carbon credit sales. However, challenges like high initial costs and regulatory barriers still exist. Government support, financial incentives, and technical assistance are vital for their adoption.

Project RE-FEED expected outcomes include improved energy efficiency, reduced emissions, sustainable waste management, and economic benefits for farmers, highlighting the environmental, economic, and social advantages of renewable energy in the agriculture sector.

Acknowledgements: RE-FEED is financed by PRR/IFAP/Agendas Mobilizadoras para a Inovação Empresarial - R&D+I Projects (N.o 19/C05-i03/2022 – PRR- C05-i03-I-000248)

Biography:

Rita Fragoso is an Assistant Professor at the Instituto Superior de Agronomia, Universidade de Lisboa, and a member of the EIP-AGRI Focus Group on Renewable Energy on Farm. With over two decades of experience, she works extensively as an environmental consultant, ISO 14001:2015 lead auditor, and trainer in environmental management, chemistry, and food technology. Her expertise spans bioenergy production from agro-industrial waste, environmental performance assessment, industrial water-use auditing, waste minimization, and the design of efficient wastewater treatment systems. Rita also contributes to research projects on sustainable agriculture and livestock emissions, combining scientific rigor with practical solutions for environmental sustainability.

~ Go to Contribution List

Computational Modeling of Biomass–Plastic Co-Gasification for Green Hydrogen Production

Oliveira Mateus, Eliseu Monteiro, Abel Rouboa

FEUP – Porto, Portugal

The transition to sustainable energy systems demands efficient technologies capable of converting waste resources into clean fuels. This study presents a computational investigation of the co-gasification of agricultural residues and plastic waste as a promising route for producing hydrogen-rich syngas. A 24 kWe downdraft gasifier was modeled using Aspen Plus® to simulate and optimize process performance under varying operating conditions. The model was validated against experimental data, demonstrating strong agreement in predicting syngas composition and overall thermal efficiency. Simulation results reveal that incorporating 10–20% plastic waste into the biomass feed enhances hydrogen yield by up to 12% while maintaining stable gasification behavior and low tar formation. These findings underscore the potential of biomass–plastic co-gasification as an effective strategy to couple waste valorization with renewable hydrogen production, supporting circular economy principles and global decarbonization goals.

Biography:

Prof. Dr. A. Rouboa is a distinguished academic at the Faculty of Engineering, University of Porto, and a long-standing Visiting Professor at the University of Pennsylvania. With expertise in fluid dynamics, heat transfer, combustion, and renewable energy, he leads an active CFD research group and has supervised numerous Ph.D. and Master's students. His work spans biomechanics, applied energy systems, and advanced gasification modeling validated through semi-industrial facilities. Over his career, he has contributed 12 book chapters and 64 ISI-indexed papers and has led several nationally and internationally funded R&D projects focused on sustainable and innovative energy solutions.

~ Go to Contribution List

Day-1

Session-02 - Sustainable Biorefineries in a Circular Economy

Oral Presentations

Disrupting Bacterial Cellulose Production: A Cost-Effective and Sustainable Solid-State Fermentation Process Using Agro-Industrial Waste

Kamaljit Sood

Sainc Biotech, SAINC ENERGY LIMITED, United Kingdom

Bacterial cellulose (BC) is a remarkably pure and versatile biomaterial with significant potential in high-value markets ranging from medical wound care to sustainable food packaging. However, its commercial scalability has been consistently hampered by the high cost and resource intensity of traditional submerged fermentation (SmF) methods. This presentation will detail a breakthrough Solid-State Fermentation (SSF) process that fundamentally disrupts this paradigm. By leveraging low-value agro-industrial waste streams such as fruit waste and sugarcane bagasse as feedstock, our patented SSF system achieves a dramatic leap in efficiency and sustainability. We demonstrate a doubling of yield to 15-20g/L and a halving of fermentation time to just 5-7 days compared to SmF. Most significantly, this process reduces operational costs by an estimated 50%, achieving a production cost of approximately $8/kg. This positions bacterial cellulose not as a niche specialty chemical, but as a cost-competitive, sustainable material ready for widespread adoption, effectively closing the loop between agricultural waste and advanced biomaterial production.

Background Information

- **Background:** Bacterial cellulose (BC) is a high-purity polymer with superior properties for medical, cosmetic, and food applications. However, its widespread adoption is hindered by the high production costs of conventional submerged fermentation (SmF), which relies on expensive substrates and energy-intensive processes.
- **Objective:** This presentation introduces a novel, patented Solid-State Fermentation (SSF) process to overcome these economic and sustainability barriers.
- **Methods:** Our method utilizes agro-industrial side streams (e.g., fruit waste, sugarcane bagasse) as low-cost feedstock. A high-yield strain of *Komagataeibacter xylinus* is cultivated under controlled SSF conditions (25-30°C, 70% humidity) in a specially designed bioreactor system.
- **Results:** The SSF process demonstrates a dramatic improvement over SmF, achieving yields of 15-20g/L—double that of traditional methods—while reducing fermentation time by 50% (5-7 days). Crucially, it slashes operational costs by approximately 50%, achieving a production cost of $8/kg versus $15/kg for SmF, primarily due to minimal water usage, lower energy for aeration, and waste valorization.
- **Conclusion:** This SSF technology represents a paradigm shift in BC production, offering a scalable, cost-competitive, and circular bio-manufacturing route. It unlocks the potential for BC to become a widely adopted sustainable material across multiple high-value industries.

`

Biography:

Kamaljit Sood is an accomplished entrepreneur, engineer, and innovator with over 40 years of experience spanning clean technologies, renewable energy, biotechnology, and publishing. As Founder and CEO of BIOXYTOL SL and Sainc Energy, he has led the development of advanced biomass processing technologies, continuous-flow pretreatment systems, and enzyme-driven biotransformation processes. His work includes pioneering yeast-enzyme platforms, hemicellulose extraction methods, and affordable biorefinery designs tailored for developing regions. With a background in nuclear safety engineering and hybrid computing, he has guided major projects in coal, gas, and renewable energy sectors. He also founded Wimbledon Publishing Company, expanding global academic publishing.

~ Go to Contribution List

From Residual Yeast to Hydrochar: Exploring Sustainable Bioprocesses Within the Sugar-Energy Sector

Fanny Machado Jofre, PhD

Escola de Engenharia de Lorena, Universidade de São Paulo (EEL-USP), Brazil

The global energy transition is redefining how resources and residues are managed. In this context, the sugar-energy sector has the potential to transform into a biorefinery model capable of producing biofuels, biochemicals, and biomaterials within the context of circular bioeconomy. In this sense, lignocellulosic biomass from sugarcane by-products, such as bagasse and straw, is a valuable feedstock for bioprocesses. However, the utilization of its carbohydrates in the form of hydrolysates for fermentation processes is limited by toxic compounds released and/or generated during the hydrolysis, that impairs yeast growth, process efficiency and yield. Innovative strategies should be explored in science to reduce the concentration of these inhibitors and enable efficient conversion of lignocellulosic biomass into high value-added products. One promising approach is the reutilization of Saccharomyces cerevisiae, an industrial yeast produced at large scale in beverage fermentation and ethanol production. When subjected to hydrothermal hydrolysis, this biomass can be converted into yeast-based hydrochar, a material with high surface area, capable of adsorbing inhibitory compounds from sugarcane hydrolysates, including phenolics, furans, and organic acids. By transforming residual yeast biomass into hydrochar, this approach offers a sustainable opportunity to detoxify lignocellulosic hydrolysates and address a key bottleneck in bioprocesses, presenting an opportunity to improve efficiency and sustainability in circular bioeconomy biorefineries.

Biography:

Fanny Machado Jofre is a researcher in Industrial Biotechnology with expertise in lignocellulosic biomass valorization, yeast fermentation, and bioprocess optimization. She holds a PhD from the University of São Paulo (USP), where she worked extensively on xylitol production, biomass pretreatment, and advanced material characterization. Her experience includes research internships in Portugal focusing on hydrothermal hydrolysis and biochar production. In addition to her scientific work, she has taught Cell Biology, Histology, and Genetics, strengthening her skills in academic instruction and mentorship. She is currently engaged in postdoctoral research at USP and is open to opportunities in biotechnology, bioprocess engineering, and sustainability.

Day-1

Session-03- Sustainable feedstock Supply and Integration

Oral Presentations

Unlocking Full Value from Biomass: Scale-Up of an Integrated Biorefinery for the Co-Production of Xylooligosaccharides, Xylose, and Lignocellulosic Streams

Kamaljit Sood

Sainc Biotech, SAINC ENERGY LIMITED, United Kingdom

The transition to a circular bioeconomy necessitates the development of integrated biorefineries that maximize the value extracted from lignocellulosic biomass. The history of biorefining is littered with several failed mega-projects costing hundreds of millions of Euros in public money, in the EU and in the USA. This presentation outlines a fundamentally different and de-risked approach: a medium-scale, integrated biorefinery designed for strong profitability for mid-size companies, not mega-corporations. Moving beyond single-output processes, we present a scalable and economically viable platform for the holistic fractionation of biomass (e.g., agricultural residues and woody biomass). This presentation will detail our proven scale-up services for a cascading valorization process that sequentially isolates high-value components with minimal waste.

The integrated process begins with a mild, optimized autohydrolysis step to solubilize hemicellulose. Our project favors the greeneer autohydrolysis, although it can equally be used for mild acid hydrolyis. This stream is then refined to produce three distinct product lines: extractives (flavonids and terpenes) high-purity Xylooligosaccharides (XOS), a high-value prebiotic for the food and feed industries, and Xylose for chemical or biofuel production. The remaining solid fraction undergoes further separation to recover valuable extractives (e.g., phenolics, resins) before a final fractionation step yields a high-quality cellulose pulp and a technically sound lignin.

Critically, this model operates on a capital expenditure (Capex) in the low eight-figure range, making it a strategically viable investment. By leveraging in-house design expertise and selective technical outsourcing, we have developed a project blueprint with a confirmed Capex that is 30-50% lower than quotations from standard EPC firms. This substantial discount is achieved through optimized process integration and pragmatic engineering, avoiding the over-design that plagues larger projects. This work demonstrates a practical and investable pathway for transforming heterogeneous biomass into a suite of marketable bioproducts, de-risking the commercial-scale deployment of advanced biorefining technologies.

Our project and its concomitant services begin with techno-economic analysis, demonstrating that profitability is not contingent on speculative, massive scale but on smart, integrated processing and realistic capital costs, offering a clear and achievable path to success in the bioeconomy.

Biography:

Kamaljit Sood is an accomplished entrepreneur, engineer, and innovator with over 40 years of experience spanning clean technologies, renewable energy, biotechnology, and publishing. As Founder and CEO of BIOXYTOL SL and Sainc Energy, he has led the development of advanced biomass processing technologies, continuous-flow pretreatment systems, and enzyme-driven biotransformation processes. His work includes pioneering yeast-enzyme platforms, hemicellulose extraction methods, and affordable biorefinery designs tailored for developing regions. With a background in nuclear safety engineering and hybrid computing, he has guided major projects in coal, gas, and renewable energy sectors. He also founded Wimbledon Publishing Company, expanding global academic publishing.

~ Go to Contribution List

Can Biomass from Peatlands Be a Future Source of Renewable Raw Materials for Sustainable Products?

Ralf Pecenka[1], Carsten Lühr[1], Florian Wolter[1], Karina Michalska[2], Monika Heiermann[2]

[1]System Process Engineering, Leibniz Institute for Agricultural Engineering (ATB), Potsdam, Germany
[2] Technology Assessment, Leibniz Institute for Agricultural Engineering (ATB), Potsdam, Germany

Rewetting of drained peatlands to reduce GHG emissions is an issue that affects many European countries and an agricultural area of more than 50 million hectares in the EU until 2045. This not only poses enormous challenges for agriculture, but also offers great potential for biomass production as this land can no longer be used for common crop production in the near future. Therefore, ATB investigates together with partners from industry the opportunities to use grass-like biomass from peatland (paludi-biomass) as alternative raw material for products, which are currently produced particularly from wood, miscanthus, cereal straw or maize. Until now, most promising options are to use paludi-biomass for geotextiles and insulation, to produce fibres for paper and cardboards or using it for substitution of peat in growing substrates or for biogas production. Some of these developments are already tested at practice scale and are very promising. For example, on basis of a novel continuous thermo-mechanical pulping technology developed at ATB, paper from paludi-biomass could be produced that achieves approx. 90% of the tensile strength of conventional recycling paper. Results of this research as well as the next steps for putting these new value chains into practice will be presented.

Biography:

Dr.-Ing. Ralf Pecenka is the Work Group Leader for Process Engineering for Energy Crops at the Leibniz Institute for Agricultural Engineering and Bioeconomy (ATB). His research focuses on sustainable biomass production, including agroforestry systems, short rotation coppice, and paludiculture on rewetted peatlands. He specializes in harvesting, storage, drying, milling, and thermo-mechanical processing of agricultural lignocellulose, as well as the production of pellets, briquettes, and fibres. His work includes environmental and economic assessments, energy and carbon balance analyses, and the development of innovative biomass value chains. He serves on multiple scientific committees and acts as an ombudsperson for good scientific practice.

~ Go to Contribution List

Advancing Algal Biorefineries: From Micro/Macroalgae to Added-Value Bioproducts in a Single-Step Conversion

Pedro L. Martins1,[2], Cristiana Andrade[1], Luís C. Duarte[1], Carla Motta[3], Cristina Oliveira[1], Alberto Reis[1], Helena Pereira[2], Florbela Carvalheiro[1*]

[1]Unidade de Bioenergia e Biorrefinarias, LNEG - Laboratório Nacional de Energia e Geologia, I.P., Estrada do Paço do Lumiar, 22, 1649-038, Lisboa, Portugal

[2]Centro de Estudos Florestais, Laboratório Associado TERRA, Instituto Superior de Agronomia, Universidade de Lisboa, Tapada da Ajuda, 1349-017 Lisboa, Portugal

[3]Departamento de Alimentação e Nutrição, INSA-Instituto Nacional de Saúde Doutor Ricardo Jorge, Avenida Padre Cruz, 1649-016 Lisboa, Portugal

Algae (microalgae and macroalgae) have been increasingly recognized as strategic for biorefineries due to their sustainability and versatility as regenerative bioresources, as they can be produced on non-arable land, even utilizing wastewater, while sequestering CO_2.

Macroalgae, also referred to as seaweeds, are large, multicellular organisms, while microalgae are microscopic, single cell organisms, with both groups presenting significant differences in relation to cellular complexity, (bio)chemical composition, and facing distinct challenges regarding cultivation, harvesting and utilization. As compared to vascular plants (the traditional biorefinery feedstock), both types of algae present cell wall devoid of true lignin, which potentially simplifies their utilization in the biorefinery, but there is still a shortage/lack of techno-scientific know-how regarding their selective fractionation and upgrade.

This work systematically reviews the use of three hydrothermal-based technologies (autohydrolysis, dilute acid hydrolysis (DAH), and inorganic salts-catalysed hydrolysis, ISH) developed to produce added-value bioproducts, aiming at a single-step conversion of *Scenedesmus obliquus* (microalgae) and *Ulva lactuca* (macroalgae), chosen as model feedstocks given their high productivity and chemical composition.

The autohydrolysis enabled a similar sugar recovery yield of 50% mainly as oligomers 92% and 87%, respectively, for the micro- and macroalgae. DAH enabled a decrease in the reaction temperature and improved kinetics, producing a similar 50% sugar recovery yield for microalgae (91% oligosaccharides) but a higher sugar recovery of 83% for macroalgae (86% as oligosaccharides). Furthermore, these treatments retain almost all of the initial protein content of the biomass, and its valuable amino acid composition was also evaluated.

As U. lactuca presented a better performance regarding sugar recovery, putatively attributed to its less-recalcitrant call wall, it was geared for ISH processing to produce furans. This led to an increase in sugar solubilization to a maximum of 84% resulting in 100% xylose, 36% glucose, and 46% rhamnose conversion to the respective furans: furfural, 5-HMF, and 5-MF.

Integration of these processes can strengthen the competitiveness of algal biorefineries, contributing to resource-efficient systems aligned with the goals of the blue bioeconomy and climate change mitigation.

Biography:

Pedro L. Martins is a PhD student at the National Laboratory of Energy and Geology (LNEG), focusing on the valorization of microalgal and macroalgal biomass for sustainable biorefineries. His research centers on advanced biomass fractionation, hydrothermal processing, and the extraction of value-added compounds including proteins, carbohydrates, and furans. With experience in microalgae cultivation, subcritical water extraction, and inorganic salt–assisted pretreatments, Pedro aims to enhance the efficiency and sustainability of algae-based conversion processes. He has published several peer-reviewed studies and actively contributes to scientific dissemination through conferences and collaborative research initiatives. Pedro's work supports innovation within the emerging bioeconomy.

~ Go to Contribution List

Biorefinery of Chestnut Burrs: A Promising Feedstock for Sustainable Production of High Value-Added Biomolecules

Iván Costa-Trigo[1], José Manuel Domínguez[2], Nelson Pérez Guerra[3]

[1]Unidade de Bioenergia e Biorrefinarias, LNEG – Laboratório Nacional de Energia e Geologia, 1649-038 Lisboa, Portugal

[2]University of Vigo, Campus Auga, Industrial Biotechnology and Environmental Engineering Group "BiotecnIA", Chemical Engineering Department, 32004 Ourense, Spain

[3]Department of Analytical and Food Chemistry, Faculty of Sciences, University of Vigo (Campus Ourense), As Lagoas s/n, 32004 Ourense, Spain

Castanea sativa, widely cultivated in southern Europe, generates significant agro-industrial residues during chestnut processing, including leaves, pruning, shells, and burrs. Among these, chestnut burrs (CB) stand out for their high polysaccharide content and potential for biorefinery applications. This work explores a multi-step valorization strategy to convert CB into culture broths, organic acids, bacteriocins, and biosurfactants.

Initial acid hydrolysis of CB biorefinery was subjected under optimized conditions (130 °C, 3% H_2SO_4) yielded up to 22.6 g/L of xylose, with activated charcoal effectively removing inhibitory compounds. Detoxified hydrolyzates supported the growth of lactic acid bacteria (LAB), achieving efficient lactic acid production.

Further studies investigated focused on adsorption mechanisms of phenolic compounds using activated charcoal, confirming Langmuir isotherm and pseudo-second-order kinetics. The best removal (95.5%) occurred at 30 °C and 5% of charcoal. Lactobacillus plantarum produced bacteriocins, lactic acid, and biosurfactants, with superior yields in detoxified hydrolysate in bioreactor (2L).

To enhance saccharification, alkaline hydrolysis (PH120) was applied to prehydrolysis pretreated CB. Fermentation of enzymatic hydrolyzates at different pH levels showed the highest bacteriocin yield (9.21 BU/mL) at pH 6.0 with nutrient supplementation, outperforming commercial MRS media.

Finally, a novel green pretreatment using cholinium chloride–urea deep eutectic solvent (DES) was optimized in other biorefinery approach, reaching ~40% delignification and improving glucan and xylan recovery. DES-treated CB and washed CB released over 12 g/L of sugars, supporting efficient LAB fermentation.

Overall, this integrated approach demonstrates a sustainable and scalable biorefinery model using underutilized chestnut burrs to produce high-value biomolecules, contributing to circular bioeconomy development.

Biography:

Iván Costa Trigo is a Junior Researcher at the National Laboratory of Energy and Geology (LNEG) in Lisbon, where he contributes to projects focused on environmental management, sustainable resource use, and energy-related environmental assessment. He holds a Master's degree in Agro-Food and Environmental Science and Technology from the Universidade de Vigo, building on a Bachelor's in Environmental Sciences from the same institution. Iván has gained practical experience through internships at XESMEGA S.L. and Landa Medio Ambiente, working on environmental monitoring and waste management. His research interests span environmental sustainability, resource efficiency, and the development of data-driven environmental solutions.

~ Go to Contribution List

Valorization of Tomato Processing By-Products via Green Extraction: A NADES-Based Method for Single-Step Isolation of Different Classes of Compounds

Nádia Ribeiro[1,§], Paul Sauvetes[2,§], Chahinez Aouf[2], Cristina Silva Pereira[1]

[1]*Applied and Environmental Mycology Group, Instituto de Tecnologia Química e Biológica António Xavier, Universidade Nova de Lisboa (ITQB NOVA), Oeiras, Portugal*
[2] *INRAE, UMR IATE-1208, Montpellier, France*

According to the Food and Agriculture Organization, global tomato production has been increasing in recent years, reaching 186.82 million metric tons in 2022. While a significant portion is consumed fresh, tomato processing generates large volumes of by-products, often referred to as pomaces. These agri-residues are an underexploited resource despite their chemical and biological richness. This project investigates the potential of converting these agricultural residues into added-value products using eco-friendly solvents, such as Natural Deep Eutectic Solvents (NADES), under mild conditions. Our approach focused on the simultaneous extraction and isolation of phenolic compounds and the bio-polyester cutin. Using a choline: lactic acid-based NADES, we successfully obtained a phenolic-rich extract. The major constituents were identified and quantified via HPLC-MAS, revealing a composition with strong antioxidant activity, making it a promising candidate for incorporation into advanced formulations. Cutin was recovered in its polymeric form, confirmed by NMR analysis. This natural polymer is being explored as an ingredient in the development of biodegradable materials. Hydrolysis products of cutin demonstrated bactericidal activity against model bacteria, highlighting additional application potential.

Overall, this study demonstrates a promising cascading valorization strategy for tomato processing by-products, enabling the recovery of multiple bio-based materials with potential application across various industries, including packaging, cosmetics and food preservation.

Acknowledgements: This work was supported by the Horizon Europe Project AGRILOOP: pushing the frontier of circular agriculture by converting residues into novel economic, social and environmental opportunities. AGRILOOP (2022-2026) was funded by European Union's HEU research and innovation program, the UK Research and Innovation fund under the UK government's HEU funding guarantee (GA n.101081776) and The National Key Research and Development Funds of China. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union. Neither the European Union, the United Kingdom, the Swiss Confederation or the People's Republic of China nor the European Commission, UKRI, SERI or NKRDPC can be held responsible for them.

Biography:

Nádia Ribeiro is a Postdoctoral Researcher at ITQB NOVA, specializing in sustainable chemistry with a focus on agro-residue recycling, biopolymer development, and metal recovery. Her work integrates advanced extraction systems, coordination compounds, and real-world applications to support circular bioeconomy solutions. Previously, at the Centro de Ciências e Tecnologia Nuclear, she investigated radiation effects on the human digestive microbiome and microbial interactions with tryptophan metabolites. Nádia's expertise spans inorganic chemistry, NMR spectroscopy, and functional material characterization. She actively contributes to the AgriLoop initiative and promotes innovative, sustainable biorefinery strategies through webinars, scientific engagement, and interdisciplinary collaboration.

~ Go to Contribution List

Day-1

Session-04 - Pathways to Net-Zero and Negative Emissions, and Climate Change Mitigation Strategies

Oral Presentations

From Water Circularity to Carbon Savings: Energy-Efficient Strategies for Sustainable Hotel Operations

Fernando Rivera[1], Flávio Silva[1,2], Filipa Brandão[3,4], Helena Nadais[1,2]

[1]Department of Environment and Planning, University of Aveiro, Aveiro, Portugal
[2]CESAM-Center for Environmental and Marine Studies, University of Aveiro, Aveiro, Portugal
3Department of Economics, Management, Industrial Engineering and Tourism, University of Aveiro, Aveiro, Portugal
4GOVCOOP - Governance, Competitiveness and Public Policies, University of Aveiro, Campus de Santiago, Aveiro 3810-193, Portugal

The hospitality sector is a major consumer of both freshwater and energy, with 15–30% of a hotel's total energy use linked to water heating, pumping, and wastewater treatment. In regions under growing water stress, increasing circularity in hotel water systems not only reduces resource demand but also represents a significant opportunity for energy savings and associated reductions in greenhouse gas emissions. This study assesses the circularity performance of a 4-star hotel in Portugal using the AQUA+Hotéis® efficiency framework combined with the Water Circularity Index (WCI), quantifying environmental and operational gains linked to circular water strategies within the broader water-energy nexus.

The baseline assessment shows a fully linear water system (WCI = 0.00), with 100% reliance on potable supply and no internal reuse. Modelling of circular interventions—greywater recycling, rainwater harvesting, low-flow retrofits, real-time leak detection, and heat-recovery from effluent—demonstrates a potential 21% reduction in potable water demand and a rise in circularity to WCI = 0.208. These measures translate into energy savings of 30–40 MWh/year, primarily from reduced hot-water production and pumping needs, and an estimated avoidance of 4.4-5.8 tonnes CO_2-eq/year, depending on the local energy mix.

By integrating water-energy nexus indicators, the study demonstrates that circularity measures can act as indirect bioenergy and decarbonization strategies, reducing pressure on municipal infrastructures while lowering operational costs. The results show that circular water management is not only an environmental compliance tool but a value-adding pathway for the tourism bioeconomy, enabling hotels to align with Net-Zero agendas, ESG reporting frameworks and SDG-driven destination policies.

Biography:

Maria Helena Gomes de Almeida Gonçalves Nadais is an Auxiliary Professor at the University of Aveiro, specializing in environmental engineering, wastewater treatment, anaerobic processes, biochar applications, and sustainability assessment. She holds a PhD in Applied Environmental Sciences and a Master's in Chemical Engineering from Instituto Superior Técnico, as well as a Master's in Specialized Translation. With over 30 journal articles and two books, her research spans anaerobic digestion, biopolymers, water quality, industrial effluents, and environmental management systems (ISO 9001/14001). She has contributed to numerous national and international projects, advancing circular economy practices, resource recovery, and sustainable environmental technologies.

~ Go to Contribution List

Renewable Energy in Poland – Biomass and Waste in Biogas Production

Wojciech Czekała, Karol Kupryaniuk, Damian Janczak, Kamil Witaszek, Ludmila Machaieie

Department of Biosystems Engineering, Poznań University of Life Sciences, Wojska Polskiego 50, 60-627, Poznań, Poland

This presentation explores the role of biomass and waste as key renewable energy sources in Poland. It examines current technological developments, the potential for sustainable waste management, and the environmental benefits of biomass and waste-to-energy solutions. The presentation underscores the importance of biomass and waste in advancing Poland's transition toward a cleaner and more sustainable energy system.

Biography:

I am a scientist working at the Poznań University of Life Sciences in Poland. Graduate of two fields of study: environmental protection and geology. I am a scientist, educator, and practitioner working in the areas of waste management, energy, renewable energy, biofuel production, sustainable development, the circular economy, and broadly defined environmental protection and management. Environmental education and knowledge dissemination are also important elements of my work. In 2023, at the age of 36, I was awarded the title of Professor of Engineering and Technical Sciences in the discipline of Environmental Engineering, Mining, and Energy for my outstanding scientific achievements and overall achievements.

~ Go to Contribution List

Energy Potential of Leaves of Selected Tree Species From Urban Parks

Damian Janczak[1], Karol Kupryaniuk[1], Wojciech Czekała[1], Kamil Witaszek[1], Ludmila Machaieie[1], Jakub Kupryaniuk[2]

[1]Department of Biosystems Engineering, Poznań University of Life Sciences, Wojska Polskiego 50, 60-627, Poznań, Poland
[2]Department of Economics, Maria Curie-Skłodowska University, Maria Curie-Skłodowska Square 5, 20-031 Lublin

Every year, during autumn, trees around the world produce enormous amounts of leaves falling from them. This waste can be used as input for biogas plants, which can be used to produce electricity, heat, digestate as a high-quality fertilizer, and carbon dioxide as a byproduct of biogas combustion in a cogeneration unit. The aim of this study was to determine the energy potential of leaves from selected trees in urban parks. Methane and biogas production were assessed under standardized fermentation conditions. After testing the biogas yield of the selected leaves, it was found that the leaves from the trees have significant potential for use in biogas plants.

Biography:

In 2010, I graduated from the Poznań University of Life Sciences, field of study: agricultural and forest technique, MSc thesis entitled "Efficiency of management technology of digestate waste from biogas plants."

In 2014 I completed PhD studies at the Poznan University of Life Sciences and defended my doctoral dissertation "Technology of biogas production using selected waste materials from vegetables production and processing".

I am a scientist working at the Poznań University of Life Sciences. I graduated with a degree in Agricultural and Forestry Technology, specializing in Ecoenergetics. I am a scientist, educator, and practitioner working in the areas of waste management, energy, renewable energy sources, sustainable development, and the circular economy.

The Effect of Corn Ensiling Methods on Digestibility and Biogas Efficiency

Karol Kupryaniuk[1], Kamil Witaszek[1], Damian Janczak[1], Wojciech Czekała[1], Ludmila Machaieie[1], Jakub Kupryaniuk[2], Julia Panasiewicz[3]

[1]Department of Biosystems Engineering, Poznań University of Life Sciences, Wojska Polskiego 50, 60-627, Poznań, Poland
[2]Department of Economics, Maria Curie-Skłodowska University, Maria Curie-Skłodowska Square 5, 20-031 Lublin
[3]Department of Law and Administration, Maria Curie-Skłodowska University, Maria Curie-Skłodowska Square 5, 20-031 Lublin

This study investigates the impact of different corn silage preparation methods, namely the traditional and Shredlage methods, on digestibility and biogas yield in anaer obic digestion and its nutritional value—the first complex study of its kind. Key parame ters of both silage types were analyzed, including chemical composition, fiber content, and elemental makeup. Methane and biogas production were assessed under standard ized fermentation conditions. The results showed that the Shredlage method, character ized by more intensive chopping, led to higher biogas and methane yields per unit of organic dry ma er compared to traditional silage. This improvement is a ributed to en hanced digestibility due to the lower content of neutral detergent fiber (NDF), acid deter gent fiber (ADF), and crude fiber in Shredlage..

Biography:

I am a researcher working at the University of Life Sciences in Poznań, Poland. I graduated in Mechanical Engineering from the Faculty of Production Engineering at the University of Life Sciences in Lublin. Since November 2023, I have been a researcher, educator, and practitioner working at the University of Life Sciences in Poznań. My field of knowledge and practice is based on issues related to the impact of pre-treatment selection on the biogas yield of lignocellulosic materials, circular economy, and the broadly understood possibility of using lignocellulosic materials for energy purposes. An important element of my work is also environmental education and dissemination of knowledge.

~ Go to Contribution List

Turning Biomass at Risk of Wildfire into Bioenergy: A Win-Win Solution for Remote and Indigenous Communities of Canada

Nicolas Mansuy

Natural Resources Canada, Canadian Forest Service, Northern Forestry Centre, 5320 122 St. Edmonton AB T6H 3S5, Canada

The growing global urgency of increasingly damaging wildfires calls for proactive solutions—especially in Canada, where fire seasons are breaking records year after year, driven by climate change. Integrating FireSmart fuels management with bioenergy could help mitigate wildfire risk while simultaneously providing sustainable feedstock for wood-based bioenergy. We explore this strategy in off-grid communities in Canada who are heavily dependent on diesel for their energy needs, many of which are home to Indigenous peoples. We used a combination of national remote sensing data and community-based information to identify those communities that are both at high risk from wildfire and could use biomass from fuel treatments as feedstock for their bioenergy supply. Our results indicate that, out of the 276 remote communities used in our analysis, 33 are both diesel-dependent and at high risk from wildfire with a large accumulation of undisturbed flammable forest (i.e., > 30 years of age) within their surroundings. We demonstrate that regardless of their current energy needs, 30 of these 33 communities could theoretically replace their yearly fossil fuel demand by collecting less than 1% of the biomass identified at high risk of wildfire, which through thoughtful planning constitute effective fuel treatments around these communities. This study provides the first national quantitative assessment of the hazardous biomass surrounding communities vulnerable to forest fires, which could be utilized as sustainable feedstock for bioenergy production. Given the growing wildfire risk and the urgent need for energy security in Indigenous communities across northern Canada, our approach presents a win-win solution that combines clean energy development with wildfire mitigation. Effective community leadership and engagement, including the integration of Indigenous knowledge and collaboration with local governments and wildland fire agencies, will be essential for developing integrated fuel management strategies and identifying synergies with the bioenergy sector.

Biography:

Dr. Nicolas (Nick) Mansuy is a Senior Researcher with Natural Resources Canada's Canadian Forest Service. His research lies at the intersection of sustainable forest management, the bioeconomy, and climate strategy, where he leads innovative projects integrating forest-based solutions into climate change mitigation and clean energy transitions. Dr. Mansuy's recent work focuses on reducing greenhouse gas emissions in off-grid and remote communities through the development of bioenergy systems that simultaneously enhance wildfire risk reduction, energy security, and community resilience, particularly in northern contexts. His contributions play a key role in advancing Canada's efforts toward a sustainable, low-carbon future.

Techno-Economic Assessment of Methanol from Biogas CO_2 and Green Hydrogen for Maritime Applications

Ajay Koushik Venkatanarasimhan, Andrea Ramírez Ramírez

Department of Chemical Engineering, Faculty of Applied Sciences, Delft University of Technology, Delft, The Netherlands

Methanol produced from biogenic CO_2 and green hydrogen is a viable alternative fuel for the maritime sector, which contributes to 2- 3% to global GHG emissions. Biogenic CO_2 maintains a circular carbon cycle, enabling climate-aligned fuel production. Biogas (a mixture of CH_4 and CO_2) production happens through the anerobic digestion of biomass. On average, this CO_2 corresponds to roughly 10% of Europe's total biogenic CO_2 potential. Though significant, biogas plants are typically small, with average plant emissions of 5,000–15,000 tCO2/year. Integrating methanol synthesis directly at each plant would yield only ~3,450-10,350 t/year of methanol, far below the typical scale of emerging e-methanol facilities (~42,000t/year) or conventional methanol plants (1–2 Mt/year), leading to efficiency losses due to sub-optimal economies of scale. While the scale limitation in CO_2 capture is unavoidable, since transporting purified CO_2 is more efficient than transporting dilute flue gas, this bottleneck can be mitigated through centralized synthesis by aggregating CO_2 from several biogas plants supporting a single methanol facility.

In this work we assess two synthesis options for methanol transport given the differences in pressures and condition between transporting CO_2 vs co-locating CO_2 to the centralized facility:

(i) maintaining CO_2 at 110 bar for high-pressure methanol production, but requires pressurizing green H_2 to match

(ii) expanding CO_2 to conventional pressures (60–80 bar), incurring energy losses from decompression.

Detailed plant modeling and techno-economic analysis will be used to evaluate these options and identify trade-offs, focusing on the Netherlands, where 87 biomethane plants are reported as of 2025.

The presentation for this symposium will focus on the techno-economic results, within a broader European study covering the full value chain from CO_2 capture and green H_2 production to centralized methanol synthesis and delivery to ports.

Biography:

Ajay Koushik Venkatanarasimhan is a Postdoctoral Researcher working on the European M²ARE project, a multinational initiative advancing low-carbon shipping. His research focuses on developing bio-CO_2–based methanol as a sustainable marine fuel through plant-scale process simulation, life cycle assessment, and value chain design. He also works on geo-spatial optimization to integrate CO_2 and H_2 sources with methanol production and port infrastructure. Ajay earned his Ph.D. in Chemical Engineering from IIT Madras, specializing in microkinetic modeling, techno-economic analysis, and multi-objective optimization. Originally from Tamil Nadu, India, he is dedicated to linking technology, policy, and education for a cleaner energy future.

Day-2

Keynote Presentations

A Reality Check on Hydrogen Production from Biomass

Philippe Tanguy

Founder and CEO, Hynergy Consulting Ltd, Portugal

Hydrogen is increasingly viewed as a cornerstone of future low-carbon energy systems, offering a viable pathway to decarbonize sectors and applications that cannot be directly electrified. At present, however, the share of low-carbon hydrogen remains small, constrained by the high costs of water electrolysis and renewable electricity. While technological progress and economies of scale are expected to reduce these costs over time, alternative resources and production routes merit consideration. Biomass represents one such promising option, providing a renewable and potentially carbon-neutral feedstock for hydrogen generation.

A range of conversion pathways are available for producing hydrogen from biomass, encompassing both thermochemical processes—such as gasification, pyrolysis, and reforming—and biological routes including fermentation and photobiological methods. This presentation will examine these various production pathways, discussing their underlying mechanisms, process efficiencies, and environmental performance. Emphasis will be placed on technologies that have advanced beyond the laboratory stage and show clear potential for commercial application.

Biography:

Philippe Tanguy is the Founder and CEO of Hynergy Consulting Ltd., supporting the development of green hydrogen ecosystems and industrial decarbonization. He recently served as Chief Strategy Officer for HTEC–Quebec, advancing net-zero hydrogen solutions for long-haul transport. Previously, he was the 15th President of Polytechnique Montréal, leading major institutional growth, and Deputy CTO at TotalEnergies, where he contributed to innovation in the energy transition. Philippe has also held a distinguished academic and consulting career in process R&D and optimization. He is a Fellow of the Canadian Academy of Engineering and an honorary fellow of IChemE. He holds doctorates in physics and chemical engineering.

~ Go to Contribution List

The Future of Bioenergy and Bioeconomy: A Sub-Saharan Africa Perspective

Mohammed Hassan Abdullahi

Former Minister of Environment, Nigeria

Sub-Saharan Africa (SSA) stands at a critical juncture, grappling with profound energy poverty, climate vulnerability, and economic challenges, yet endowed with immense biomass and land resources. This paper argues that an integrated bioenergy and bioeconomy strategy presents a transformative pathway for SSA to achieve energy security, sustainable agricultural development, and inclusive economic growth. Moving beyond traditional biomass use, we explore the potential of modern bioenergy systems—including biofuels, biogas, and biomass power—as catalysts for a broader bioeconomy. This bioeconomy would leverage biological resources to produce not just energy, but also bio-based products, materials, and services. However, this future is not preordained. Through a critical review of existing initiatives, technological options, and policy frameworks, this paper identifies key opportunities—such as job creation, waste valorization, and rural electrification—and significant challenges—including land tenure issues, food-fuel conflicts, and technological capacity gaps. We conclude that the successful realization of a sustainable African bioeconomy hinges on proactive, context-specific policies that prioritize circular systems, community involvement, and strategic partnerships. This paper provides a strategic framework for policymakers, investors, and researchers to navigate this complex yet promising landscape.

Biography:

Mohammed Hassan Abdullahi is a Nigerian statesman with extensive experience in governance and public administration. He served as the Honourable Minister for the Environment (2022–2023) and previously as Minister of State at the Federal Ministry of Science, Technology & Innovation (2019–2022), overseeing key agencies including the Nigerian Research Institute for Chemical Technology, Raw Materials Research and Development Council, and National Centre for Technology Management. Abdullahi has also held significant state-level positions, including Secretary to the State Government of Nasarawa State (2017–2019), Special Adviser for Special Duties (2013–2015), and Attorney General and Commissioner for Justice (2011–2013). In these roles, he provided strategic leadership, supervised cabinet affairs, and implemented government policies across political, administrative, and security sectors. A graduate of the Nigerian Law School, he combines legal expertise with administrative acumen, contributing to national and state-level policy development, science and technology innovation, and environmental governance in Nigeria.

~ Go to Contribution List

Viability of bioSNG Production from Biomass: Risk-Return Analysis Comparing European and Canadian Case Studies

Zahra Kazemi Mehrabadi[1], Virginie Chambost[2], Simone Martel[1], Mikael Rönnqvist[3], Paul Stuart[1,2]

[1]Department of Chemical Engineering, Polytechnique Montréal (CA)
[2]EnVertis Consulting (CA)
[3]Department of Mechanical and Industrial Engineering, Université Laval (CA)

Biomass-derived synthetic natural gas (bio-SNG), produced via gasification and methanation, is a promising low-carbon alternative for fossil natural gas. However, its large deployment for larger capacities is constrained by a variety of factors such as technology risk, capital intensity, and feedstock cost and uncertainties, necessitating comprehensive risk-return assessments.

This Horizon Europe project enabled the evaluation of the implementation potential of the FlexSNG process for bio-SNG production across regional contexts in Europe and Canada, having significantly different biomass availabilities and economic realities, whose impact are rarely quantified. The techno-economic viability and risk-return trade-offs were assessed for ten case studies: 6 cases in different locations across Europe, and 4 cases at the same location in Canada.

Based on available feedstock/capacity and the process configuration, these cases were simulated in Aspen Plus®, incorporating pilot plant results for different biomass mixtures, and obtaining capital costs from commercial suppliers. The viability of the 10 cases was assessed using net present value (NPV) and internal rate of return (IRR) metrics, as well as various risk-related metrics. A Multi-Criteria Decision-Making (MCDM) panel, involving decision-making stakeholders from industry, weighed the risk-return criteria to identify the "preferred cases" and identify robust investment pathways. The analysis explicitly accounts for regional differences in feedstock availability, cost structures, energy pricing, and policy support, enabling a structured comparison of the different case studies. The results are summarized in Table 1.

The Swedish (NE2) and Finnish (NE1) cases achieved the highest IRRs at 11.4% and 11.2%, respectively - benefiting from abundant biomass, competitive capital costs, and especially district heating integration. Central (CE1 and CE2) and Southern European (SE1 and SE2) cases underperformed economically (-4% to 1% IRR). The best Canadian case (CA3) reached an IRR of 9.2% and NPV of 118.7 M€. Notably, benefits of economies-of-scale at larger design capacities were largely off-set by increased specific biomass costs (€/bdt).

The MCDM panel prioritized (1) Minimum Technological Risk, (2) Impact of Under-Estimated Capital Costs, and (3) IRR. Considering these, the Finnish and Swedish cases were identified as most preferred by the panel members. These cases demonstrated optimal balance between well-established forestry sectors that lower biomass availability risk and moderate-scale designs that mitigate capital and scale-related risks. It was also found that removing capital cost support by government rendered all Canadian cases unviable due mainly to lower bio-SNG selling prices, even if supported by a mandate.

Case Study	Location	Mode of Operation	Capacity (MW)	Biomass Type	Biomass Price (€/bdt)	Total Capex (M€)	Operating Costs (M€/Y)	Revenues (M€/Y)	NPV (M€)	IRR (%)
NE1	Finland	Biorefinery, Maximization	150	Waste wood + SRF	73/ 17	401	32.4	89	120	11.2
NE2	Sweden	Biorefinery, Co-production	300	Pulp mill wood residue + biochar	131	671	104	200	213	11.4
CE1	Germany	Hybrid, Co-production	50	Waste wood	31	375	67	85	-203	1
CE2	France	Biorefinery, Maximization	20	Waste wood	65	135	14	16	-113	-4
SE1	Greece (Crete)	City-refinery, Maximization	20	Urban Pruning + RDF	47/ 30	128	9	13	-90	-1.3
SE2	Greece (Thessaloniki)	City-refinery, Co-production	20	Olive pruning + RDF	30/ 30	131	8	23	-70	0.9
CA1	Canada	Biorefinery, Maximization	200	Forest Residues	33	592	57	105	12	8.4
CA2	Canada	City-refinery, Maximization	350	Forest Residues + SRF	34/ 0	936	83	173	25	8.4
CA3	Canada	Biorefinery, Maximization	600	Forest Residues	37	1357	160	313	119	9.2
CA4	Canada	Biorefinery, Maximization	350	Forest Residues + SRF	34/ 0	975	83	184	69	9.1

Biography:

After a career in engineering design and strategic consulting, Paul joined the Chemical Engineering Department at Polytechnique to become Chairholder of the first NSERC Chair in Design Engineering. In 2010 Paul co-founded and is today Principal Consultant of EnVertis Consulting, a global consultancy that assists companies with their business transformation in the bioeconomy – working with the forest products and allied sector companies, technology developers, and government. In his consulting activities, as well as with his talented graduate students in his university research program, Paul addresses industry-driven problems using product and process design methodologies and systems analysis tools, targeting the forest products industry and its transformation to new business models for the production of biofuels, biochemicals and biomaterials. Through the systematic and practical application of technology assessment methodologies, Paul has been involved in various ways with companies helping to establish biorefinery strategies and biorefineries, in Canada and around the world. Paul is a founding Fellow of the Pulp and Paper Technical Association of Canada (PAPTAC), a past President of the Canadian Society for Chemical Engineering (CSChE), and a Fellow of the Canadian Academy of Engineering (CAE).

EnVertis

POLYTECHNIQUE MONTRÉAL
WORLD-CLASS ENGINEERING

Day-2

Session-05 - Advanced Biofuels and Platform Chemicals for Industry Sectors

Invited Presentations

A Novel Process Technology Alternative to Address the Contaminant Challenge for Pretreating HEFA Feedstock for SAF Production

Matthew Clingerman

Sulzer Chemtech, USA

Various Renewable Feedstock used in Sustainable Aviation Fuel (SAF) production by Hydrotreatment fall into one of the three categories – Fats, Oils, & Greases (FOGs) – that share similar characteristics despite the source. These triglycerides-based feedstocks also contain impurities such as phosphorus, chlorides, and metals that needs removal prior to hydrotreating. This requires pretreatment to remove contaminants to avoid issues like coking & plugging of the catalyst bed, early catalyst deactivation and throughput limitation that can potentially cause failure to meet desired product properties.

Multiple processes already exist for feedstock purification, but they have been developed primarily with edible fats and oils using acid degumming and bleaching to remove phosphorus and metals while the main feed remaining unconverted. The pre-treated product, when processed in a subsequent hydrotreater (revamped or new), will still require olefin saturation, deoxygenation, and isomerization, along with associate high hydrogen consumption relative to petroleum feedstock.

This presentation focuses on an alternate pretreatment approach - BioFlux® Thermal Pretreatment, that is designed to economically treat FOGs to not only remove the impurities but also enable more efficient hydrotreating operations downstream by converting the feedstock into a distillate like product with much lower oxygen content that can significantly reduce hydrogen consumption in subsequent hydrotreating step, thereby unlocking significant economic value for producers.

It's truly a step-change in technology—something completely different from what most in the industry are used to. The technology's wide applicability means it's of interest to many in the industry, from new builds or grassroots facilities to refineries looking to convert existing hydrotreaters or co-process with traditional fossil jet or diesel fuel and allow them to add more renewable feedstock into their co-processing units than they would otherwise be able to.

The main aspects covered in this presentation are

1. Industry Transformation to Sustainable Clean Fuels
2. Conventional pretreatment options
3. BioFlux Thermal pretreatment - Alternate approach to pretreatment
4. Case study of advantages of an integrated thermal pretreatment and Hydrotreatment unit

Biography:

Matthew Clingerman is Head of Licensing Technology Development in Sulzer Chemtech's Technology and Innovation group. He has 25 years of experience in the refining industry, having previously worked in R&D, operations, and technology development. His focus now is on the development and commercialization of new technologies for sustainable fuels. Matthew holds a B.S. degree and a Ph.D. in chemical engineering from Michigan Technological University and is a registered professional engineer.

Pre-treatment of Waste Oils and Fats for Advanced Biofuels Production

Raül Sanchis i Gonzàlez

Sales Area Manager, TECHNOILOGY srl, Italy

The production of advanced biofuels such as Hydrotreated Vegetable Oil (HVO) and Sustainable Aviation Fuel (SAF) increasingly relies on waste-derived feedstocks, including used cooking oil, animal fats, and exhausted bleaching earths. These residues are abundant and sustainable but present major challenges due to their high content of contaminants such as phosphorous, metals, sulfur, chlorine, water, and polyethylene. If not properly removed, these contaminants can poison catalysts, increase operational costs, and compromise the performance of hydrotreatment units.

This presentation will focus on the critical role of advanced pre-treatment technologies in enabling the large-scale valorization of challenging waste oils and fats. Drawing on TECHNOILOGY's expertise, we will present optimized solutions such as Advanced Degumming and Advanced Bleaching, complemented by ancillary units including Organic Dechlorination, Polyethylene Removal, Oil Cleaning, and Animal Fat Depuration. Special attention will be given to Organic Dechlorination, a breakthrough process that reduces organic chlorine from >40 ppm to <5 ppm while simultaneously lowering phosphorous and sulfur.

In addition, we will highlight ongoing developments in Solució Circular, a Spanish start-up dedicated to recovering lipids from spent bleaching earths without the use of chemicals. Together, these innovations demonstrate how advanced pre-treatment contributes to circular economy goals and the pathway to net-zero emissions.

Biography:

Raül Sanchis i Gonzàlez is an economist and entrepreneur with more than 20 years of experience in the biofuels, waste valorization, and oleochemical sectors. He is currently Area Sales Agent at TECHNOILOGY (Italy), responsible for oleochemical and pre-treatment installations across Western Europe, and Founder & CEO of Solució Circular (Spain), a company dedicated to waste management and the recovery of lipids for biofuels from spent bleaching earths without the use of chemicals.

Previously, Raül founded and managed Biocom Energia, the first Spanish company to produce biodiesel from waste, where he successfully internationalized operations and managed two large-scale plants. He has led consulting, trading, and project development initiatives in Europe, North Africa, and Latin America.

He holds a Degree in Business and Economics, a Master in Environmental Engineering, and is currently pursuing a PhD at the University of Valencia focused on circular economy and waste management. Raül is fluent in Spanish, Valencian, French, and English.

Day-2

Session-06 - Hydrogen Value Chain

Invited Presentations

Technologies and Challenges for a Sustainable Hydrogen Value Chain

Carmen M, Rangel

National Laboratory for Energy and Geology, Lisbon, Portugal

Green hydrogen is expected to integrate the energy transition as an energy carrier for decarbonization, critical in the increase of renewables in the energy mix and system storage capability, tackling climate change and security of supply issues. The European Green Deal and REpowerEU Plan have recognized H_2 as a crucial pillar for reaching climate neutrality by 2050, the latter with the intensification of hydrogen delivery targets to enhance Europe's energy security. Renewable hydrogen produced through water electrolysis powered by renewable electricity is prioritized as a strategy to promote the development of a hydrogen infrastructure, sector integration, and certification mechanisms to support the transition towards a sustainable Hydrogen economy.

The presentation will review key aspects of the green hydrogen value chain, highlighting current technologies significant advancements and also the associated challenges, particularly in production, since Europe´s electrolyser installed capacity remains low. Challenges will be discussed, including materials criticality referring scarce resources used for essential components, in production, storage and fuel cells. Geopolitical implications may lead to supply chain risks and sustainability concerns, requiring strategies targeting low TRL research for circularity, innovation and policy implementation to facilitate the cost-effective implementation of technologies. Cost have been expected to be reduced in the short term due to innovation, learning-by-doing, economies of scale and improved manufacturing techniques, but slower than expected deployment has prevented it. Other challenges include electrolyser coupling with renewable sources regarding durability concerns in dynamic operation. Progress in energy networks, storage, and distribution remains limited.

Increased coordinated efforts are needed in research, innovation and policy implementation, across the value chain, to overcome the challenges and bridge the gap to large scale, cost-competitive and sustainable hydrogen deployment.

Biography:

Carmen M. Rangel is Research Coordinator, now retired, at the National Laboratory for Energy and Geology in Portugal. She is involved in Advanced Research in Hydrogen technologies addressing challenges of new materials for Production and Storage, design of Catalysts and Membranes for efficient/cost effective electrolysers, fuel cells as well the synthesis of solar fuels, including CO2 co-electrolysis. C.M. Rangel is author of more than 300 publications in International Journals and Conference Proceedings and more than 200 reports associated to Consultancy to Industry. On a European level she has acted as a National Representative in the States Members Group of the Joint Undertaking in Hydrogen and Fuel Cells FCH_JU (2009-2014), as a member of the Expert Group of the Agenda Process for European Research and Innovation Initiative on Green Hydrogen contributing to the Strategic Research Agenda document (2021-2022) and as a member of the Temporary Working Group_TWG Hydrogen SET Plan (2025)

Connecting Bioeconomy and Hydrogen Value Chains: A Nordic Approach to a Sustainable and Independent Europe

Jatta Jussila

CLIC Innovation Oy, Finland

Europe's pathway to sustainability and strategic independence requires connecting two worlds that too often operate in isolation: the bioeconomy and clean hydrogen. The bioeconomy transforms renewable resources into high-value products and materials — and when integrated with hydrogen and Bio-CCU, even side streams and biogenic CO_2 become circular feedstocks. Hydrogen, in turn, provides the clean energy and reducing power that upgrade these bio-based residues into new fuels, fertilizers, and green chemicals, turning linear resource use into a closed carbon loop. Together, hydrogen and the bioeconomy form a coherent European value network capable of replacing fossil resources, enhance security of supply, and strengthen industrial resilience. This presentation explores how Nordic collaboration and initiatives such as the BalticSeaH_2 Hydrogen Valley demonstrate the potential of linking hydrogen and bio-based carbon value chains to build a truly sustainable, competitive, and fossil-independent Europe.

Biography:

Dr. Jatta Jussila is the CEO of CLIC Innovation Ltd, an open innovation cluster in Finland dedicated to developing breakthrough solutions in the bioeconomy, circular economy, and energy systems. With over 25 years of experience in managing cross-industry innovation and public–private partnerships, she is renowned for leading co-creation processes focused on sustainability. Dr. Jussila currently coordinates the BalticSeaH2 Hydrogen Valley project, which aims to build an integrated hydrogen economy across Northern Europe. Throughout her career, she has led over 10 large-scale research and innovation programs valued between 20–100 million euros, spanning areas such as smart grids, bioenergy, and carbon capture, utilization, and storage (CCUS). Before joining CLIC Innovation, she worked in the energy industry, specializing in renewable energy and emission control technologies. She holds a PhD in Chemical Engineering from Åbo Akademi University, Finland, and continues to champion sustainable innovation across sectors.

Rational Design of Mixed-Oxides as Isothermal CO_2 Sorbents for Intensified Hydrogen Production from Biogenic Feedstocks

Fanxing Li

North Carolina State University, USA

The pursuit of intensified, carbon-free hydrogen production from biogenic feedstocks such as woody biomass and biogas has motivated the development of sorption-enhanced reforming with high-temperature CO_2 sorbents. Conventional CaO-based sorbent materials, though widely studied, suffer from rapid deactivation and require large temperature swings for the highly endothermic CO_2 release step. To overcome these limitations, we introduce a new class of redox-activated, perovskite-structured sorbents capable of isothermal operation with excellent long-term stability.

These perovskite-structured sorbents present several advantages, including the ability to fine-tune the energy distribution between carbonation and de-carbonation processes, thereby optimizing the exergy efficiency. Leveraging the compositional and structural flexibility of perovskites, we conducted high-throughput first-principles screening of various doped perovskite oxides to identify optimal sorbent candidates. Experimental evaluations validated the computation-driven design, yielded a predictive descriptor for sorbent capacity, and significantly accelerated the optimization process.

To complement the simulation studies, we performed experimental evaluations, which not only validated the robustness of the computation-driven sorbent design approach but also led to the development of a predictive descriptor for sorbent capacity. The incorporation of this descriptor expedites the sorbent optimization process. In practical applications, these sorbents generated >95% pure H_2 in a packed bed reactor setup for biogas conversion. Biomass gasification to hydrogen enriched syngas was also validated in fluidized bed tests. Our findings also support the potential for integrated CO_2 capture and highlight the promise of redox-activated isothermal towards carbon-negative hydrogen generation.

Biography:

Dr. Li's research interests include energy and environmental engineering and particle technology. His research focuses on the design, synthesis, and characterization of nano catalyst and reagent particles for biomass and fossil energy conversions, green liquid fuel synthesis, CO2 capture, and pollutant control. The research also encompasses chemical reaction engineering and process synthesis and optimization. Density Functional Theory (DFT) based methods are also used to elucidate the particle reaction mechanisms and to identify potential ways to improve particle performance.

~ Go to Contribution List

Day-2

Session-07- Digital Transformation in Biorefinery, Decision Support Systems and Scenario Analysis

Invited Presentations

On the Road to Evaluate an Integrated Biomethane and Microbial Protein Production With a Prospective Holistic and Integrated LCSA Approach (pHILCSA)

Andrés Murillo[1], Heiko Wagner[2], Odorico Konrad3, Munique Marder3, Joice Mörs3, Camila Naiele Giovanella3, Fernanda Nicolodi Brum3, Fernanda Leonhardt3, Rohan Karande[2], Alberto Bezama1,4, Daniela Thrän[1]

[1]Helmholtz Centre for Environmental Research, Department of System Analysis and Sustainability Assessment. Leipzig, Germany
[2]Universität Leipzig, Research and Transfer Center for bioactive Matter, Leipzig, Germany
[3]Universidade do Vale do Taquari, Engenharia Ambiental, Lajeado, Brasil
[4]University of Calgary, Schulich School of Engineering, Calgary, Canada

Animal protein production comes along with several environmental impacts, such as extensive deforestation and biodiversity loss associated to land use change, as well as water use, and GHG emissions. Most of these impacts are attributed to the cultivation of protein-rich crops, such as soybeans and cereals, which are primarily utilized for livestock consumption. In addition, there is global nitrogen pollution caused by the low efficiency of nitrogen fertilizer absorption by plant-soil systems and the loss of nutrients in the management of animal waste. Emerging protein production systems like microbial protein are actively addressing these challenges, offering the potential not only to replace traditional plant-based proteins in animal feed but also to reshape the future of food. To this end, the BioGas2protein project was initiated, aiming to upgrade biogas by capturing waste gases with microbial consortia to produce both biomethane and microbial protein. To systematically embed life cycle thinking and a systems perspective into the design and development of biomethane and microbial protein production processes, an ex-ante LCA will be conducted, thereby enabling the identification and implementation of sustainability improvements already at the pilot stage. This systemic approach includes upscaling laboratory data using SuperPro Designer. Based on the generated model information, a prospective HILCSA will be carried out to address how socially, ecologically, and economically sustainable will be the production of an integrated biomethane and microbial protein production compared to other alternative technologies, identifying the hotspots, trade-offs, and synergies. The relevance of conducting prospective assessment for technologies at low TRLs lies in the fact that critical hotspots can be identified at an early stage, when it is easier to implement improvements. Better knowledge on the potential impacts of these prospective technologies under study will help to improve or adjust these technologies during their development for a better implementation on the future.

Biography:

M.Sc. Andrés Murillo is a PhD Researcher in the Department of System Analysis and Sustainability Assessment (SANA) at the Helmholtz Centre for Environmental Research (UFZ) in Leipzig, Germany. Since January 2024, he has conducted research in the bioeconomy field, focusing on the complementation of a Social Life Cycle Assessment (S-LCA) with a regional approach (RESPONSA). Since January 2025, his work has expanded to the assessment of prospective technologies, scaling up, and incorporating a holistic perspective (HILCSA). Currently, Andrés contributes to the BioGas2Protein project, which aims to upgrade biogas by capturing waste gases with microbial consortia to produce both biomethane and microbial protein. His research assesses the potential environmental and socio-economic impacts of this emerging technology to identify hotspots and guide sustainable design improvements.

~ Go to Contribution List

Day-2

Session-08- Project Financing Options

Invited Presentations

Exploring CETPartnership: Funding Opportunities and How to Join

Nina Dayana Berger

CETPartnership, Communication Office EU Partnership Nordic Energy Research, Communication Office, Oslo, Norway

Achieving a sustainable energy future requires coordinated efforts across countries and sectors. CETPartnership offers a strategic framework to support this transition through joint funding and collaborative projects.

This presentation aims to introduce CETPartnership, outline available funding opportunities, and explain how potential partners can join and benefit from the program.

Attendees will gain clarity on funding opportunities, timelines, and steps for successful engagement in CETPartnership initiatives.

CETPartnership offers researchers the chance to access funding, collaborate across borders, and contribute to innovative projects that accelerate the clean energy transition. By joining, you become part of a broader international community committed to driving sustainable solutions and shaping the future of energy.

Biography:

Nina manages strategic operational communication for the Clean Energy Transition Partnership (CETPartnership), fostering collaboration between researchers, policymakers, and industry on sustainable energy solutions. She holds an MPhil in Political Communication from the University of Oslo and brings extensive journalistic and editorial experience from leading Norwegian media outlets, including VG and the Norwegian Broadcasting Corporation.

The Fundamentals of Project Finance and Using It to Fund Biogas Projects

Michael Ware

Senior Director, Green Giraffe, Netherlands

Europe consumes about 350 billion cubic metres (bcm) of natural gas per year and this is nearly all imported. The Russian invasion of the Ukraine has made energy security the key political concern amongst European politicians.

To try and reduce reliance on imports, European leaders have agreed a biomethane target of 35 billion cubic metres (bcm) per year by 2030. Current production is about 7 bcm. This leaves a gap of 28 bcm which equates to roughly 560 large-scale plants, each producing 50 million cubic metres per annum, needing to be built in the next five years. This will require €28 billion of capital — about €19.6 billion of debt and €7 billion of equity all of which will be funded by project finance.

The fundamentals of project finance and using it to fund biogas projects

- What is project finance
- How do biogas projects differ from other renewables
- Key risks and mitigants
- Typical valuation metrics
- How to attract funding – do’s and don’t

Biography:

Michael Ware is a Senior Director at Green Giraffe. Green Giraffe Advisory is an independent financial advisory, focused on helping clients shape the energy transition. Our reputation was built over the last decade, on entrepreneurial and innovative finance solutions for capital intensive renewable projects and energy transition initiatives Launched in 2010 and with offices all over the world, we offer bespoke financial advice, market intelligence and development services in all renewable and energy transition technologies Michael is one of the world’s foremost authorities on funding biogas plants. He has worked in project finance for 20 years, closed over 100 deals and raised in excess of GBP 5 billion for his clients. He is currently working on 10 biogas deals in Europe and Canada.

~ Go to Contribution List

Biogas Production Facilities - The Funding Choices & Financing Benchmarks for Owners

Andrew Rice

Chief Operating Officer, Global NRG Advisory Belfast, United Kingdom

Funding for Biogas projects can be a complex area to negotiate and at Global NRG Advisory, we aim to simplify the process for our clients and make sure that maximum value and ease is secured for them. Looking at the key project stages of Pre-Development, Construction and Operation, it is crucial to ensure that the right funding mechanism is applied to the right stage to prevent overextending. We're going to look at the key types of funding to assist operators, - asset finance, project finance, lease options, equity funding and green bonds. We'll look at the key criteria for investment; project viability, revenue streams, risk mitigation, regulatory compliance and technology & scalability, as well as practical tips for securing funding. In concluding, we'll look at how matching the right funder to the right project is vital to success, ('attitude vs aptitude") and how solid business models, risk management, clear feedstock and revenue streams will see the aspirations of project owners turned in to reality.

Biography:

Andrew Rice is the Chief Operating Officer at Global NRG Advisory & Global NRG Renewables, bringing over 30 years of experience in commercial and private finance, relationship management, and renewable energy project development. His expertise spans biogas, solar, wind, finance procurement, and business consulting, supporting global renewable infrastructure from feasibility to operation. Previously, he spent eight years at Privilege Finance, managing agricultural asset and renewable energy portfolios across the UK, specializing in financial reviews, asset audits, and debt recovery. Before that, at Willis, he led debt recovery teams and managed multimillion-pound portfolios across Ipswich and Mumbai. Based between London and New York, Andrew is passionate about advancing sustainable finance and global decarbonization initiatives, leveraging financial innovation and international partnerships to accelerate renewable energy adoption.

~ Go to Contribution List

What’s Next for the Energy Sector in Horizon Europe Cluster 5 (2026–2027) and a Glimpse of the Future

Cristiana Leandro

Agência Nacional de Inovação (ANI), Portugal

The presentation will provide a comprehensive overview of the final Horizon Europe Cluster 5 calls (2026–2027), with a specific focus on the energy sector. It will outline the newly emerging thematic priorities, horizontal calls, and forthcoming European initiatives that shape the future direction of research and innovation in sustainable energy systems. Additionally, the presentation will offer an exclusive glimpse into the upcoming Framework Programme 10 (FP10) and the European Competitiveness Fund, highlighting their potential impact on advancing Europe’s energy transition, industrial competitiveness, and climate objectives.

Biography:

Cristiana Leandro is national representative and national contact point for Horizonte Europe since 2020 at ANI – National Innovation Agency. It supports the areas of Cluster 5 - Climate, Energy and Mobility, including the European Cities Mission. She has a PhD in Chemistry (University of York, UK) and extensive experience in international affairs.

Circular Design and Systems Thinking for Resilient and Profitable Biorefinery Operations

Ricardo Eiras

TNE – Technologies New Energy, Portugal

In an era shaped by accelerating global megatrends—sustainability, resource efficiency, and the shift toward localized consumption—traditional linear business models are becoming increasingly fragile. Technologies New Energy PLC (TNE) demonstrates how a transition to circular design principles and systems thinking can redefine the biorefinery sector, creating a new class of enterprises that are both resilient and profitable, with a net positive impact.

TNE has developed a comprehensive technology platform that goes beyond efficiency, integrating applications across the entire clean fuels value chain - from upstream feedstock management to midstream processing and downstream product utilization. Circular design is embedded throughout our operations, encompassing material sourcing, product lifecycle extension, and waste-to-resource strategies. This is not merely an ethical stance but a strategic foundation for resilience, shielding our business from supply chain volatility and resource scarcity.

At the heart of our clean fuels projects lies the synergy between circularity and systems thinking. By positioning the enterprise as an integral part of a broader social, economic, and environmental ecosystem, we open new pathways for value creation. Through data-driven decision-making, we achieve measurable reductions in operating costs, improved product durability, and deeper community engagement. Our goal is not only to operate sustainably, but to integrate harmoniously and regeneratively within the ecosystems that sustain us.

Biography:

Ricardo Eiras is the Chief Operating Officer (COO) at TNE PLC, with a lifelong record of delivering excellence in innovation and operational management for leading S&P 500 companies in the technology and infrastructure sectors. Throughout his career, he has championed strategic transformation, efficiency, and sustainability, aligning innovation with business performance. At TNE PLC, Ricardo leads initiatives that integrate advanced technologies and resilient operations to drive sustainable growth. His leadership reflects a deep commitment to operational excellence, collaboration, and continuous improvement, positioning him as a key contributor to advancing innovation and performance across global industrial systems.

Day-2

Task XI - Decision Support Tools for a Feasible Bioeconomy

Development of Reliable Phase Equilibria Calculations to Improve the Design of Integrated Biorefineries: The Example of Fast Pyrolysis

Axel Funke

Institute of Catalysis Research and Technology, Karlsruhe Institute of Technology, Karlsruhe, Germany

Many reasonable process chains from biomass to value added products have been developed in the past. Most of them rely on (intermediate) products with oxygen containing functional groups – either to create a link between biomass use and the existing hydrocarbon chemistry or to directly create products with new characteristics and features. Processing these (intermediate) products requires reliable calculation of phase equilibria, be it for the design of separation processes, reactor optimization or simply product quality control. However, phase equilibria calculations for such compounds have to be associated with a largely unknown uncertainty and need to be considered unreliable in consequence. The objective of this project is to develop a reliable methodology to approach phase equilibria calculations of bio-based compounds using the example of fast pyrolysis bio-oil, which combines many of above outlined challenges. Moreover, the ability to control product fraction properties allows for the development of an integrated biorefinery based on (fast) pyrolysis.

Available experimental data of compounds typically observed after/ during biomass conversion and empiric methods that allow for an estimation of critical properties are collected. Based on existing solutions (i.e. the UNIFAC variety and COSMO-SAC), reliability of phase equilibria calculations is assessed and solutions for remaining challenges proposed. Gaps in decisive parameters and biased fitting of interaction parameters are assessed. Optimization of interaction parameters does help to reduce deviations between predictions and experimental values; however, this requires more effort in extending the experimental database. More important for the improvement of phase equilibria calculations is the representation of unknown compounds in combination with the definition of a reasonable surrogate mixture to avoid over-excessive use of empiric correlations. Finally, an experimentally validated example of phase equilibria calculation for process improvement is provided to showcase its importance to the field.

Biography:

Dr. Axel Funke is a researcher and team leader at the Karlsruhe Institute of Technology (KIT), Institute for Catalysis Research and Technology (IKFT), specializing in thermochemical conversion of biomass. His work focuses on fast pyrolysis and hydrothermal carbonization, advancing technologies that transform biomass into energy-dense bio-oils and sustainable carbon-rich products such as biochar. With more than a decade of experience at KIT, he leads research that bridges engineering innovation with environmental benefits, including applications in soil improvement, renewable fuels, and integrated biomass utilization. Previously, Dr. Funke was a postdoctoral researcher at the Leibniz Institute for Agricultural Engineering, where he investigated biochar production and synergistic process integration with anaerobic fermentation systems. His industrial background includes roles in QA/QC and technical due diligence for power plants, biofuel installations, and regulatory compliance across the energy sector. He holds a Ph.D. from Technische Universität Berlin, supported by the German Federal Environmental Foundation.

Fast Pyrolysis – Winning Economic Conditions for Emerging Fast Pyrolysis Technologies

Paul Stuart[1,2] and Geetanjali Yadav[3]

[1]*Department of Chemical Engineering, Polytechnique Montréal, Canada*
[2]*EnVertis Consulting, Montréal, Canada*
[3]*National Renewable Energy Laboratory (NREL), Golden, CO USA*

Emerging intensified and often modular Fast Pyrolysis (FP) technologies offer opportunities in addition to capital cost reduction to improve profitability, by co-producing biochar, a valuable co-product with diverse environmental applications. There are key questions around the opportunity with these technologies (1) biochar value as a function of yield, and (2) revenue scenarios from carbon credits from biochar applications. This industrial case study examines a 400 dry tonne-per-day fast pyrolysis system integrated into a pulp and paper mill. It assesses the techno-economic impact of biochar co-production under both conventional and intensified FP configurations. The conventional system, typically constrained to a large extent by fixed mass-energy coupling, fails to meet target IRRs under baseline conditions for different product replacement strategies. Intensified FP, for the design considered, enables flexible yields between pyrolysis oil and biochar (up to 30%), and could achieve IRRs of 23–29% considering different implementation scenarios, surpassing targeted business case thresholds. Sensitivity and scenario analyses identified product pricing, market access, and certification as key economic drivers and barriers. Risk mitigation strategies—such as phased implementation, diversified product portfolios, and long-term off-take agreements were shown to reduce exposure to policy and market volatility, enhancing investment attractiveness.

Biography:

After a career in engineering design and strategic consulting, Paul joined the Chemical Engineering Department at Polytechnique to become Chairholder of the first NSERC Chair in Design Engineering. In 2010 Paul co-founded and is today Principal Consultant of EnVertis Consulting, a global consultancy that assists companies with their business transformation in the bioeconomy – working with the forest products and allied sector companies, technology developers, and government. In his consulting activities, as well as with his talented graduate students in his university research program, Paul addresses industry-driven problems using product and process design methodologies and systems analysis tools, targeting the forest products industry and its transformation to new business models for the production of biofuels, biochemicals and biomaterials. Through the systematic and practical application of technology assessment methodologies, Paul has been involved in various ways with companies helping to establish biorefinery strategies and biorefineries, in Canada and around the world. Paul is a founding Fellow of the Pulp and Paper Technical Association of Canada (PAPTAC), a past President of the Canadian Society for Chemical Engineering (CSChE), and a Fellow of the Canadian Academy of Engineering (CAE).

~ Go to Contribution List

An Early-Stage Framework For TRL-based Assessment of Risks, Mitigation Strategies, and Drivers In bio-based and Biorefinery Technologies

Karam Moussa[1], Luana Dessbesell[2]

[1]Department of Bioproduct and Biosystem, Aalto University, Espoo, Finland
[2]Department of Bioproduct and Biosystem, Aalto University, Espoo, Finland

The commercialization of sustainable material innovations requires not only technical and economic breakthroughs but also structured approaches to identify and manage uncertainties at early development stages. This paper introduces a qualitative framework for early-stage bio-based and biorefinery technology assessment that integrates risk identification, mitigation strategies, and enabling drivers, systematically mapped to Technology Readiness Levels (TRLs). The approach aims to bridge gaps between laboratory proof-of-concept and scalable industrial application by providing a structured basis for decision-making across the value chain.

The framework combines three dimensions: (i) risk mapping and prioritization (severity × probability), (ii) evaluation of mitigation strategies based on effectiveness (implementation× feasibility), and (iii) identification of drivers based on the influence that accelerate TRL advancement. Each risk, mitigation strategy, and driver is explicitly mapped to corresponding TRL, ensuring that uncertainties and enablers are contextualized within the technology's development stage. The methodology is applied to case studies of regenerated cellulose films (Ionphane), developed via a Lyocell-type ionic liquid process, to illustrate its utility in highlighting feedstock, process, and product-level challenges. Results demonstrate how the approach not only supports preliminary risk and mitigation planning but also lays the groundwork for techno-economic analysis, circularity assessment, product development, and circular business model design.

By offering a structured pathway from uncertainty mapping to phased implementation, this early-stage technology assessment framework serves as a decision-support tool to accelerate sustainable innovation and commercialization. The work contributes to methodological advances in technology assessment and provides actionable insights for both researchers and industry stakeholders engaged in scaling renewable material technologies.

Biography:

Karam Moussa is a Doctoral Researcher in the Department of Bioproducts and Biosystems and a Doctoral Student in the School of Chemical Engineering at Aalto University. His research focuses on sustainable bioproducts innovation, scientific translation, and the development of future-ready bio-based materials. He contributes actively to major research initiatives, including the SciSustain: Science Translation Framework for Sustainable Bioproducts Innovation project (2024–2026) and the Aalto University Bioinnovation Center project (2021–2030). His work emphasizes interdisciplinary collaboration across bioproducts, sustainability, and chemical engineering, contributing to advancements in Finland's bioeconomy and global sustainable materials research.

~ Go to Contribution List

Business Models in Recycling: Make or Coordinate

Jawad Elomari

SINTEF Industry, Sustainable Energy Technology, Trondheim, Norway

One challenge in planning a recycling business model is balancing between owning the entire supply chain and only coordinating its activities. This work reviews existing mathematical models tackling this problem and identifies their limitations.

Real-world test cases and published scientific journals are the two sources of the review. The ScienceDirect database has about 1500 research articles published in the last five years, and containing the keywords: "recycling" AND "net present value" AND "cash flow" AND "optimization" were used. Other financial metrics keywords were explored, like: "payback period," and "return on investment." These articles were further filtered to match the case-study fields, which are, waste-to-energy, pulp and paper, solar panels, and carbon capture and utilization. A net of 503 articles were reviewed based on their abstracts to identify the most promising ones for further investigation.

Main drawbacks in existing models include I) focusing on one or two financial metrics only and mixing long term ones with short term ones, instead of forming the problem as multi-objective optimization with clustered metrics depending on the planning horizon; II) no link between the strategic and tactical decision variables and time-dependent cash flows in the objective function; and III) no decision variables to optimize when cash should flow if this was an option.

A preliminary review of research articles, coupled with practical experience from case-studies, revealed a need to further advance decision support tools regarding business modelling within recycling. Existing models evaluate businesses as an after-math, rather than provide a design tool to how the business should be set up; that is, how much of it to coordinate vs. own. This work identified three main gaps and is a first step to complementing existing models with a more comprehensive representation of the problem.

Biography:

Dr. Jawad Elomari is a Scientific Researcher at SINTEF, Trondheim, specializing in mathematical modelling, statistical learning, and optimization for real-world industrial and sustainability challenges. With extensive experience bridging technical innovation and business strategy, he leads and coordinates European R&D projects focused on renewable energy systems, critical raw materials, circular economy solutions, and sustainable infrastructure. His work supports decision-making that considers not only economic performance but also environmental and societal impacts. Before joining SINTEF, Dr. Elomari worked as an R&D Scientist at RISE Research Institutes of Sweden, contributing to digitalization and Industry 4.0 initiatives in the manufacturing and energy sectors. His earlier roles as an Optimization Specialist and Postdoctoral Scientist enabled impactful work in supply chain design, waste-to-energy optimization, CO_2 capture and storage, and digital twins for industrial operations. Dr. Elomari holds a Ph.D. in Operations Research and Management Sciences from the University of Warwick, UK, and has led diverse international teams delivering innovative, data-driven solutions.

~ Go to Contribution List

Green Biorefineries: Coupling Feed, Bioenergy and Biomaterials Production With Restorative Agriculture

Sebnem Yilmaz Balaman[1], Göran Berndes[2], Christel Cederberg[2], Håkan Rosenqvist[3]

[1]Chalmers Industriteknik, Department of Material & Circularity, Division of Circular economy, Göteborg, Sweden
[2]Division of Physical Resource Theory, Department of Space, Earth and Environment, Chalmers University of Technology, Göteborg, Sweden
[3]Independent Researcher, Prästvägen 5, S-268 73 Billeberga, Sweden

Grass-based biomass from grasslands can be used as feedstock in green biorefineries that produce a range of bio-products. In addition, adjustments made as part of crop rotation to increase areas under temporary grasslands can yield benefits such as carbon sequestration, increased soil productivity, reduced eutrophication, and reduced need for pesticides. In this study, a flexible modeling framework is developed to analyze the deployment options for GBs that use grass-clover to produce protein feed and feedstock for bioenergy. The focus was on optimal deployment, considering system configuration and operation, as well as land use changes designed to increase grass-clover cultivation on cropland. A case study and scenario analyses involving 17 counties in Sweden showed that future deployment of green biorefineries could support biomethane and protein feed production corresponding to 5%–60% and 13%–154%, respectively, of biomethane and soybean feed imports to Sweden in Year 2020.

Biography:

Dr. Sebnem Yilmaz Balaman is a Senior Researcher and Project Manager at Chalmers Industriteknik, Sweden, specializing in circular supply chains, bio-based production systems, and sustainability transitions. With over a decade of multidisciplinary experience, she develops modelling-based decision support frameworks to accelerate real-world implementation of bioenergy, renewable fuels, and circular material solutions. Her research delivers actionable pathways for industry, policy makers, and regional planners, helping stakeholders navigate the complex trade-offs in the shift toward a climate-neutral bioeconomy. Prior to joining Chalmers Industriteknik, Dr. Balaman served as an Assistant Professor at Dokuz Eylul University, Turkey, and held research roles at Aston University and Chalmers University of Technology. Her expertise spans techno-economic and environmental assessment, supply chain optimization, sustainability policy impacts, stakeholder engagement, and innovation-focused project management. She holds a Ph.D. in Industrial Engineering from Dokuz Eylul University and actively contributes to European collaborations driving green industrial transformation and circular value chain deployment.

~ Go to Contribution List

Biogenic Carbon Flow Mapping in Swedish Agriculture

Sebnem Yilmaz Balaman, Chris Hellström

Chalmers Industriteknik, Department of Material & Circularity, Division of Circular economy, Göteborg, Sweden

This study examines carbon flows in Sweden's agricultural sector, emphasizing its role in sustainability and climate mitigation. The ultimate aim is to enhance the management of biogenic carbon flows in Sweden's agriculture and agriculture-related industries. By addressing data gaps and challenges in tracking carbon inputs and emissions, the findings support informed decision-making for sustainable agricultural practices.

Understanding the complex dynamics of carbon sources and applications is crucial for stakeholders navigating the challenges and opportunities of the evolving energy landscape. Key insights include detailed analyses of carbon flows across arable land, pasture, and livestock systems. Arable lands receive significant carbon inputs through photosynthesis and organic amendments, such as manure and food industry residues, but also experience losses during harvest and decomposition. Pastures, with their extensive root systems, serve as long- term carbon sinks. Livestock systems, having the biggest impact on the carbon flow, illustrate the complex interdependencies between feed production, manure recycling, and emissions. The insights from the interviews report advocates for improved data integration, digitalization, and industrial symbiosis to enhance resource efficiency and reduce waste. It calls for robust policies to incentivize sustainable practices, such as reduced VAT on eco-friendly products and potential taxes on high-emission goods like meat.

Biography:

Dr. Sebnem Yilmaz Balaman is a Senior Researcher and Project Manager at Chalmers Industriteknik, Sweden, specializing in circular supply chains, bio-based production systems, and sustainability transitions. With over a decade of multidisciplinary experience, she develops modelling-based decision support frameworks to accelerate real-world implementation of bioenergy, renewable fuels, and circular material solutions. Her research delivers actionable pathways for industry, policy makers, and regional planners, helping stakeholders navigate the complex trade-offs in the shift toward a climate-neutral bioeconomy. Prior to joining Chalmers Industriteknik, Dr. Balaman served as an Assistant Professor at Dokuz Eylul University, Turkey, and held research roles at Aston University and Chalmers University of Technology. Her expertise spans techno-economic and environmental assessment, supply chain optimization, sustainability policy impacts, stakeholder engagement, and innovation-focused project management. She holds a Ph.D. in Industrial Engineering from Dokuz Eylul University and actively contributes to European collaborations driving green industrial transformation and circular value chain deployment.

Day-2

Task XXIV- Process Integration for Industry Decarbonization

Accelerating Industrial Decarbonization through Symbiosis: Insights from the Belgian Case

Rafailia Mitraki[1*], Muhammad Salman[1], Daniel Flórez-Orrego[2], François Maréchal[2], Grégoire Léonard[1]

[1]*Chemical Engineering, University of Liège, Liège, Belgium*
[2]*IPESE group, École Polytechnique Fédérale de Lausanne, Sion, Switzerland*

Industrial symbiosis is a systemic approach that promotes collaboration among industries by resources exchanges, such as energy, water, materials, and by-products, enhancing collective sustainability of industrial processes. Despite environmental and economic benefits (e.g., minimization of extracted virgin materials, mitigated emissions, reduced waste, business expansion, and higher revenues from by-products sales) barriers to the implementation of industrial symbiosis include limited knowledge of exchange possibilities and increased reliance on other system actors. Hence, this study aims to uncover possible synergies and identify robust optimal decarbonization pathways for a Belgian case study, namely, the Mons-Tournai cluster. It encompasses clinker (0.9 Mt/y) and cement (4 Mt/y) production, glass manufacturing (0.1 Mt/y), and synthesis of chemicals such as formaldehyde (0.1 Mt/y), ammonia (0.4 Mt/y), and nitric acid (0.8 Mt/y). For this purpose, equation-oriented models of the aforementioned sectors are developed, consisting of mass and energy balances, and economic details. These models incorporate industry-specific superstructures of various decarbonization pathways. These superstructures are evaluated and a Mixed-Integer Linear Programming (MILP) problem is solved to identify, for different scenarios, the optimal decarbonization configurations for each industry from an economic perspective. The corresponding total energy and molecules demand (e.g., electricity, natural gas, biomass, hydrogen, oxygen, etc.) and the CO_2 emissions of the cluster are evaluated and compared with the results obtained when cooperation between actors is implemented. In that case, by-products (e.g., oxygen from electrolysis, nitrogen from ASU, or captured CO_2 from combustion or chemical reactions) are repurposed, and the environmental and economic benefits of these synergies are assessed. Cluster-level optimization demonstrates that industrial symbiosis in Belgium contributes to industrial decarbonization and supports development of resilient, low-carbon infrastructures by uncovering cross-sectoral synergies that lower emissions and specific abatement costs compared to industry-specific strategies.

Biography:

Rafailia Mitraki is a PhD student in Chemical Engineering at the University of Liège, specializing in industrial decarbonization and industrial symbiosis. Her research focuses on designing low-carbon, resource-efficient systems through techno-economic assessments and superstructure optimization. She holds a Master's degree in Chemical Engineering and Materials Science and a Bachelor's degree in Engineering Sciences from ULiège. Rafailia also gained industry experience at Belsim, where she contributed to modeling and data validation for ethane cracking processes. Motivated by the global energy transition, she aims to support industries in achieving net-zero goals by developing innovative and scalable decarbonization solutions.

Municipal Solid Waste Valorization into Chemical Solvents for Industrial Symbiosis: Techno-Economic and Environmental Assessment

Oktay Boztaş[*1], Daniel Flórez-Orrego[1,2], Meire Ellen Gorete Ribeiro Domingos[1], François Maréchal[1]

[1]*IPESE EPFL, Federal Polytechnic School of Lausanne, Rue de l'Industrie 17, Valais/Wallis, Switzerland*
[2]*Faculty of Minas, National University of Colombia, Av. 80 #65 - 223 Medellín, Colombia*

Waste management is essential for addressing society's growing resources consumption. In countries where landfilling is banned, the waste incineration for cogeneration plays a key role in supplying power and heat to residential areas and industrial clusters. However, this solution contributes to significant CO_2 emissions. Thus, alternatives should be investigated through waste valorization and process integration to support decarbonization targets. One approach is to gasify municipal solid waste (MSW) to obtain syngas, rather than merely incinerating waste and post-capturing CO_2. The syngas obtained together with electrolysis-derived H_2 can be utilized for the synthesis of basic solvents, such as dimethylformamide (DMF) and isopropanol, commonly used in chemical industries. Spent solvents can be also recovered from industrial sites to establish a circular economy. As electricity market prices and heating demands vary significantly throughout the year due to fluctuations in renewable availability and ambient conditions, this intermittency must be addressed through chemical and/or energy storage systems, aimed to reduce the system's total cost. The analysis is performed using a multi-period mixed-integer linear programming (MILP) optimization in OSMOSE framework. These carbon management and renewable integration strategies may enhance energy efficiency (15-20%) compared to conventional waste incineration with cogeneration. Scope 1 and 2 emissions can drop 40-60% relative to current practices in waste incineration and solvents production.

Biography:

Oktay Boztaş is a Project Engineer at the Industrial Process and Energy Systems Engineering (IPESE) Laboratory at EPFL, Switzerland. His work focuses on sustainable industrial transformation through techno-economic and environmental assessment of low-carbon process technologies. He has contributed to research on circular pathways for olefins production integrating thermochemical recycling, electrification, and carbon management strategies, with recent findings published in Renewable Energy. Oktay also supports teaching in sustainable chemical process development at EPFL. He holds a Master's degree in Chemical Engineering and Biotechnology from EPFL and has prior experience in industrial R&D and process engineering roles in Switzerland and Turkey.

Transforming Whiskey Production into a Carbon-Negative and Energy-Flexible System via Heat Pumping and Renewable Energy Integration

Pullah Bhatnagar[*1], Daniel Flórez-Orrego[1,2], Oktay Boztaş[1], Meire Ellen Ribeiro Domingos[1], François Maréchal[1]

[1]IPESE EPFL, Federal Polytechnic School of Lausanne, Rue de l'Industrie 17, Valais/Wallis, Switzerland
2Faculty of Minas, National University of Colombia, Av. 80 #65 - 223 Medellín, Colombia

Whiskey production is an energy-intensive process, which also accounts for around 5 Mt of annual global CO_2 emissions. Although a majority of those emissions are derived from fermentation processes, other energy-related CO_2 emissions (e.g. distillation, refrigeration, etc.) significantly contribute to the environmental impact of this beverages sector. Thus, this study investigates decarbonization pathways that integrate electrification technologies, such as high temperature heat pumps used for low-carbon heat supply via process waste heat recovery. Moreover, biogenic CO_2 valorization via methanation to produce sustainable natural gas (SNG) is also considered. When powered by renewable electricity, the system can achieve over 90% overall CO_2 emission reductions and potentially deliver net-negative emissions by reusing biogenic carbon to displace fossil resources or permanently sequestering the biogenic CO_2. A multi-period mixed-integer linear programming (MILP) optimization using the OSMOSE framework captures the seasonal and operational variations, enabling power-to-methane integration to utilize surplus renewable electricity in low-demand periods and supply stored SNG during peak demand, thus mitigating renewable energy intermittency. The results highlight a viable pathway for transforming whiskey production and similar food and beverage applications into a carbon-negative and energy-flexible systems, which may help supporting a broader circular economy and promote net-zero transition goals even in sectors using typical unit operations of biorefineries, like fermentation.

Biography:

Pullah Bhatnagar is a PhD researcher in Process Engineering at EPFL, focusing on industrial decarbonization and sustainable energy transition pathways. His work involves techno-economic optimization and decision-support methodologies to guide emissions reduction in energy-intensive industries. He holds a Master's degree in Energy, Environment: Science, Technology & Management from École Polytechnique, and has completed research internships at IIT Delhi and Honda Motorcycle & Scooter India. His academic and professional projects span renewable energy integration, energy storage solutions, and sustainable development planning for local communities. Passionate about innovation for climate action, Pullah aims to contribute impactful solutions toward achieving global net-zero goals.

Assessment of the Impact of Alternative Energy Resources in Colombia and their Relationship with Climate Change from a Thermodynamic Perspective and the Sustainable Development Goals

Pablo Silva Ortiz

Escuela de Ingeniería Mecánica, Universidad Industrial de Santander (UIS), Bucaramanga, Colombia

In Non-Interconnected Zones (NIZ) of Colombia, fossil fuels energy consumption (i.e., coal, natural gas, firewood) generates significant greenhouse gas (GHG) emissions, contributing to global warming. This problem is intensified by a low efficiency of residential and industrial thermal systems, untapped potential of solar and biomass energy, and limited education about the environmental impact of energy use decisions. Furthermore, NIZs face challenges related to energy management (Sustainable Development Goal, SDG 7), climate action (SDG 13), and inclusive economic development (SDG 8). Given the region's climate vulnerability and Colombia's international commitment to the SDGs, classroom projects are proposed to Mechanical Engineering students at UIS in the Thermodynamics I course to research and propose sustainable solutions based on thermodynamic principles. The methodology was characterized by the flipped classroom teaching strategy in engineering applications oriented toward the analysis/evaluation of Sustainable Development Goals for energy communities in the Santander department, Colombia. The objective was to contribute to the comprehensive training of Thermodynamics I students (a 5-semester course), particularly in soft skills (Communication and Teamwork). Eight (8) case studies were defined as energy systems of interest by delimiting system boundaries and defining reference conditions and thermodynamic properties. Mass and energy balances for each process were presented. Technical performance indicators were determined and reported based on the fundamental principles of the 1st and 2nd thermodynamic laws. Next, energy and exergy efficiencies were evaluated for each case study. Additionally, financial and environmental indicators were used to assess energy management. In brief, the use of ICT tools transformed traditional teaching into an interactive, accessible, and problem-oriented model, strengthening thermodynamics training and a commitment to sustainability, raising students' awareness of issues associated with environmental and social impact. It also showcased the role of future UIS professionals as citizens and engineers who, using their knowledge, seek creative solutions to address local issues.

Biography:

Pablo Andres Silva Ortiz is an engineer specializing in research, teaching, and consulting activities supporting the transition from a fossil-based energy system to a sustainable, low-carbon biobased economy. With ten years of professional experience, I focus on the selection and implementation of energy-efficient solutions, particularly in thermal energy systems and renewable energy integration. My work spans energy, environmental, and exergy analyses, as well as process integration and optimization of complex energy systems. I am dedicated to developing innovative and practical approaches that enhance resource efficiency, reduce emissions, and accelerate the adoption of clean energy technologies across industrial and societal applications.

Integration of Biomass Gasification and Power-to-Hydrogen for Enabling Carbon-Negative Aluminium Production

Dareen Dardor[1,2], Meire Ellen Ribeiro Domingos[1], Daniel Flórez-Orrego[1], Reginald Germanier[3], Manuele Margni[2], François Maréchal[1]

[1]*Industrial Process and Energy Systems Engineering, Ecole Polytechnique Fédérale de Lausanne, EPFL, Sion, 1950, Switzerland*
[2]*Institute of Energy and Environment, School of Engineering, HES-SO Valais-Wallis, Sion, 1950, Switzerland*
[3]*Novelis Switzerland S.A., Sierre, 3960, Switzerland*

Primary aluminium production is one of the most carbon-intensive industrial processes with a global average footprint of 12–15 t_{CO2}/t_{Al} largely driven by electricity use and fossil carbon anodes in Hall–Héroult process. In this work, a systemic framework for rendering aluminium smelting a carbon-negative process is presented. It integrates biomass gasification, renewable hydrogen production, waste heat recovery, and carbon mineralization via a total-site optimization. The approach combines process simulation, mixed-integer linear programming, and prospective life-cycle assessment to evaluate the decarbonization pathways for an integrated primary and secondary aluminium production facility and a district heating network, using the Novelis Sierre site in Switzerland as a case study. Six technology configurations are assessed, including bio-char and bio-hydrogen reduction routes, water electrolysis, and hybrid seasonal switching between biomass and electricity sources. The results demonstrate that carbon-negative aluminium production (*-0.5* t_{CO2}/t_{Al}) is achievable by coupling biomass utilization, biogenic CO_2 mineralization, along with on-site power generation from waste heat recovery. As a result, the bio-hydrogen pathway offers the most cost-effective solution, combining moderate energy use with net-negative emissions and high renewable energy share. Conversely, fully electrified routes depend strongly on grid carbon intensity, emphasizing the importance of local resource integration. By coupling process-level innovation with site-wide energy and carbon integration, this study illustrates a feasible pathway toward fossil-free, carbon-negative aluminium. The developed framework provides na example of decision-support tool for other hard-to-abate sectors seeking to combine renewable resources, process optimization, and industrial-urban symbiosis for achieving climate-neutral manufacturing.

Biography:

Dr. Daniel Alexander Florez Orrego is a Mechanical Engineer from the Faculty of Mines at the National University of Colombia, Medellín, graduating as valedictorian in 2011. He holds a Master's (2014) and Ph.D. (2018, with honors) in Mechanical Engineering from the Polytechnic School of the University of São Paulo, Brazil, specializing in Energy and Fluids. With more than a decade of experience in academia, research, and industrial collaboration, his work focuses on the synthesis, optimization, and sustainability of industrial, chemical, and power generation processes. Dr. Florez Orrego has authored over 70 international technical contributions and has received support from leading institutions including ANP, ESKAS, COLCIENCIAS, PETROBRAS, NOVELIS, and the Swiss Federal Office of Energy. His excellence has been recognized with prestigious awards such as the ABCM Embraer Award for Best Doctoral Thesis (2019) and an Honorable Mention in the Outstanding Thesis USP Award (2020). He is a recognized researcher by MINCIENCIAS and an active member of ACIEM.

Integrated Bio-waste and Biogenic CO_2 Valorization, and Solid Oxide Cells for Enhanced Sustainable Natural Gas Production

Meire Ellen Ribeiro Domingos[1], Oktay Boztas[1], Daniel Flórez-Orrego[1,2], Dareen Dardor[1], François Maréchal[1]

[1]IPESE EPFL, Federal Polytechnic School of Lausanne, Rue de l'Industrie 17, Valais/Wallis, Switzerland
[2]Faculty of Minas, National University of Colombia, Av. 80 #65 - 223 Medellín, Colombia

The European Union's classification of natural gas as a transitional energy source is contested due to its high overall carbon intensity (around 450 gCO_2/kWh). Achieving European climate targets and ensuring energy independence requires scalable, sustainable alternatives like biomethane and bio-SNG. However, current biomethane production faces limitations, primarily land-use competition, demanding the exploration and upscaling of new, efficient production processes utilizing bio-waste and residues. This work investigates a novel, integrated system designed to maximize sustainable natural gas yield, while minimizing both CO_2 emissions and total cost under fluctuating energy demands and intermittent renewable energy supply. The core of the system combines anaerobic digestion and thermal gasification of unconverted digestate biomass with reversible solid oxide cells (rSOC). The rSOC provides operational flexibility by functioning either as an electrolyzer (i.e. Power-to-Gas) or as a fuel cell. The former converts excess renewable electricity into hydrogen (H_2), which can be combined with the gasification-derived syngas to produce additional methane (CH_4). Moreover, a CO_2 management system allows for seasonal storage and subsequent utilization of biogenic CO_2 to produce more CH_4 when renewable electricity becomes available. The system's power requirements are balanced by partially operating the rSOC in fuel cell mode (SOFC), in which the stored CH_4 is oxidized to generate electricity. This systematic approach demonstrates a powerful strategy for harvesting excess renewable power and converting biogenic CO_2 emissions into a value-added fuel. The performances of the integrated CO_2 management system and the overall decarbonization potential are dependent on the availability and intermittency of renewable electricity, reaching an overall efficiency above 50%.

Biography:

Chemical Engineer (University of Brasília, 2017) and PhD in Chemical Engineering (University of São Paulo, 2022), currently Postdoctoral Researcher in the IPESE group at EPFL under Prof. François Maréchal. My expertise includes biorefineries, fertilizer complexes, hydrogen and synthetic fuels (Power-to-X), and the modeling, optimization, and integration of industrial and energy conversion systems with techno-economic and environmental assessment. I contribute to major EU projects including METHAREN, PressHyous, NIAGARA, and Fertilizers AIDRES, and support industry decarbonization training through EPFL programs. I also serve as teaching assistant and co-supervise graduate students. Awards include Honorable Mention in the Outstanding Thesis USP Award.

~ Go to Contribution List

Day-2

Session-02 - Sustainable Biorefineries in a Circular Economy

Oral Presentations

Environmental Performance of Polyurethane Production from Spent Coffee Grounds

Ana Arias[1], Jose Luis Ares Sainz[1], Stamatia Skoutida[2], Sofia Maria Ioannidou[2], Apostolis Koutinas[2], Maria Teresa Moreira[1]

[1]CRETUS, Department of Chemical Engineering, School of Engineering, University of Santiago de Compostela, 15782 Santiago de Compostela, Spain

[2]Department of Food Science & Human Nutrition, Agricultural University of Athens, Iera Odos 75, Athens 118 55, Greece

In response to increasing environmental regulations and the global shift toward circular economy models, interest in bio-based feedstocks derived from waste streams is growing. Spent coffee grounds (SCGs), generated at a rate of 2 kg/kg of coffee brewed, contribute an estimated 6 Mtons of waste annually and present a valuable opportunity for valorization. This study evaluates the environmental sustainability of producing polyurethane (PU) from SCGs through a cradle-to-gate life cycle assessment (LCA). The biotechnological process comprises four main stages: pretreatment, fermentation, purification, and PU synthesis. The pretreatment stage involves sequential extraction of coffee oil (using ethyl acetate) and phenolic antioxidants (using ethanol/HCl), followed by hydrothermal treatment at 140°C and enzymatic hydrolysis to release fermentable sugars. Fermentation is conducted over 40 h using Escherichia coli producing succinic acid at a rate of 2.04 $g \cdot L^{-1} \cdot h^{-1}$. Downstream processing includes centrifugation, activated carbon filtration and compression. The succinic acid produced undergoes a two-step polymerization process to produce PU through various synthesis steps. The life cycle inventory considers 1 kg of PU as the functional unit, accounting for two co-products and applying both mass-based and economic allocation methods. Environmental impacts were assessed using ReCiPe Midpoint and Endpoint methodologies, covering 11 impact categories and 3 damage categories. Results indicate that energy consumption, particularly electricity and steam, represents the dominant contributor to environmental burdens, accounting for over 59% of total impacts across most categories. The pretreatment stage is identified as the most environmentally intensive due to its high energy and enzyme demands. Allocation analysis confirms PU as the primary impact carrier. Sensitivity analysis shows that improvements in energy efficiency and PU yield can significantly reduce environmental impacts. These findings highlight the potential of SCG-derived PU as a sustainable alternative to fossil-based polymers, provided that targeted process optimizations are implemented. This study was supported by STAR4BBS (101060588) project, funded by HORIZON-CL6-2021-ZEROPOLLUTION-01.

Biography:

Ana Arias Calvo is a postdoctoral researcher in the Department of Chemical Engineering at the Higher Technical Engineering School, University of Santiago de Compostela. She is part of the BIOGROUP Environmental Biotechnology research group, focusing on sustainable bioprocesses and circular economy approaches. Ana earned her doctorate from the University of Santiago de Compostela in 2023, with a thesis on transforming biowaste into biomaterials and bioactive products, supervised by Dr. María Teresa Moreira Vilar and Dr. Gumersindo Feijoo Costa. Her research integrates environmental biotechnology, resource recovery, and valorization of waste streams, contributing to sustainable and innovative solutions for industrial and environmental applications.

~ Go to Contribution List

Improving the Cell Robustness of Heyndrickxia coagulans for Bioconversion of Municipal Forest Wastes into Lactic Acid

M.F. Blanco, A.D. Moreno, J.M. Oliva, C. Álvarez, M. García, M.J. Negro, R. Iglesias, I. Ballesteros.

Advanced Biofuel and bioproducts Unit, Energy Department, Research Centre for Energy, Environment, and Technology (Ciemat) Madrid, Spain

Municipal Forest Waste (MFW) is an abundant lignocellulosic residue with potential for biorefinery applications. Currently, MFWs are primarily used for composting, producing products with limited added value. Its conversion through fermentation into lactic acid for polylactic acid (PLA) production could increase economic and environmental benefits within a circular economy. The thermotolerant bacterium Heydrickxia coagulans is a great candidate for lignocellulosic biomass bioconversion, due can consume xylose and glucose and transform them into lactic acid under anaerobic fermentation at high temperatures. However, lignocellulose fermentation is a challenging process due to the inhibitors released into the media during the pretreatment stages. In this study, an adaptive laboratory evolution was performed to enhance the robustness of H. coagulans against inhibitors present in lignocellulosic prehydrolysates. In the first stage, 25 passages in batch cultures were performed, increasing the concentration from 50 to 75% v/v of liquid fraction from steam-exploded MFW. In the second stage, a fed-batch bioreactor strategy was employed, and the concentration of prehydrolysate was increased gradually. After 43 days of continuous fermentation, the evolved population could ferment the complete prehydrolysate without any dilution. Several candidates were isolated from the culture, and those candidates that showed higher sugar consumption and lactic acid production were selected for future genome sequencing and transcriptome analysis in the presence of lignocellulosic-derived inhibitors. This work establishes the basis for developing an H. coagulans strain capable of fermenting MFW prehydrolysate without detoxification steps, reducing process costs and increasing feasibility for sustainable lactic acid production. Different analyses at the molecular level of the selected evolved strain will contribute to understanding the molecular mechanisms involved in robustness against lignocellulose-derived inhibitors.

Biography:

Manuel Francisco Blanco Roldán is a PhD student in Microbiology, Genetics, Biotechnology, and Bioprocessing at CIEMAT–Madrid, focusing on thermotolerant microorganisms and non-conventional yeasts for transforming lignocellulosic residues into biofuels and bioproducts. His research also explores thermotolerant bacteria for sustainable poly lactic acid production. He has prior experience in CRISPR/Cas9 plant genetic engineering, molecular biology, bioprocess optimization, and advanced cell therapies involving neural stem cells. Manuel has worked in GMP facilities, international laboratories, and collaborative EU projects, bringing strong expertise in microbial engineering, bioprocess development, and biotechnology applications. He is also an active science communicator and volunteer.

Dry Carbonization of Olive Pomace, Olive Stone and Olive Wastewater Solids for Production of Biofuels, Porous Carbon Materials or Soil Amendment Agents

Ana Paula Ramos[1,2], Didier Sanchez[1,2], Catarina Sousa[1,3], José Paulo Mota[2], Margarida Gonçalves[1,2,4]

[1]MEtRICs, Chemistry Department, FCT NOVA, Universidade NOVA de Lisboa, Caparica, Portugal
[2]LAQV/REQUIMTE, Chemistry Department, NOVA School of Science and Technology, Universidade NOVA de Lisboa, Caparica, Portugal
[3]LEAF – Linking Landscape, Environment, Agriculture and Food, Associate Laboratory TERRA, School of Agriculture, University of Lisbon, Lisbon, Portugal
[4]VALORIZA, Polytechnic Institute of Portalegre, Portalegre, Portugal

Olive pomace, olive stones and olive tree leaves are by-products of the olive oil industry. Olive stones and olive leaves are generally used for heat production. Wet olive pomace requires drying before extraction of the olive pomace oil and further use as solid biofuel. The dried olive pomace is composed of two very different fractions: olive pulp and olive stones. In this work was evaluated the production of biochars from olive mill by-products and effluents after fractionation to isolate homogeneous biomass fractions. The wet pomace was filtered, dried, milled and sieved to separate the pulp and the stone fractions. The collected wastewater was also evaporated to isolate the solid contents. All these solid fractions were subject to dry carbonization at temperatures from 250°C and 500°C, for a period of 1h. The original biomass fractions and the produced biochars were characterized by determination of elemental composition, mineral composition, apparent density and low heating value. The porosity of the biochars was indirectly evaluated by the adsorption capacity towards methyl orange and the samples with higher adsorption capacity were further characterized for porosity. The biochar samples was further characterized for water retention capacity, water leaching test and ecotoxicity of the leachate (lettuce germination test).

Increasing the carbonization temperature led to a decrease of the biochar yield (72.2% to 17.5%), and an increase of biochar porosity and ash content. The biochars produced from olive stones and the lignocellulosic fraction of olive pomace at lower temperatures are more adequate for fuel applications, while the biochars produced from olive pulp or olive mill wastewater solids at higher temperatures are more suited for soil amendment or production of carbon absorbents. The by-product fractionation enabled the isolation of homogeneous products that could be upgraded to several useful carbon-based fuels or materials.

Biography:

Ana Paula Ramos is a Chemical Engineer graduated from Lisbon University – Instituto Superior Técnico (IST) in 1984 and a member of the Portuguese Order of Engineers. She has over 35 years of experience in management systems, quality, and process optimization. Ana Paula served as Head of Corporate Quality and Process Optimization at Galp Energia, leading the design and implementation of a five-dimension Integrated Management System (Quality, Environment, Safety, Energy, and Social Responsibility) and achieving ISO certifications. Her career spans leadership roles in HSEQ, business continuity, laboratory management, accreditation, and audit. She is fluent in Portuguese, English, French, and Spanish and actively contributes to professional quality associations.

~ Go to Contribution List

Sustainability of an Innovative Antibiotics Degradation System Using Fungal Bioreactors in Livestock Manure

Pedro Tourís Sobradelo[1], Álvaro Fernández Braña[2], Julio Fierro Fernández[3]

[1]Junior Researcher, CETIM Technological Centre, Parque Empresarial de Alvedro, calle H, 20, 15810, Culleredo, A Coruña, Spain
[2]Researcher, CETIM Technological Centre, Parque Empresarial de Alvedro, calle H, 20, 15810, Culleredo, A Coruña, Spain
[3]Senior Researcher, CETIM Technological Centre, Parque Empresarial de Alvedro, calle H, 20, 15810, Culleredo, A Coruña, Spain

Livestock manure is already integrated in circular economy as it is a valuable feedstock to produce biogas and compost. However, the antibiotics used on farm animals are present on the manure and are not effectively eliminated inside anaerobic digestors, ending up on the environment and contributing to the rise of antibiotic-resistant bacteria. Fungi bioreactors have been proposed to address this problem, complementing anaerobic digestors and removing antibiotics from the final effluent, but their feasibility must be tested from the environmental and economic points of view. To do so, the Life Cycle Assessment is used to estimate the environmental performance of the proposed technology, evaluating its carbon footprint among other impact categories. To continue with the Life Cycle framework, Life Cycle Costing was selected to estimate the economic feasibility of the proposed solutions considering design, construction, operation and end of life stages. An eco-design approach is possible with both tools at our disposal, allowing to propose changes in the developing technology that minimise both the environmental footprint and the costs associated. This way, antibiotics pollution and the resistance which create is reduced with a system that is environmentally respectful and guarantees the profitability of the biorefinery. The preliminary results show that adding the fungi bioreactor to the anaerobic digestor added less than 10% of carbon footprint and is a cost-efficient strategy to eliminate antibiotics. Considering this study, the potential benefits of adding fungal bioreactors to already existing anaerobic digestors are enough to justify the expected investment, as it will provide an adaptable technology able to complement them solving a growing environmental concern at reasonable cost.

Biography:

Pedro Tourís Sobradelo is a research and development professional at CETIM Technological Centre with a strong background in physics and renewable energy. He holds a degree in Physics and a Master's in Renewable Energy, Climate Change, and Sustainable Development from the Universidade de Santiago de Compostela. Pedro specializes in Life Cycle Assessment (LCA), Life Cycle Costing (LCC), and Social LCA (S-LCA) using software like SimaPro and OpenLCA, applying ecodesign principles to promote sustainability. His work focuses on translating scientific knowledge into practical solutions for renewable energy and sustainable development, contributing to industry projects and research that drive environmental and social impact.

~ Go to Contribution List

Practical Application and Environmental Profile of Sustainable Sludge Management by Biopolymer Valorisation

Á. Fernández Braña, L., Sánchez Fernández, R., Iglesias Iglesias, A. Otero Rodriguez, J. Fierro Fernández

1Centro Tecnológico de Investigación Multisectorial (CETIM), 15180 Parque Empresarial de Alvedro (Culleredo), A Coruña (Spain)

The management of specific types of biowaste such as those originated in agro-industrial activities, food processing, dairy industry, sewage sludge or biodiesel and syngas production in biorefineries represents a challenging task, as they are heterogeneous substances, rich in organic matter and in other nutrients that cause environmental pollution if not managed properly. Therefore, it is of great interest to implement alternative management strategies which enable the valorisation of this biowaste, in order to obtain not only resources – biogas, compost – but also high-value added products. To this respect, the production of polyhydroxyalkanoates (PHAs) is one of the most promising approaches to attain this goal. PHAs are a kind of biopolymers with biodegradable and biocompatible properties that make them potential substitutes for petroleum-based plastics with a varied field of applications in medicine, packaging, etc. However, the industrial-scale production of PHAs is stalled by its costs. In particular, the price of the carbon substrate represents more than 50% of the total production cost. Hence, the utilisation of inexpensive and renewable residual carbon substrates such as sewage sludge generated in wastewater treatment plants (WWTPs), as well as relying on microbial mixed cultures naturally found in wastewater, might be a way of reducing PHA production cost, while at the same time providing a feasible and commercially attractive solution for valorising the waste flows generated in the water cycle. Within the scope of the REWAISE project, a series of experiments of PHA production based on urban WWTP sludge was performed with the purpose of establishing the optimal conditions for the microbial consortium, in order to maximize both biopolymer production and process stability. A first batch experiment was done to evaluate the acidogenic potential of the sludge from a given urban WWTP. After several trials, the best operating conditions for the volatile fatty acids (VFAs) production corresponded to a hydraulic residence time (HRT) of 10 days, pH not controlled and range of organic loading rate (OLR) between 0.5–2 g COD/L per day. Next, for selection and enrichment of a PHA-accumulating culture, a CSTR of 3 L was inoculated with aerobic sludge from Guijuelo WWTP and other sludge from a WWTP of brewery industry. The reactor was operated under a feast and famine regime with uncoupled carbon and nitrogen availability, and fed with two types of feedstocks: the first one was a synthetic feedstock of VFAs and the second one corresponded to the effluent produced during the acidification stage with the urban WWTP sludge. Finally, different fed batch accumulation assays were carried out with the different feedstocks produced in the acidogenic reactor and also with a synthetic feedstock in order to know the maximum capacity of PHA intracellular accumulation of the microbial mixed culture. Accumulation with synthetic feed reached 55% while with real feed it reached 30%. The results of the fed-batch experiments showed that nitrogen content was the most determining parameter in PHA accumulation. When nitrogen is not present in the media as with the feedstock mixture, the maximum capacity of the culture to accumulate PHA inside of the biomass is almost double. Based on lab results and characteristics of both substrates, a pilot plant for PHA production will be constructed for further validation in a real scale environment – a fibreboard production factory – with specific wastewater composition, to demonstrate its feasibility under upscaled conditions. Experimental results will serve as basis and be complemented by a Life Cycle Assessment (LCA) in order to obtain an updated environmental profile of PHAs production, thus highlighting its environmental benefits compared to conventional fossil-based. The whole life cycle will be considered, with a special focus on extraction stage, since it is identified as an environmental bottleneck.

Biography:

Ana Otero Rodríguez is a PhD Chemical Engineer specializing in sustainability, circular economy, and waste valorization. She works as a Researcher in ECO BIO Technologies at CETIM Technological Centre, where she coordinates and executes R&D projects focused on biorefineries, renewable gases (biogas, biomethane, biohydrogen), and the valorization of organic waste and wastewater. With experience at IRTA and MAFRICA S.A., her doctoral research centered on optimizing anaerobic digestion of animal by-products for enhanced biogas production. Ana brings strong technical, supervisory, and project management skills, collaborating with multidisciplinary teams to develop innovative and sustainable solutions for energy and environmental challenges.

~ Go to Contribution List

Advancing Power-to-Protein for Anaerobic Digestion By-Products Valorization: The Impact of Cathode Functionalization

Gabriele Soggia[1], Amin Narimani[1], Barbara Mecheri[2], Niccolò Forin[3], Andrea Squartini[3], Fabrizio Adani[1]

[1]Gruppo Ricicla, Dipartimento di Scienze Agrarie e Ambientali: Produzione, Territorio, Agroenergia, Via Celoria 2, 20133, Milan, Italy

[2]Department of Chemical Science and Technologies, University of Rome Tor Vergata, Via della Ricerca Scientifica 1, 00133, Rome, Italy

[3]Department of Agronomy, Food, Natural Resources, Animals and Environment, DAFNAE, University of Padova, Viale Dell'Università 16, 35020, Legnaro, Italy

Power-to-Protein represents an innovative strategy for storing surplus renewable electricity by converting it into single-cell protein (SCP). Compared to conventional protein sources, SCP offers several advantages: greater environmental sustainability, independence from climatic variability, substantially lower water and land requirements, higher nutrient utilization efficiency, and superior protein yield (on a dry weight basis). Moreover, in accordance with circular economy principles, agricultural by-products such as CO_2 and NH_3 derived from anaerobic digestion can be valorized through the integration of SCP production with bioelectrochemical systems (BES).

In this study, three different biochar-based cathode functionalizations were tested to evaluate their impact on microbial activity, biomass productivity, SCP yield, and nitrogen capture efficiency using a microbial electrosynthesis cell operated at a cathode potential of –1.2 V vs Ag/AgCl, with 1.25 g L-1 of NH_4Cl in the medium. The results demonstrated that functionalized cathodes (E1, E2, and E3) significantly enhanced system performance compared to bare carbon cloth (E0, control). The best-performing cathode (E1) achieved over 500% increase in biomass productivity compared to the control. The protein content ranged between 42% and 49% d.m., markedly higher than the 8% observed using E0.

Nitrogen capture efficiency reached 20% with E1. Amino acid analysis revealed that cathode functionalization enabled achieving up to 40% essential amino acids relative to the total protein content.

These findings highlight the potential of SCP as a sustainable alternative to conventional (animal- and plant-based) protein sources and demonstrate how cathode functionalization with low-cost, environmentally friendly materials such as biochar can enhance SCP production in BES, enabling simultaneous by-product valorization, carbon capture, and the generation of value-added products in a circular and bioeconomy perspective.

Biography:

Gabriele Soggia is a PhD student at Università degli Studi di Milano, cofunded by RSE S.p.A., specializing in bioelectrochemical Power-to-X technologies for sustainable energy solutions. His research focuses on Power-to-Methane and Power-to-Protein, integrating renewable energy storage with resource recovery to produce high-value products. Passionate about bioeconomy and circular economy, Gabriele aims to bridge biotechnology and sustainability. He has experience in pilot-scale algal biomass production and microbial electrosynthesis systems, including cathodic biofilm characterization using Optical Coherence Tomography. He holds a Master's in Biotechnology for the Bioeconomy and a Bachelor's in Biotechnology, with strong expertise in green chemistry, microorganisms, plants, and innovative sustainable practices.

Unlocking Bioenergy from Industrial Wastewater: Enhancing Methane Recovery through Intermittent Anaerobic Digestion

Cátia Couras[1], Jorge H. Leitão[2], Maria Helena Nadais[3]

[1]Department of Environment and Planning, University of Aveiro, Aveiro, Portugal
[2]Bioengineering Department & iBB-Institute for Bioengineering and Biosciences, Associate Laboratory Institute for Health and Bioeconomy-i4HB, Instituto Superior Técnico - University of Lisbon, Lisbon, Portugal.
[3]Department of Environment and Planning & CESAM-Centre for Environmental and Marine Studies, University of Aveiro, Aveiro, Portugal

Industrial wastewater streams from food and agro-processing sectors contain large amounts of biodegradable organic matter with significant energetic potential. However, the conversion of these complex substrates into biogas is often limited under conventional continuous anaerobic digestion, resulting in incomplete methane recovery and frequent operational instability. Advancing wastewater treatment from a cost-based process to a bioenergy-generating system requires operational strategies capable of improving both conversion efficiency and system robustness.

This work investigates the use of intermittent (sequencing) feeding in UASB reactors as an alternative to continuous operation when treating high-strength wastewater containing slowly biodegradable compounds. The objective is to assess whether feed–pause cycles can enhance microbial degradation performance, increase methane yield, and improve reactor stability, without requiring additional infrastructure or pretreatment.

Several laboratory-scale experiments were carried out under controlled operating conditions, applying alternating phases of organic loading and feedless digestion. Performance was evaluated based on methane production, COD removal efficiency, sludge activity, and biogas composition. The results show that intermittent feeding can increase specific methane yield by up to 25%, reduce the accumulation of inhibitory intermediates and improve the degradation of fats and long-chain fatty acids typically present in food industry effluents. The strategy also demonstrated greater tolerance to fluctuations in organic load, suggesting improved resilience for real-scale operation. Importantly, these benefits were achieved without changes in reactor design, making the approach compatible with retrofitting existing anaerobic treatment systems.

In addition to enhanced bioenergy recovery, intermittent operation exhibited higher process stability in the presence of the antibiotic sulfamethoxazole (SMX), a contaminant of increasing concern in industrial effluents. Reactors operated in sequencing mode showed lower performance inhibition and a significant reduction in the propagation of antibiotic-resistant bacteria and resistance genes, indicating an added environmental and public-health benefit beyond bioenergy production.

The findings position intermittent anaerobic digestion as a practical pathway for integrating bioenergy recovery and contaminant mitigation into industrial wastewater management, contributing to circular bioeconomy goals, energy self-sufficiency and reduced environmental risk.

Biography:

Maria Helena Gomes de Almeida Gonçalves Nadais is an Auxiliary Professor at the University of Aveiro, specializing in environmental engineering, wastewater treatment, anaerobic processes, biochar applications, and sustainability assessment. She holds a PhD in Applied Environmental Sciences and a Master's in Chemical Engineering from Instituto Superior Técnico, as well as a Master's in Specialized Translation. With over 30 journal articles and two books, her research spans anaerobic digestion, biopolymers, water quality, industrial effluents, and environmental management systems (ISO 9001/14001). She has contributed to numerous national and international projects, advancing circular economy practices, resource recovery, and sustainable environmental technologies.

~ Go to Contribution List

Integration of Upstream to Downstream Processes for Renewable Resources Conversions into Valuable Products of Biofuels and Biopolymers Under Minimizing Waste, Maximizing Resource Efficiency, and Regenerating Natural Concepts

Pakawadee Kaewkannetra[1], P. Dujjanutat[2], T. Kumsaen[3], A. Neramittagapong[3], K. Wantala[3]

[1]*Department of Biotechnology, Faculty of Technology, Khon Kaen University, Khon Kaen 40002, Thailand.*
[2]*Department of Agricultural Extension and Development, Faculty of Agriculture, Khon Kaen University, Khon Kaen 40002, Thailand*
[3]*Department of Chemical Engineering, Faculty of Engineering, Khon Kaen University, Khon Kaen 40002, Thailand.*

Sustainable biorefineries represent a critical component for converting renewable resources into valuable biofuels. This study explores the integration of various conversion processes to produce high-value biofuels and biopolymers.

Our approach focusses on developing an integrated biorefinery system that connects upstream biomass processing with downstream conversion to produce high-value biofuels including biodiesel or fatty acid methyl esters (FAMEs), bio-hydrogenated diesel (BHD), and sustainable aviation fuel (SAF) from waste cooking oil (WCO), palm oil, rice bran oil and microalgal oil as initial raw materials. While, for biopolymer of polyhydroxyalkanoate (PHA) was produced using sugar based raw materials such as sugarcane, sweet sorghum, longan and even pineapple cannery waste. The research project integrates sustainability and nature-positive indicators to ensure both economic viability and environmental regeneration objectives.

Experiments were conducted via lab to pilot scales through testing of key conversion processes; for biofuels including acidic/basic/enzymatic transesterifications to produce biodiesel or FAMEs, a hydro-processing route (hydrotreating and hydrocracking reactions) for BHD and SAF production. Meanwhile, different bio-fermentations of batch, fed-batch, repeated batch and repeated fed batch processes to produce a biopolymer of PHA.

Results demonstrated that the improvement in overall resource efficiency compared to standalone conversion processes, achieving zero waste generation through effective valorization and process integration. The optimized upstream-downstream successfully produced high-quality biofuels (FAME, BHD, and SAF) and polymers of PHA meeting international standards. Implementation of circular economy principles not only minimized environmental impact but also created additional revenue from valorized waste products, demonstrating economic viability of nature-regenerative biorefinery operations.

Successfully, integration of upstream-downstream processes for multiple biofuels and biopolymers products. The findings indicate that nature-positive biorefinery operations can serve as catalysts for circular economy, transforming waste management and agricultural practices. These results have significant suggesting that targeted incentives for integrated biorefinery development could accelerate the transition to sustainable energy systems.

Biography:

Pakawadee Kaewkannetra is a Professor of Biotechnology at Khon Kaen University, Thailand, with over 25 years of academic and research experience. She has held positions as Assistant Professor, Associate Professor, and Professor, contributing extensively to teaching, research, and mentorship in biotechnology. Her work encompasses molecular biology, microbial biotechnology, and applied research aimed at advancing scientific knowledge and practical applications in the field. Committed to academic excellence, Pakawadee has guided numerous students and researchers, fostering innovation and collaboration in biotechnology at Khon Kaen University. She continues to influence the field through her expertise, leadership, and dedication to sustainable scientific development.

~ Go to Contribution List

Day-2

Session-05 - Advanced Biofuels and Platform Chemicals for Industry Sectors

Oral Presentations

Evaluating Circularity and Sustainability Impacts of Renewable Liquid Fuel Production Pathways

Cédric Diffo Téguia, Georgiana Bele and Marzouk Benali

Natural Resources Canada, CanmetENERGY, Varennes (Quebec) Canada

The transition to a low-carbon economy is a critical global challenge, requiring systemic approaches that integrate both sustainability and circularity within industrial value chains. For renewable liquid fuel pathways, this means going beyond traditional assessments of environmental and economic performance to also address material and energy circularity, to effectively contribute to carbon management objectives.

This study addresses the challenge of evaluating sustainability and circularity impacts, using a generalized and unified approach that could be systematically applied for various contexts of industrial biorefinery implementation. Such an approach builds on a comprehensive framework of sustainability metrics—covering economic, environmental, social, and policy dimensions—while integrating circularity indicators tailored to biorefinery systems. Key metrics include the share of non-virgin feedstock and utilities, the proportion of renewable and bio-based non-virgin feedstock relative to total inputs, and the ratio of renewable energy use to total site energy demand. Together, such metrics provide insight into resource efficiency, reliance on virgin materials, and alignment with broader bioeconomy goals.

The framework is demonstrated through a case study comparing three renewable liquid fuel pathways: Gasification with Fischer-Tropsch, integrated catalytic fast pyrolysis and hydroprocessing, and integrated hydrothermal liquefaction. Results reveal trade-offs and synergies between sustainability and circularity performance across pathways, underscoring the value of combining these metrics to guide decision-making and enable the sustainable deployment of biorefineries.

Biography:

Marzouk Benali is a Research Manager and Senior Research Scientist at Natural Resources Canada (CanmetENERGY) in Varennes, Quebec, specializing in bioenergy, clean fuels, hydrogen, and biomaterials. With over 30 years of experience, he focuses on chemical process design, industrial process optimization, and decarbonization strategies, including pilot-scale development, techno-economic assessments, and LCA-based environmental evaluation. Marzouk leads multidisciplinary projects in biorefinery and forest value chain optimization, contributing to sustainable energy solutions and net-zero GHG emission pathways. He has also served as an adjunct professor at Université Laval and Polytechnique Montréal, mentoring students and advancing research in energy transition and clean technology innovation.

Comparative LCA of Municipal Solid Waste to Fischer-Tropsch Fuel Pathways and Tail Gas Utilization Strategies

Jayakrishnan K. Ravindran[1,2], Duncan P. Fagg[1,2], Margarida C. Coelho[2,3]

[1]*Department of Mechanical Engineering / Centre for Mechanical Technology and Automation (TEMA), University of Aveiro, Campus Universitário de Santiago, 3810-193 Aveiro – Portugal*
[2]*LASI – Intelligent Systems Associate Laboratory, Guimarães, Portugal.*
[3]*Department of Environment and Planning / Centre for Mechanical Technology and Automation (TEMA), University of Aveiro, Campus Universitário de Santiago, 3810-193 Aveiro – Portugal*

The use of liquid fuels, especially in the transportation sector, is a significant contributor to climate change. Another significant issue is that of municipal solid waste (MSW) disposal. This study quantifies the environmental impacts associated with the production of drop-in fuels from MSW by combining gasification and the Fischer-Tropsch (FT) process. A cradle-to-gate life cycle assessment (LCA) compares four process configurations (direct or indirect gasification combined with a solid oxide electrolyzer (SOEC) or the water gas shift reaction (WGS) for H_2/CO ratio correction) and two tail gas utilization strategies (recirculation within the system or combustion for energy generation) to identify the most environmentally friendly option. The functional unit of the study is 48.5 MJ of FT-fuel produced and the environmental impacts are quantified using the ReCiPe 2016 midpoint methodology on SimaPro 10.2.

Among the four process configurations, it is seen that combining direct gasification with an SOEC for H2/CO ratio correction leads to the lowest overall environmental impacts. Reductions of almost 20% can be seen in global warming potential (GWP) for this configuration as compared to direct gasification combined with WGS. The recirculation of tail gas with a recirculation ratio of 0.8 leads to a further reduction of global warming potential GWP by 42% as compared to energy generation with the tail gas. Similar trends are seen in all the other impact categories, with the most significant reductions seen in ozone formation potential (OFP) (51%) and fossil resource scarcity (FRS) (51%).

This study demonstrates that by using an SOEC and utilizing tail gas efficiently, significant reductions in environmental impacts can be achieved in drop-in fuel production from MSW.

Biography:

Jayakrishnan Ravindran is a Ph.D. researcher at TEMA – Centre for Mechanical Technology and Automation, Universidade de Aveiro, specializing in clean energy transition. His work focuses on the environmental, economic, technical, and policy aspects of green liquid fuels derived from biogas, combining life cycle assessment, feasibility studies, use-phase simulations, and policy analysis. With a Master's in Sustainable Energy and Green Technologies from UCD and a Bachelor's in Physics, he has strong expertise in renewable energy systems, impact analysis, and modeling tools such as GaBi, Screen-view, and Homer. Jayakrishnan is passionate about sustainable energy, teamwork, and applying research to drive a low-carbon future.

~ Go to Contribution List

Day-2

Session-06 - Hydrogen Value Chain

Oral Presentations

Integrated Hydrogen Production and Chemical Storage: Techno-economic and Carbon Intensity Perspectives

Georgiana Bele, Cédric Diffo Téguia and Marzouk Benali

Natural Resources Canada, CanmetENERGY, Varennes (Quebec) Canada

Hydrogen is increasingly recognized as a key enabler of deep decarbonization across industrial sectors, playing a role of both an energy carrier and chemical feedstock. Its conversion to ammonia enables large-scale chemical storage and long-distance trade, as well as utilization flexibility in various chemical applications. Developing efficient low-carbon hydrogen-to-ammonia pathways is therefore critical to scale-up hydrogen value chains and support sustainable energy transitions.

This study extends a harmonized techno-economic and environmental assessment performed for water electrolysis and natural gas-based hydrogen production pathways by evaluating their integration with ammonia synthesis for large-scale storage. Comprehensive mass- and energy-based analysis was carried out to evaluate hydrogen and ammonia production, while exploring potential synergies from process integration perspectives. As the carbon footprint and price of electricity are anticipated to play a major role, the pathways are further evaluated under three distinct grid scenarios: fossil-dominant, renewable-dominant, and mixed grid.

Results reveal important trade-offs between efficiency, cost, and carbon intensity when coupling hydrogen production with ammonia storage, as well as the influence of policy mechanisms such as subsidies, carbon pricing, and emissions reduction incentives. This integrated modelling assessment provides insights for industry stakeholders and policymakers on the competitiveness and long-term viability of low-carbon hydrogen within the context of sustainable energy systems.

Biography:

Marzouk Benali is a Research Manager and Senior Research Scientist at Natural Resources Canada (CanmetENERGY) in Varennes, Quebec, specializing in bioenergy, clean fuels, hydrogen, and biomaterials. With over 30 years of experience, he focuses on chemical process design, industrial process optimization, and decarbonization strategies, including pilot-scale development, techno-economic assessments, and LCA-based environmental evaluation. Marzouk leads multidisciplinary projects in biorefinery and forest value chain optimization, contributing to sustainable energy solutions and net-zero GHG emission pathways. He has also served as an adjunct professor at Université Laval and Polytechnique Montréal, mentoring students and advancing research in energy transition and clean technology innovation.

~ Go to Contribution List

Advancing Low-Carbon Hydrogen Deployment: Codes and Standards for a Sustainable Value Chain

Olumoye [Moye] Ajao[1] and Marzouk Benali[1]

[1]*Natural Resources Canada, Natural Gas and Hydrogen Division, Ottawa (Ontario) Canada*
[2]*Natural Resources Canada, CanmetENERGY, Varennes (Quebec) Canada*

Achieving a net-zero future will require diverse decarbonization pathways, with low-carbon hydrogen playing a pivotal role in transforming hard-to-abate sectors such as steelmaking, aviation, and heavy transport. To support this transition, Natural Resources Canada, in collaboration with the Standards Council of Canada, has developed the Canadian Hydrogen Codes and Standards Roadmap. This comprehensive document identifies critical gaps across the hydrogen value chain and highlights priority areas where codes and standards can enable the safe, efficient, and sustainable deployment of hydrogen and related technologies.

As a flagship output of the Codes and Standards Working Group (CSWG), the roadmap advances Canadian priorities by providing a unified framework to guide standardization solutions involving industry, policymakers, and technical experts. It emphasizes the foundational importance of harmonized standards to support hydrogen production, transportation, storage, and end-use applications.

In response to the priority gaps identified in the roadmap, the presentation will demonstrate how codes and standards act as enablers across the bio-based hydrogen value chain—from innovation to commercialization. Case studies will illustrate how research and capacity-building activities contribute to standardization, including the development of a harmonized methodology for reporting hydrogen production pathways and carbon intensity. By bridging science and policy, the Canadian experience demonstrates how coordinated codes and standards efforts will accelerate hydrogen adoption, enhance safety and public confidence, and strengthen international collaboration toward sustainable value chains.

Biography:

Marzouk Benali is a Research Manager and Senior Research Scientist at Natural Resources Canada (CanmetENERGY) in Varennes, Quebec, specializing in bioenergy, clean fuels, hydrogen, and biomaterials. With over 30 years of experience, he focuses on chemical process design, industrial process optimization, and decarbonization strategies, including pilot-scale development, techno-economic assessments, and LCA-based environmental evaluation. Marzouk leads multidisciplinary projects in biorefinery and forest value chain optimization, contributing to sustainable energy solutions and net-zero GHG emission pathways. He has also served as an adjunct professor at Université Laval and Polytechnique Montréal, mentoring students and advancing research in energy transition and clean technology innovation.

~ Go to Contribution List

Day-2

Session-07- Digital Transformation in Biorefinery, Decision Support Systems and Scenario Analysis

Oral Presentations

Assessing the Potential for Bio-Aromatics Supply to the Netherlands: A Techno-Economic and Regional Supply Chain Perspective

Puck Wammes, Milkica Jovicic, Tonny Manalal, Ayla Uslu, Jonathan Moncada Botero

The Netherlands Organisation for Applied Scientific Research – TNO, Energy & Material Transition (EMT), Amsterdam, The Netherlands

The abstract should clearly and succinctly summarize the key aspects of the work, including:

- Background: Brief context and motivation.
- Objectives: Main aims of the study/project.
- Methods: Summary of the methodology or approach used.
- Results: Key findings, if available.
- Conclusions: Main takeaways and/or potential implications. Avoid references, figures, or equations.

Background: Achieving net-zero emissions by 2050 requires a transition to sustainable feedstocks for the chemical industry. Biomass-derived aromatics, more specifically benzene, toluene, and xylene (bio-BTX) can defossilise aromatics production, but their supply potential and cost competitiveness remain uncertain.

Objectives: This study evaluates the techno-economic feasibility of supplying bio-BTX to the Netherlands from various European regions, focusing on the trade-offs, bottlenecks, and opportunities across the supply chain to meet the Dutch bio-aromatics demand.

Methods: A spatially explicit supply chain tool was developed that integrates biomass availability, conversion technologies, biomass compatibility, logistics, and competing uses. The tool accounts for biomass competition with energy generation and alternative uses such as second-generation bunker fuel, bio-based methanol, and olefins.

In this paper, two conversion pathways are compared, hydrothermal liquefaction (HTL) and methanol-based synthesis (BTA) and three transport configurations (import of: biomass, intermediates like bio-crude oil, and aromatics to the Netherlands), across five regional clusters: France (FR), Germany (DE), Finland and Sweden (FI+SE), Romania-BulgariaCroatia (RO+BG+HR), and Portugal-Spain (PT+ES). The analysis quantifies BTX production costs for 2030 and 2050, disaggregated into raw material, utilities, operations and maintenance (O&M), capital expenditure (CAPEX), and transport costs.

Key findings: In a conservative 2050 scenario, meeting Dutch demand requires 15% of remaining regional biomass. System costs via HTL range from €2740/tonne (FI+SE intermediate imports) to €3993/tonne (BTX imports from RO+BG+HR). Bio-BTX imports average €3778/tonne of BTX, while importing the intermediate averages €3079/tonne of BTX. For BTA, system costs range from €2334/tonne (BTX from DE) to €1710/tonne (intermediate from FR), both lower than HTL.

Conclusion: Results indicate variation in cost contribution and highlight regional differences. The tool therefore allows for strategic decision making to meet the Dutch bio-aromatics demand whilst emphasising that no single pathway is superior universally.

Biography:

Puck Wammes is a scientific researcher at TNO, focusing on energy transition and the decarbonization of industry, fuels, and feedstocks. His work integrates economic, societal, and policy dimensions, using both qualitative and quantitative analyses to evaluate environmental and climate impacts of energy policies, technological innovations, and societal behavior. He holds a Master's degree in Industrial Ecology from Delft University of Technology and Leiden University, with research experience in life cycle assessment of biofuels. Puck combines multidisciplinary expertise with practical experience in sustainability projects, communication, and industrial ecology, aiming to advance fossil-free energy solutions and support the transition to a low-carbon society.

~ Go to Contribution List

Poster Presentations

Effect of Operational Parameters on the Alcohol-Based Liquefaction of sargassum fluitans and natans

Katerin J. Páez M.[1], Loubna Hadhoum[1,2], Khaled Loubar[1], Morgane Briand[3]

[1]IMT Atlantique, CNRS, GEPEA, UMR 6144, F-44304 Nantes, France
[2]ICAM, Nantes, France
[3]S3d Ingénierie, Nantes, France

Sargassum fluitans and Sargassum natans, accumulate massively in the Atlantic Ocean and the Caribbean region, forming large floating mats. Since 2011, Martinique has faced recurring strandings of these pelagic algae, posing serious health, environmental and economic challenges due to hydrogen sulfide (H_2S). Hydrothermal liquefaction (HTL) has emerged as a promising technology for converting Sargassum into bio-oil, as it operates in aqueous environment, avoiding the need for drying and at relatively low temperatures, offering better energy efficiency than other thermochemical methods.

In this study, Sargassum liquefaction was optimized using a Central Composite Design (CCD) by varying temperature, biomass concentration, and reaction time to maximize bio-oil (BO) yield and minimize solid residue (SR) yield. The mathematical model indicated that the solvent-to-biomass ratio had the greatest impact on BO yield, followed by temperature, with residence time showing no significant effect.

Optimal operating conditions were determined via Minitab, resulting in a temperature of 295°C, a reaction time of 19 min, and a solvent-to-biomass ratio of 9 (g/g). Under these conditions, the experimental products yield distribution were 44.62 wt% BO, 28.95 wt% SR, 19.31 wt% aqueous phase and 7.12 wt% of gas. When compared to the model predictions, the relative errors were minimal, 5.78 wt% for BO yield and 1.14 wt% for SR yield. Additionally, an increase in conversion rate and an improvement in oil quality were observed, as the carbon content and higher heating value (HHV) were higher compared to bio-oils produced under other conditions.

However, the HHV remains relatively low at 6.55 MJ/kg, even lower than that of the raw biomass which is 9.33 MJ/kg, suggesting that this process may not represent the most effective route for the valorization of Sargassum. Future work will focus on exploring alternative valorization pathways for the various products obtained.

~ Go to Contribution List

Projecting Future Costs of Methanol Production From Biogenic CO_2 Sources Using Component-Based Learning Rates

Eliana Lozano Sanchez[1], Ajay Koushik[2], Andrea Ramirez Ramirez[2]

[1] *Department of Energy, Aalborg University, Aalborg, Denmark*
[2] *Department of Chemical Engineering, Faculty of Applied Sciences, Delft University of Technology, Delft, The Netherlands*

Learning curves have been extensively used in the past decades to project cost reductions of renewable energy technologies as a result of increased accumulated experience over time. The method correlates historical data of costs and cumulative production and has become increasingly valuable for scenario analysis and energy systems modeling. In the case of relatively new technologies, component-based approaches have been used to project overall costs based on assumed/existing data of separate components, given the lack of empirical data for a complete plant. This approach addresses the fact that individual components can learn at different rates. Recent examples in literature are e.g. direct-air capture and Fisher-Tropsch fuels.

In this study, we focus on the production of synthetic methanol, a key molecule for the energy transition in the chemical and transport sectors, for which generic learning rates have been used in literature but component-based approaches have not been investigated in detail. Thus, the main objective is to develop a component-based expression to estimate future investment and operational costs of methanol production plants that can be integrated in ex-ante techno-economic assessments for future energy systems modeling.

For this purpose, we derive a cost correlation that integrates well-established scaling and learning terms per component to predict total capital investments at different plant sizes. This bottom-up analysis is based on Aspen simulations, correlations from open literature, and gathered data on learning ratios and installed capacities for different components, with special emphasis on electrolyzers and compressors due to their anticipated high share in the overall capital and operational costs. Furthermore, we use the derived expression to investigate the impact of learning in optimum methanol plant sizes for different types of biogenic CO_2 transport and in-situ electrolytic hydrogen production.

Circular Bioeconomy Strategies: Microalgae-Driven Bioremediation and Bioenergy Recovery from Anaerobic Digestate

Guilherme Silva[1,2], Tiago Lopes[2], Alberto Reis[2], Natalia Renato[1]

[1]National Laboratory of Energy and Geology (LNEG), Bioenergy and Biorefineries Unit, Lisbon, Portugal
[2]Federal University of Viçosa, Department of Agricultural Engineering, Viçosa, Brazil

Anaerobic biotechnology is recognized as an effective technology, converting waste into value-added products. Biomass-derived energy is increasingly acknowledged as a key renewable source for the future. In response to the growing demand for sustainable energy solutions, advances in bioenergy have increased interest in the anaerobic co-digestion of cattle manure in combination with various biomass sources to maximize biogas yields. Additionally, the application of microalgae in digestate remediation offers a method for nutrient recovery, providing a sustainable feedstock for biofuels and other bio-based products. This process supports resource efficiency and sustainability in the bioeconomy. The objective of the work was to evaluate the efficiency of the anaerobic digestion process and production of biogas through co-digestion of Arundo donax L. plant biomass and cattle wastewater (CWW), then evaluate the digestate bioremediation mediated by microalgae. Batch tests were conducted in anaerobic digesters with different substrate ratios. The co-digestion treatment produced 695 mL of biogas compared to 412 mL from the control. However, the final digestates from the co-digestion process had high nitrogen and phosphate compound values for disposal, but with potential for use as a culture medium for the microalgae. Subsequent treatment in photobioreactors achieved expressive bioremediation, with values by over 90% for COD and PO_4^{3-}, and almost up to 100% for NH_4^+, while enabling bioproduct generation. The environmental impact of the system was evaluated using Life Cycle Assessment (LCA) methodology, as outlined by ISO 14040/44. The Life Cycle Inventory (LCI) was developed with mass and energy balances derived from process simulation in SuperPro Designer. LCA analysis was conducted with openLCA v2.5, utilizing Ecoinvent 3.11 and the ReCiPe 2016 Midpoint impact assessment method. Co-digestion increased biogas, and microalgae treatment removed nutrients and enabled bioproducts. The preliminary LCA indicates that the proposed approach may have potential for environmental sustainability.

~ Go to Contribution List

Experimental Optimization on Hemicellulosic Sugars Production From Sunflower Stalks Pretreated by Steam Explosion

Alfonso M. Vidal[1,2], Francisco Espínola[1*], Cristóbal Cara[1,2], Raquel García-Barranco[1], José Miguel Oliva[3], Cristina Álvarez[3], Encarnación Ruiz[1,2]

[1]Department of Chemical, Environmental and Materials Engineering, University of Jaén, Campus Las Lagunillas, 23071, Jaén, Spain
[2]Institute of Biorefineries Research (I3B), University of Jaén, Campus Las Lagunillas, 23071, Jaén, Spain
[3]CIEMAT, Avda. Complutense 40, 28040, Madrid, Spain

The growing concern for sustainability has driven the search for renewable sources, with lignocellulosic biomass being emphasized as a key alternative to fossil resources. Agricultural residues such as sunflower stalks, produced in millions of tons annually, remain largely underutilized despite their potential to yield platform sugars, including valuable oligosaccharides. Effective biomass pretreatment is needed to achieve fractionation and utilization of all biomass components. For all these reasons, the main objective of this study is to valorize sunflower cultivation byproducts by converting them into value-added platform products.

Sunflower stalks were used as the raw material for valorization, and steam explosion was employed as the pretreatment method. A design of experiments (DOE) approach was used to plan the trials, conduct statistical analyses, and identify relationships between process variables. A Box-Behnken DOE, comprising 17 runs (including five replicates at the center point), was conducted to study the influence of sulfuric acid concentration (0–30 mg H_2SO_4/g biomass), temperature (180–220 °C), and residence time (2–10 minutes). The concentration of solubilized sugars in the liquid fraction was analyzed by high-performance liquid chromatography (HPLC).

Following statistical analysis, process optimization was performed to maximize xylose recovery, the predominant hemicellulosic sugar, in the prehydrolysate. The optimal conditions were determined to be 185 °C, 3.1 minutes, and 29.9 mg H_2SO_4/g biomass. Under these conditions, a xylose recovery of 53% was achieved, with oligosaccharides accounting for 92% of the solubilized sugars. These oligosaccharides could hold potential for use in the food and pharmaceutical industries. The remaining solid could also be investigated for other applications.

Autohydrolysis of Camellia Seed Husks: Dual Valorization for Bioactive Compounds Extraction and Bioethanol Production

F. Díaz[1,2], R. Ferreira[3], K.D. González-Gloria[4], N. Flórez-Fernández[1], R. Silva-Reis[3], Rosa M. Rodríguez-Jasso[4], Héctor A. Ruiz[4], S. Cardoso[3], M. D. Torres[1*], B. Piñeiro-Lago[5], H. Domínguez[1]

[1]*CINBIO, Department of Chemical Engineering. Faculty of Science, Campus Ourense University of Vigo, 32004 Ourense, Spain.*
[2]*CINBIO, Campus Auga, University of Vigo, 32004 Ourense, Spain*
[3]*LAQV-REQUIMTE, Department of Chemistry, Campus Universitario Santiago, University Aveiro, 3810-193 Aveiro, Portugal.*
[4]*Biorefinery Group, Food Research Department, School of Chemistry, Universidad Autónoma de Coahuila, Saltillo, 25280, Coahuila, Mexico.*
[5]*Dept. Innovation, Pazo Quinteiro da Cruz. A Cruz 88-Lois 36635 Ribadumia, Pontevedra, Spain.*

Lignocellulose biomass is the main resource for biofuel production for air, road, and water transport, in comparison to other renewable resources. Furthermore, it has the potential to substitute petroleum-based plastics and other petrochemical materials fully or partially. Camellia residues have been receiving increasing attention due to the presence of several bioactive compounds, including polyphenols or saponins, which have several health benefits. However, subjected to adequate treatments, they can be a raw material useful for the production of biofuels. In this work, Camellia sp. seed husks have been subjected to an autohydrolysis treatment, which involves the use of water at a subcritical state, at various temperatures (140 °C – 220 °C) at a solid liquid ratio of 1:30, in order to valorize this residue. The liquors obtained were analysed according to the Folin-Cicolteau method to measure total phenolic content, and to several methods regarding its antioxidant activity. The proximal composition of the residual solids was analyzed in order to enhance its valorisation, which resulted in a general increase in the Highest Heating Value (HHV), from 16707 kJ/kg to between 17877 to 20187 kJ/kg. The 140ºC (highest phenolic content liquor) and 200ºC (highest carbohydrate solid residue) residual solids were subjected to a separate hydrolysis and fermentation, in order to calculate the amount of bioethanol that could be produced. Pre-saccharification yielded 27.24 ± 1.2 g/L of glucose from biomass treated at 200 °C, in contrast to 9.09 ± 0.3 g/L from biomass treated at 140 °C. Ethanol production attained 18.56 ± 0.79 g/L during 48 h of fermentation with the 200 °C sample, but it remained below 3.8 ± 0.6 g/L for the 140 °C-treated material. These findings indicate that autohydrolysis not only facilitates the selective extraction of bioactives for health advantages, but is also suitable for bioethanol production, underscoring its biorefinery potential.

Anaerobic Co-digestion of Insect Frass and Brewers' Spent Grain: Assessing Biomethane Potential for Circular Bioenergy Systems

Miguel Nogueira, Mariana Rodriguez, Elizabete Figueiredo, Rita Fragoso

LEAF- Linking Landscape, Environment, Agriculture and Food Research Center, Associate Laboratory TERRA, Instituto Superior de Agronomia, Universidade de Lisboa, Tapada da Ajuda, 1349-017 Lisboa, Portugal

The rapid expansion of insect farming offers sustainable sources of protein and fat while generating large volumes of frass as a by-product. Valorising this nutrient-rich residue through anaerobic digestion could simultaneously mitigate waste and provide renewable energy within circular bioeconomy frameworks. In this work, the biomethane potential (BMP) of cricket (Acheta domesticus) and mealworm (Tenebrio molitor) frass was assessed and compared, alongside brewers' spent grain.

Batch BMP assays were performed in an AMPTS 3 system (BPC Instruments, Sweden) using 1 L reactors (700 mL working volume) operated under mesophilic conditions (37 ± 1 °C). Reactors were continuously stirred, equipped with individual CO_2 absorption traps (NaOH 3 M with thymolphthalein), and purged with N_2 prior to inoculation. The organic loading rate was 17 g VS/L with an inoculum-to-substrate ratio of 2 (VS basis). Gas production was recorded via automated displacement flow cells, with assays terminated once daily methane production dropped below 1% of cumulative yield.

The BMP values obtained were 312 NmL CH_4/g VS for T. molitor frass, 388 NmL CH_4/g VS for cricket frass, and 536 NmL CH_4/g VS for brewers' spent grain. To explore synergies, 50:50 codigestion trials (VS basis) were performed. Results demonstrated improved methane production compared to mono-digestion of frass, with co-digestion yielding 505 NmL CH_4/g VS (T. molitor + spent grain) and 473 NmL CH_4/g VS (cricket frass + spent grain).

These findings confirm that insect frass is a viable feedstock for biogas production and that co-digestion with agro-industrial residues enhances process performance. Beyond providing an additional energy recovery route for insect farming by-products, this approach fosters dual valorisation of residual streams from two industries, contributing to resource efficiency, renewable energy generation, and the development of circular bioenergy systems.

~ Go to Contribution List

Genome Sequencing of Kluyveromyces marxianus CECT 10875 and Differential Transcriptomic Response During Bioethanol Production in Presence of Lignocellulosic-Derived Inhibitors and Insoluble Solids

M.F. Blanco[1], M. García[1], I. de la Torre[2], R. Iglesias[1], J.L García[2], J.M. Oliva[1], A.D. Moreno[1]

[1] Advanced Biofuel and bioproducts Unit, Energy Department, Research Centre for Energy, Environment, and Technology (Ciemat) Madrid, Spain.

[2]Department of Biotechnology, Centro de Investigaciones Biológicas Margarita Salas, Consejo Superior de Investigaciones Científicas (CSIC), Madrid, Spain

The non-conventional yeast *Kluyveromyces marxianus* is a promising candidate for biotechnological applications. It can be used for lignocellulosic biomass conversion into bioethanol due to its thermotolerance and wide range of carbon sources consumption. Lignocellulosic biomass represents one of the most abundant organic residues, so its revalorization is crucial to reach a bio-based and circular economy. Simultaneous saccharification and fermentation (SSF) is a cost-effective strategy for this purpose. However, during biomass pretreatment, several inhibitors (LDI) are generated as furans, weak acids and phenolic compounds, and insoluble solids, therefore a robust microorganism is needed to ferment this feedstock. This work aimed to analyses the genome and the gene expression response of the strain *K. marxianus* CECT10875 in presence of LDI and insoluble solids, to identify genetic targets for strain engineering. Genome sequencing was carried out using PACBIO and Illumina technologies, revealing a genome size of 12.6 Mb across 8 chromosomes containing 5354 genes with several SNPs compared to the reference strain. Transcriptomic analysis was performed under two conditions: a high LDI concentration (50% of reference real media), and a lower LDI concentration combined with (25%) and 30% of insoluble solids. Both conditions strongly repress amino acids and nucleotide biosynthesis (MET6, ADE3), mitochondrial metabolism (SDH1, POR1, COX5A), and glycolytic pathways, meanwhile stress-related pathways such as detoxification, membrane transport and redox homeostasis (GRE2, ADH3/ADH6, GSH2) are overexpressed. Nevertheless, adaptive response differed depending on the stressor: in presence of insoluble solids, cell wall remodeling, adhesion and osmoprotection were overexpressed (STL1, OCH1 and YPS7), whereas under high inhibitor concentration, redox balance, ion homeostasis and global regulators were more activated (GRE2, ADHs, GSH2). This analysis reveals that the transcriptional response of *K. marxianus* can be different depending on the stressor present in the media, therefore it is important to consider all these stressors for optimizing strain engineering.

Hybrid Carrageenan-Based Films Impregnated With Lipid Fractions for Smart Food Packaging

S. Oliveira[1,2], I. Sousa[2], A. Raymundo[2], H. Domínguez[1], M.D. Torres[1]

[1]CINBIO, Department of Chemical Engineering. Faculty of Science, Campus Ourense University of Vigo, 32004 Ourense, Spain

[2]LEAF, Instituto Superior de Agronomia, Universidade de Lisboa, Lisboa, Portugal

This work deals with the formulation and characterization of eco-friendly biopolymer-based films with suitable rheological properties impregnated with lipids from tea cake by-products, since market demand is directed towards the search for high-quality and eco-friendly materials focusing on non-petroleum-based solutions. For this purpose, Chondrus crispus red seaweed has used as raw material for the extraction of hybrid carrageenan employing water as extractive agent (90 ºC). The corresponding films were directly prepared by casting using as forming solution the liquid media where the hybrid carrageenan was contained after hot aqueous extraction. Lipids contained in a tea cake were extracted using two different methods - Soxhlet and supercritical-CO_2 - and employed as plasticizers. Both straightforward incorporation and impregnation of the films with the lipid fraction was tried. Thermomechanical-structural features of the developed films were analysed. The outcomes showed that the presence of the lipid fraction enhanced the functional and technological aptitude of the proposed films. The most adequate thermomechanical features, in terms of strength, stability, flexibility and plasticity, were observed for the films impregnated using the lipids from the supercritical-CO_2 extraction. Overall, the impregnation of the developed films with the lipids from a tea by-product make them a versatile sustainable packaging alternative.

Decision Support Systems and Scenario Analysis for Circular Migration and Green Recovery

Nataliia Antoniuk

National Academy of Management, Kyiv, Ukraine

Background: The integration of circular economy (CE) principles into migration and recovery policies is increasingly urgent in Europe. Displaced Ukrainian women represent a key social group whose skills and agency can contribute to sustainable labour markets and inclusive green recovery.

Object of research: socio-ecological and economic processes at the intersection of forced migration and circular economy (CE).

Subject: practices of displaced Ukrainian women's participation in CE-related sectors (repair, reuse, eco-services) in Poland and Austria, with transferability to Ukraine.

Relevance: Since 2022, more than 6.2 million Ukrainians have remained displaced in Europe, with women making up over 70% of adult refugees (UNHCR, 2024). At the same time, the EU Green Deal and Circular Economy Action Plan project up to 700,000 new CE jobs by 2030 (European Commission, 2022). The integration of displaced women into these sectors is underexplored, as most CE projects remain technocratic and neglect gender and migration (ScienceDirect, 2023).

Hypotheses.

1. Flexible, local governance models in Poland enable more grassroots CE engagement, while Austria's institutional frameworks provide structure but risk excluding vulnerable groups (Kindler & Wójcikowska-Baniak, 2018; NBP, 2024).
2. Displaced women, despite caregiving responsibilities, can become innovators in CE through targeted training, skills recognition, and inclusive municipal programmes (Crenshaw, 1989; Folke et al., 2010).

Methods: The study combines comparative governance analysis, semi-structured interviews with displaced Ukrainian women, participatory methods (photovoice, skills diaries), and site observations in CE hubs. Scenario analysis and a Decision Support System (DSS) framework were applied to test three models: (1) business-as-usual labour absorption, (2) gender-sensitive CE integration, and (3) co-created recovery scenarios for Ukraine.

Analysis of practices. In Poland (Kraków, Warsaw), displaced women engage in informal CE activities such as repair cafés, textile reuse, and subsistence circularity, yet lack institutional recognition (NBP, 2024). In Austria (Graz, Vienna), stronger institutional support provides access to CE hubs but excludes many women due to accreditation and language requirements (ScienceDirect, 2023). Comparative analysis shows that Poland's flexibility fosters participation "from below," while Austria's structure ensures stability "from above." Together, these practices offer complementary lessons for Ukraine's reconstruction.

Results. Up to 62% of refugee women's skills in reuse, repair, caregiving, and eco-services are directly transferable to CE sectors (Antoniuk & Kulczycka, 2022).

- Scenario modelling shows that gender-sensitive CE integration can increase employment outcomes by 30–35%, compared to conventional labour policies.
- Co-created recovery models enhance resilience by combining migrant agency with municipal and SME engagement, aligning with resilience thinking (Folke et al., 2010) and social tipping theory (Otto et al., 2020).

Implications for Ukraine. Findings provide a roadmap for embedding displaced women's skills into Ukraine's green recovery:

1. Vocational education – CE-focused curricula for Ukrainian VET schools (Antoniuk, Bochko, & Kulczycka, 2024).

2. Municipal planning – integration roadmaps linking CE and migration support.
3. Policy design – resilience indicators to track recovery in line with EU frameworks.
4. Knowledge transfer – lessons from Poland and Austria adapted for Ukraine's post-war reconstruction.

Conclusion: This study confirms that DSS and scenario analysis can bridge migration governance, gender, and CE transitions. By analysing practices in Poland and Austria and transferring insights to Ukraine, it highlights displaced women not as passive beneficiaries but as active agents of sustainable and inclusive recovery.

References

Antoniuk, N., & Kulczycka, J. (2022). The management of renewable energy resources for the energy security of Ukraine and Europe. Polityka Energetyczna – Energy Policy Journal, 25(4), 115–134. https://doi.org/10.33223/epj/154572

Antoniuk, N., Bochko, O., & Kulczycka, J. (2024). Circular economy in Ukraine – A chance for transformation in industry and service. Kraków: Publishing House MEERI PAS.

Crenshaw, K. (1989). Demarginalizing the intersection of race and sex: A Black feminist critique of antidiscrimination doctrine, feminist theory and antiracist politics. University of Chicago Legal Forum, 1989(1), 139–167.

European Commission. (2020). Migration profile – Ukraine. Brussels: Directorate-General for Migration and Home Affairs. https://home-affairs.ec.europa.eu

European Commission. (2022). EU Green Deal: Just Transition Mechanism and Circular Economy Action Plan. Brussels. https://ec.europa.eu

Folke, C., Carpenter, S. R., Walker, B., Scheffer, M., Chapin, T., & Rockström, J. (2010). Resilience thinking: Integrating resilience, adaptability and transformability. Ecology and Society, 15(4), Article 20. https://www.ecologyandsociety.org/vol15/iss4/art20/

International Organization for Migration (IOM). (2023). Ukraine displacement overview: 2022–2023. Geneva: IOM. https://iom.int

Kindler, M., & Wójcikowska-Baniak, K. (2018). Social ties of Ukrainian migrants in Poland. Journal of Refugee Studies, 31(4), 514–532. https://doi.org/10.1093/jrs/fey040

National Bank of Poland (NBP). (2024). Labour market integration of Ukrainian refugees in Poland: Economic challenges and opportunities. Warsaw: NBP Research Department. https://nbp.pl

Otto, I. M., Donges, J. F., Cremades, R., Bhowmik, A., Hewitt, R. J., Lucht, W., ... & Schellnhuber, H. J. (2020). Social tipping dynamics for stabilizing Earth's climate by 2050. Proceedings of the National Academy of Sciences, 117(5), 2354–2365. https://doi.org/10.1073/pnas.1900577117

ScienceDirect. (2023). Migrant integration into the circular economy in Austria. Sustainable Cities and Society, 91, 104053. https://doi.org/10.1016/j.scs.2023.104053

UNHCR. (2024). Ukraine refugee situation: Operational data portal. Geneva: UNHCR. https://data.unhcr.org

Production of Hydrogen and Combustible Gases from Sports Textile Waste via Pyrolysis Using Low-Cost Char-Based Nickel Catalysts.

María Ángeles Martín-Lara[1], Gabriel Blázquez[1], Lourdes Arjona[1,2,3], Mario J. Muñoz-Batista[1], Rafael R. Solís[1], Mónica Calero[1]

[1]Chemical Engineering Department, Faculty of Sciences, University of Granada, Granada, Spain.
[2]Department of Organic Chemical, Universidad de Panamá, Panamá 3366, Panamá.
[3]National Secretary of Science and Technology (SENACYT), Panamá 0816, Panamá

This study evaluates the production of combustible gases, particularly hydrogen (H_2), carbon monoxide (CO), and methane (CH_4), from the pyrolysis of sports textile waste, including 100% cotton and cotton/elastane (95/5%) blends. The influence of temperature and low-cost nickel-based catalysts derived from pyrolysis char on gas yields and composition was examined.

Pyrolysis was carried out in a horizontal tubular reactor under nitrogen at 500, 600, and 700 °C. A secondary catalytic stage employed Ni-based catalysts supported on char obtained at 700 °C, prepared by incipient wetness impregnation (5 wt% Ni). This approach offers a sustainable route by reusing solid pyrolysis residues as catalyst supports, reducing both costs and environmental impact.

Hydrogen yields increased significantly with temperature, reaching 55.54 mmol/g for 100% cotton and 78.34 mmol/g for the cotton/elastane blend at 700 °C. At 600 °C without catalysts, the pyrolysis of cotton produced 47.64 mmol/g of H_2, 38.00 mmol/g of CO and 20.77 mmol/g of CH_4. With Catalyst A (Ni/char from cotton), H_2 production increased to 58.39 mmol/g, and with Catalyst B (Ni/char from cotton-elastane), it reached 80.39 mmol/g, a 69% increase compared to the non-catalytic condition.

For the cotton/elastane blend at 600 °C, non-catalytic pyrolysis yielded 55.94 mmol/g of H_2. With Catalyst B, increased H_2 production to 76.63 mmol/g, while Catalyst A gave 58.39 mmol/g, which is still above the non-catalytic condition. CO production also improved from 21.84 mmol/g (no catalyst) to over 53 mmol/g with both catalysts. Methane yields also followed a similar trend.

These findings demonstrate that pyrolysis combined with low-cost, char-based Ni catalysts is a promising and circular strategy for producing high-value energy gases from sport textile waste.

Leaching Behavior of Chemically Activated Char from Cotton Textile Waste.

Mónica Calero[1], Lourdes Arjona[1,2,3], M. Alejandra Quintana[1], Gabriel Blázquez[1], Rafael R. Solís[1], Antonio Pérez[1], María Ángeles Martín-Lara[1]

[1]Chemical Engineering Department, Faculty of Sciences, University of Granada, Granada, Spain.
[2]Department of Organic Chemical, Universidad de Panamá, Panamá 3366, Panamá
[3]National Secretary of Science and Technology (SENACYT), Panamá 0816, Panamá

The management of textile waste is a significant environmental challenge, and pyrolysis sustainable route for its valorization into high-value carbonaceous materials. This study investigates the transformation of 100% cotton denim waste into char via pyrolysis and its subsequent chemical activation using sodium thiosulfate to use it as an adsorbent. The results aim to contribute to a circular economy for textiles, proposing a valorization option that can be integrated with the application of other products from the pyrolysis process, such as liquid and gaseous fractions.

The char, both in its raw and activated forms, was characterized in terms of physicochemical properties, adsorption performance, and environmental stability through leaching tests conducted according to UNE-EN 12457-2 under acidic, neutral, and alkaline pH conditions.

Results showed that metal leaching was highest under acidic conditions (pH 3), with nickel (Ni), barium (Ba), and zinc (Zn) being the most prevalent metals. Notably, nickel levels in unactivated char exceeded regulatory limits for inert waste; however, chemical activation substantially reduced nickel leaching. The activation also improved density, porosity, and surface chemistry.

Textural analyses revealed that activation enhanced the specific surface area to 974 m2/g, with a balanced micro–mesoporous structure. Surface characterization showed a high presence of oxygenated functional groups (carbonyl and quinone), which facilitated adsorption interactions. These properties enabled the activated char to achieve notable adsorption capacities for emerging pollutants in water, including sulfamethoxazole (312 mg/g), acetaminophen (254 mg/g), diclofenac (160 mg/g), and antipyrine (213 mg/g). In heavy metal treatment, the material showed strong performance for Pb (100 mg/g), while results for Cu, Ni, and Zn were more modest.

Despite elevated anions release after activation during water treatment applications, all leachate values remained within regulatory safety thresholds. Chemical Oxygen Demand (COD) values were also low, suggesting minimal environmental impact under appropriate conditions.

Alkaline Extrusion as Pretreatment in a Sunflower Biomass Biorefinery

Anderson Correa, José Miguel Oliva, Cristina Álvarez, Ana Susmozas, Raquel Iglesias, Alfonso Vidal, Encarnación Ruiz, Daniel Pasquini, Milla Alves Baffi, Aleta Duque

[1]Federal University of Uberlândia, Uberlândia, Brazil
[2]Advanced Biofuels and Bioproducts Unit, CIEMAT, Madrid, Spain
[3]Department of Chemical Engineering, University of Jaén, Jaén, Spain

Sunflower is the most extensively grown oleaginous crop in Spain. This cultivation generates a substantial amount of residual biomass, particularly stalks, which hold significant potential for valorization through biorefinery processes. Extrusion technology offers a combination of mechanical, thermal, and chemical effects that make it a compelling pretreatment method for biomass fractionation and conversion.

This study explores the impact of sodium hydroxide (NaOH) concentration and temperature on the fractionation of sunflower stalks via extrusion. Biomass was collected in Córdoba by the University of Jaén and processed at CIEMAT, where it was milled to 2 mm and characterized following National Renewable Energy Laboratory (NREL) protocols to determine cellulose, hemicellulose, lignin, and non-structural content.

A 2^3 factorial design was applied, testing three NaOH concentrations (1%, 2%, 3% w/v) and three temperatures (50 °C, 100 °C, 150 °C). The extrudates were filtered and washed, and the first liquid fraction was analyzed chromatographically to quantify hemicellulosic sugars (monomers and oligomers). The solid fraction was characterized to assess component recovery.

To evaluate fermentable sugar production, the solid fraction underwent enzymatic hydrolysis using Cellic® CTec2 (30 mg enzyme/g dry extrudate) at 50 °C and 150 rpm for 72 hours. Glucose and xylose concentrations were measured, and hydrolysis efficiency was calculated.

Overall, NaOH-catalyzed extrusion proved to be a promising pretreatment strategy for agricultural residues such as sunflower stalks, facilitating both the recovery of hemicellulosic sugars in soluble form and the production of fermentable sugars from the solid fraction.

Acknowledgements: These results are part of the R&D project PID2023-147594OB-C31, funded by MICIU/AEI/10.13039/501100011033

Experimental Study of Biomass Gasification in a Prototype Bubbling Fluidized Bed Reactor

Marianna Shevchenko, Márcia C. Santos, Luís António da Cruz Tarelho

Centre for Environmental and Marine Studies (CESAM), Department of Environment and Planning, University of Aveiro, Aveiro, Portugal

Gasification is a process of thermochemical conversion of waste into a fuel gas to generate energy and produce chemical products. Bubbling fluidized bed reactors are particularly suitable for biomass, offering stable operation and flexibility in handling various feedstocks.

In this work, the testing of a prototype (20 kWth, based on fuel input) of bubbling fluidized bed reactor (BFBR) to study the gasification of biomass is described. The reactor has an internal diameter of 0.15 m and a total height of 2.20 m, and is electrically heated by a 21 kWe furnace. Quartz sand (particle size in the range 0.25 µm to 1 mm) was used as the bed material. Experiments were performed at bed temperatures in the range 780 to 815°C under atmospheric pressure, using pine chips as the feedstock. The operating conditions included a biomass feed rate of 4.1 kg/h, a gasification agent (air) flow rate of 70 LSPT/min, an equivalence ratio of 0.22, and a superficial gas velocity of 0.26 m/s.

The results presented in this work include information on the steady-state operation of the process, the temperature profile along the reactor and product gas yield and composition. The gas yield was 2.2 $m3_{STP}$/ $kg_{biomass, dry basis,}$ and the average composition (volumetric basis) of the dry gas produced was H_2 4.1%, CH_4 3.8%, CO 15.6%, CO_2 15.1%, C_2H_4 1.3%, C_2H_6 0.2%, C_3H_8 0.3%, N_2 55.6%, corresponding to a lower heating value of 5.0 MJ/Nm^3. The cold gas efficiency of the process was 51.6%.

The results show that the prototype of BFBR provides suitable conditions of operation to study and demonstrate biomass gasification and further process optimization.

~ Go to Contribution List

Antarctic Yeast Naganishia adeliensis L95 as a Potential Microorganism for Bioprocesses: Growth and Nutritional Response on Sugarcane Bagasse and Straw Hemicellulosic Hydrolysate

Fanny Machado Jofre[1]*, Fernando Calheiros[1], Gabriele Santana de Farias[2], Lara Durães Sette[2], Adalberto Pessoa Junior[3], Valker Araújo Feitosa[3], Júlio César dos Santos[1], Maria das Graças de Almeida Felipe[1]

[1]Department of Industrial Biotechnology, Engineering School of Lorena, University of São Paulo (USP), Lorena, São Paulo, Brazil.
[2]Department of General and Applied Biology, Institute of Biosciences, São Paulo State University (UNESP), Rio Claro, São Paulo, Brazil.
[3]Department of Biochemical and Pharmaceutical Technology, School of Pharmaceutical Sciences, University of São Paulo (USP), São Paulo, Brazil.

Cold-adapted yeasts from Antarctic environments represent promising microbial resources for sustainable bioprocesses due to their metabolic versatility and stress tolerance. This study evaluated the growth performance of Naganishia adeliensis L95 (=LAMAI 803, CRM 659), isolated from a starfish at Admiralty Bay (King George Island), on sugarcane bagasse and straw hemicellulosic hydrolysate (SBSHH), with emphasis on nutritional supplementation. Cultivations were performed in shake flasks (initial pH 5.5) at 25 °C for 96 h. A Plackett–Burman design tested five nitrogen sources (peptone, yeast extract, urea, ammonium nitrate, rice bran) and six mineral/ionic factors (NaCl, $FeSO_4$, $MgSO_4$, $ZnSO_4$, $MnSO_4$, KCl). Maximum biomass (44.5 $g \cdot L^{-1}$) was achieved with high peptone, yeast extract, and ammonium nitrate, combined with low urea and rice bran, and elevated Mg^{2+}, Zn^{2+}, and Mn^{2+}. Growth was limited (16.0 $g \cdot L^{-1}$) under restricted nutrient conditions. Mean biomass across all conditions was 27.6 $g \cdot L^{-1}$, with the fastest growth between 24–72 h and viability maintained through 96 h. Zinc, yeast extract, and potassium were identified as significant positive contributors. Fermentation pH increased between 24–48 h and decreased from 72–96 h, suggesting metabolic shifts. The medium exhibited emulsification and drop-spread activity, indicating biosurfactant production. These results demonstrate that N. adeliensis can achieve industrially relevant biomass on hemicellulosic hydrolysates, tolerate variable nutrient supplementation, and produce surface-active compounds, highlighting its potential for sustainable bioprocesses and biomass valorization within a circular bioeconomy framework.

Acknowledgements: We thank São Paulo Research Foundation (FAPESP) for the grants 2023/18416-0 and 2021/12590-3 (MicroBioBank project).

Selective Fractionation of Hemicelluloses From Residual Industrial Eucalyptus Biomass Using Autohydrolysis

Pedro L. Martins, Adilaize M. Santos, Lara Justino, Luís C. Duarte, Florbela Carvalheiro

LNEG - Laboratório Nacional de Energia e Geologia, Unidade de Bioenergia e Biorrefinarias, Estrada do Paço do Lumiar, 22, 1649-038, Lisboa, Portugal

Eucalyptus globulus is one of the most widely cultivated and industrially relevant tree species for the pulp and paper industry, ranking as the second processed hardwood in European industry. During its industrial processing, several byproducts are produced, most noteworthy E. globulus wood fines that account for up to 17 % of all processed biomass in the industrial facility.

Currently, this material is mainly used as an energy source, and this work aims to study its alternative upgrade through the selective recovery of hemicellulose-derived products.

A hydrothermal process (autohydrolysis) was used under diverse (non)-isothermal operational conditions, and the effect of temperature (130 °C–170 °C) and reaction time was studied in detail, using the severity factor (Log RO) concept.

Hemicellulose removal increased with the treatment severity, reaching a maximum of 81%, being recovered predominantly in soluble oligomeric form, as xylo-oligosaccharides (XOS) up to the most severe conditions (Log RO=4.2), leading to a decrease in XOS content and a substantial increase of monomeric xylose (8.14 g/L xylose), corresponding to an XOS:Xyl ratio of 0.46. The solid residues from the pretreatment were selectively and incrementally enriched in cellulose (glucan) and lignin.

The reproducibility of the optimal conditions for XOS production (Log RO = 3.6, 170 °C, 30 min) was assayed, yielding an average XOS concentration of 12.41±-0.20 g/L, and a XOS:Xyl > 7.06 ±0.37, along with low concentrations of degradation products (furfural, HMF, and formic acid, below 0.5 g/L). Pulps also present a reproducible composition, with hemicellulose (xylan) being reduced to 8.83±0.14%.

The composition of the hemicellulosic hydrolysate obtained, together with the enrichment of cellulose (50.19± 0.93%) and lignin 32.26±0.89% in the solids facilitates their use in further fractionation processes, such as delignification, enabling the separation and valorization of all three main polymeric constituents of E. globulus biomass within a biorefinery framework.

Acknowledgements: This work was carried out under the DREAM project, funded by the European Union under the Grant Agreement 101130523. The Navigator company (Cacia, Portugal) is gratefully acknowledged for kindly providing the biomass feedstock.

Continuous Conversion of Hemicellulosic Oligosaccharides Into Monosaccharides, Furans and Aliphatic Acids

Mafalda Batalha[1], Pedro L. Martins[1], Miguel Gomes[1], Margarida Mateus[2,3], M. Joana Neiva-Correia[3,4], Florbela Carvalheiro[1], Luís C. Duarte[1]

[1]Unidade de Bioenergia e Biorrefinarias, LNEG - Laboratório Nacional de Energia e Geologia, Estrada do Paço de Lumiar, 22, 1649-038 Lisboa, Portugal
[2]C5LAB –Sustainable Construction Materials Association, Edifício Central Park, Rua Central Park 6, 2795-242 Linda-a-Velha, Portugal
[3]CERENA - Centro de Recursos Naturais e Ambiente, Av Rovisco Pais 1, 1049-001 Lisboa
[4]Departamento de Engenharia Química, Instituto Superior Técnico, Universidade de Lisboa, Av. Rovisco Pais, 1049-001 Lisboa, Portugal

Hemicellulose-derived oligosaccharides are considered high-value compounds due to their remarkable chemical diversity, versatility, and functional properties, most noteworthy prebiotic, and immunomodulation activities. Their market is currently growing but it is still limited to niche / specialized applications such as in functional foods, nutraceuticals, and advanced biomaterials. Even though it is expected that the market might expand along with the deployment of industrial biorefineries facilitating broader industrial uptake, its increased availability may also reduce their market value thus becoming interesting intermediary biorefinery feedstock, especially due to the potential lower production costs as compared to monomeric sugars.

In this work, the direct chemical production of pivotal compounds (furans and aliphatic acids) is explored, as an alternative upgrade strategy for oligosaccharides-rich streams using Miscanthus-derive hemicellulosic oligosaccharides as model compounds.

The process was developed initially under batch operation and then transfer to continuous operation using an in-house designed pilot extruder-type reactor. Specifically, the effect of relevant operating conditions, including catalyst concentration (H_2SO_4, up to 250 mM), reaction temperature (up to 200 ºC), and time (up to 120 min) were studied.

The optimal results for batch operation were achieved under the harsher tested severity, leading to complete oligosaccharides hydrolysis, and yielding 37% furfural and 34% formic acid. Continuous operation allowed the simultaneous oligosaccharides hydrolysis and pentoses conversion into pivotal compounds under higher operating temperatures and lower operating times and severities. Oligosaccharides complete conversion was not achieved, but furfural and formic acid yields (55% and 46%, respectively) were higher than the obtained under batch operation, highlighting the potential advantages and promising performance of the continuous reactor for industrial-scale conversion of oligosaccharide-rich streams.

Acknowledgements: This work was partially carried out under the following projects: TEST BED Lavoisier (Rede Nacional de Test Beds contrato 03/C16-i02/2022.PC655370553-00000774), and BioFab Pilot in the Biomass and Bioenergy Research Infrastructure (BBRI). BBRI is funded through the operation LISBOA2030-FEDER-01318200 – Infraestrutura de Investigação em Biomassa e Bioenergia supported by the Programa Regional de Lisboa 2030, by Portugal 2030 and the European Union.

Acid-Based NADES for Eucalyptus Fines Upgrading: The Effect of Anti-Solvent in Cellulose Enrichment and Lignin Recovery

Iván Costa-Trigo[1], Eliana De Carvalho-Lopes[1], Amir Mahan Ziaee [1], Pedro L. Martins[1], Luís C. Duarte[1], Florbela Carvalheiro[1]

[1]Unidade de Bioenergia e Biorrefinarias, LNEG – Laboratório Nacional de Energia e Geologia, 1649-038 Lisboa, Portugal

The valorization of lignocellulosic residues from the pulp and paper industry is gaining momentum as a strategy to enhance resource efficiency and reduce environmental impact. Eucalyptus fines, a by-product rich in cellulose and lignin, offer potential for upgrading through selective fractionation. Natural Deep Eutectic Solvents (NADES), particularly acidbased formulations, have emerged as green alternatives for biomass processing due to their tunable properties and low toxicity.

This study aimed to evaluate the performance of acid-based NADES in the fractionation of eucalyptus fines, with a focus on the role of anti-solvent addition in improving cellulose purity and lignin recovery. NADES systems based on acetic or lactic acids as hydrogen bond donors, and choline chloride as hydrogen bond acceptor were applied on Eucalyptus fines studied the best conditions of time and temperature to solubilize lignin while preserving cellulose. Subsequently, different anti-solvents (water, EtOH/water, acetone/water) were introduced to precipitate lignin and assess their impact on separation efficiency.

The results showed that the choice of anti-solvent significantly influenced both the yield and purity of the recovered fractions. Alcohol-based anti-solvents enhanced lignin remotion of pretreated pulp, leading to higher cellulose purity and improved lignin recovery. The process also demonstrated potential for solvent recycling and scalability.

Therefore, acid-based NADES combined with strategic anti-solvent selection present a promising approach for eucalyptus fines upgrading. This methodology enables efficient lignin recovery and cellulose enrichment, contributing to the development of sustainable biorefinery platforms. Further optimization could facilitate industrial implementation and integration into existing biomass valorization chains.

~ Go to Contribution List

The Role of the Ethanol-Based Organosolv Pretreatment on the Fractionation of Pulp Industry Eucalyptus Residues

Pedro L. Martins, Catarina Silva, Lara Justino, Luísa B. Roseiro, Cristina Oliveira, Luís C. Duarte, Florbela Carvalheiro

Unidade de Bioenergia e Biorrefinarias, LNEG - Laboratório Nacional de Energia e Geologia, Estrada do Paço de Lumiar, 22, 1649-038 Lisboa, Portugal

The efficient and selective fractionation of biomass into its three main macromolecular components is one of the cornerstones for profitable biomass valorization, enabling the development of specific valorization routes for each component. Typically, this is achieved either in a single-step approach, e.g. organosolv pre-treatments, which can simultaneously remove and depolymerize both hemicellulose and lignin, or in a two-step process combining selective hemicellulose removal, e.g. using hydrothermal fractionation (autohydrolysis) followed by an organosolv process for selective lignin removal. In this work, these two strategies were evaluated for the upgrade of eucalyptus fines, an industrial byproduct of the eucalyptus pulp and paper industry.

Organosolv pre-treatments were carried out in a stainless-steel reactor at 170ºC using ethanol-water mixtures for a reaction time of 60-120 min, under non-catalyzed and catalyzed conditions, both in untreated feedstock and autohydrolysis pulp.

The experimental results demonstrate that direct organosolv fractionation enabled both the recovery of hemicellulose-derived sugars and lignin, simultaneously. The highest delignification yield (93%) was obtained under isothermal (90 min) and catalyzed conditions using ethanol:water 60:40 and 25 mM H_2SO_4. Under these conditions, 80% of solubilized lignin was effectively recovered as a solid precipitate after selective water precipitation, corresponding to 97% of the theoretical yield. This process enabled the production of an almost pure cellulose pulp (containing 90% cellulose).

In comparison, the sequential use of autohydrolysis and organosolv fractionation enabled the recovery of hemicellulosic oligosaccharides in the first step, but only a maximum of 67% overall delignification, which was achieved under the same conditions as for direct catalyzed organosolv. The selective precipitation of soluble lignin enabled a recovery of up to 60% of the initial lignin, also lower than that obtained in the direct process. Regarding the pretreated pulp, it is enriched in cellulose but presents lower purity (81%) due to the presence of residual recalcitrant (pseudo)-lignin putatively produced during the initial autohydrolysis treatment. The (dis) advantages of both strategies will also be discussed in terms of the efficiency of the downstream processes, the chemical characterization of the recovered lignins and hemicellulosic sugars fractions, and their market value.

Acknowledgements: This work was carried out under the DREAM project, funded by the European Union under the Grant Agreement 101130523. The Navigator company (Cacia, Portugal) is gratefully acknowledged for kindly providing the biomass feedstock.

Mild Alkaline Pretreatment of Eucalyptus biomass: Process optimization

Pedro L. Martins, Catarina Martins, João M. Costa, Iván Costa-Trigo, Luísa B. Roseiro, Florbela Carvalheiro, Luís C. Duarte

Unidade de Bioenergia e Biorrefinarias, LNEG - Laboratório Nacional de Energia e Geologia, Estrada do Paço de Lumiar, 22, 1649-038 Lisboa, Portugal

The conventional Mild Alkaline Pretreatment (MAP) method for lignocellulosic biomass fractionation, selectively removes lignin and improves pulp porosity under mild operational conditions, typically below 100 ºC, which guarantees considerable economic advantages over other more energy intensive methods. However, its full potential and integration within the modern biorefinery/bioeconomy framework is still not comprehensively explored. Emerging, very diverse, applications such as selective recovery of high-value lignin, or nanocellulose production, demonstrate the method's growing versatility and need for careful optimization of the operational conditions.

In this work, MAP processing of Eucalyptus globulus fines, a bio-residue of the pulp and paper industry, was optimized towards lignin removal using a Response Surface Methodology (RSM) Doehlert matrix, initially for two variables, namely alkali concentration ([NaOH] up to 2.5 M), and reaction time (0 to 120 min), and later extended to a third variable, temperature (up to 75 °C). All experiments were carried out at a fixed Liquid-to-solid ratio of 10 (w/w). Upon reaction completion the solid and liquid phases were separated by centrifugation followed by rapid acidification of the supernatant. Thorough characterization of the solid and liquid streams was accomplished by HPLC-based (NREL) methods and Capillary Electrophoresis (CZE) for the characterization of the soluble phenolics profile.

Acid insoluble lignin is typically the main product found in the liquid stream, followed by acetic acid. Hemicellulosic oligosaccharides are also found but in minor amounts (below 1 g/L). The pulp presents reduced levels of lignin, and an enrichment in hemicellulose and cellulose. Delignification is close to 40% for the optimal conditions, that were found to be the most severe conditions tested. Regarding the statistical impact of the variables, sodium hydroxide concentration and temperature are statistically significant and have a positive impact (p-value $<$ 0.05). Interaction effects are more relevant at lower temperatures, as well as quadratic effects.

The optimized conditions enabled the fast recovery of lignin, almost devoid of contaminating sugars and ash in high yield and a pulp able to be further processed for the recovery of hemicellulosic sugars and cellulose upgrade.

Acknowledgements: This work was carried out under the DREAM project, funded by the European Union under the Grant Agreement 101130523, in the Biomass and Bioenergy Research Infrastructure (BBRI). BBRI is funded through the operation LISBOA2030-FEDER-01318200 – Infraestrutura de Investigação em Biomassa e Bioenergia supported by the Programa Regional de Lisboa 2030, by Portugal 2030 and the European Union. The Navigator company (Cacia, Portugal) is gratefully acknowledged for kindly providing the biomass feedstock.

~ Go to Contribution List

Screening of Bacillus Strains to Produce SAF Precursor and Biosurfactants From Chestnut Burrs Hemicellulosic Hydrolysate

Iván Costa-Trigo[1], María Guadalupe Morán-Aguilar[2], José Manuel Domínguez[3]

[1]Unidade de Bioenergia e Biorrefinarias, LNEG – Laboratório Nacional de Energia e Geologia, 1649-038 Lisboa, Portugal
[2]Advanced Biomaterials and Nanotechnology, Department of Chemical and Agricultural Engineering, and Agrifood Technology, University of Girona, 17003 Girona, Spain
[3]University of Vigo, Campus Auga, Industrial Biotechnology and Environmental Engineering Group "BiotecnIA", Chemical Engineering Department, 32004 Ourense, Spain

The increasing demand for sustainable aviation fuels (SAF) and eco-friendly bioproducts has driven interest in valorizing agricultural residues through microbial bioconversion. Chestnut burrs, a lignocellulosic by-product of chestnut processing, represent a promising feedstock due to their interesting carbohydrate content. This study explores the potential of Bacillus strains to convert chestnut burrs hemicellulosic hydrolysate into SAF precursors and biosurfactants, contributing to circular bioeconomy strategies.

The main objective was evaluating Bacillus strains capable of metabolizing sugars derived from chestnut burrs and producing valuable metabolites. A selection of 5 collection strains was screened for growth performance, sugar assimilation, and production of biosurfactants and 2,3-butanediol, which is relevant SAF precursor. The hydrolysate was obtained through mild acid pretreatment (3.52% H_2SO_4 liquid/solid ratio of 8 g/g at 130 °C for 30 ´), yielding a sugar-rich medium primarily composed of xylose.

Preliminary results revealed that three Bacillus strains exhibited robust growth on the hydrolysate and being two 2,3-butanediol producers, meanwhile only one of them was also able to produce biosurfactants. These findings suggest that chestnut burrs hydrolysate can serve as an effective substrate for microbial production of SAF-related compounds and biosurfactants.

In conclusion, the study demonstrates the feasibility of using chestnut burrs hemicellulosic hydrolysate as a low-cost, renewable feedstock for biotechnological applications. The identified Bacillus strains show promise for integrated biorefineries targeting SAF precursors and biosurfactants, paving the way for further optimization and scale-up.

Remote Sensing of Agricultural Crop Residues in Baixo Mondego (Portugal): A Systematic Review on Bioenergy Potential and Limitations

Luís Coelho[1], Hélder Viana[2,3]

[1]CERNAS-IPC Research Centre, Polytechnic Institute of Coimbra, Escola Superior Agrária de Coimbra Bencanta, 3045-601 Coimbra Portugal, Portugal.
[2]CERNAS-IPV Research Centre, Polytechnic Institute of Viseu, Campus Politécnico, Repeses, 3504-510 Viseu, Portugal.
[3]Centre for the Research and Technology of Agroenvironmental and Biological Sciences, CITAB, Inov4Agro, Universidadede Trás-os-Montes e Alto Douro, UTAD, Quinta de Prados, 5000-801 Vila Real, Portugal.

The sustainable use of agricultural crop residues as a bioenergy source requires accurate quantification of their availability while ensuring soil health and ecosystem services. This review analyzes the potential and limitations of remote sensing-based approaches for assessing crop residues in the Baixo Mondego region (Portugal). A systematic literature search identified 374 eligible papers, of which the 50 most relevant were included. Remote sensing and GIS methodologies, including spectral indices and high-resolution satellite imagery, have proven effective in mapping residues with accuracies up to 95%. These tools allow integration with crop statistics and residue-to-product ratios, improving estimates of bioenergy potential. However, challenges persist, including the differentiation of residue types, temporal variability, small-scale detection in fragmented landscapes, and the environmental risks of residue overharvesting. In Baixo Mondego, where rice and maize dominate, residue management must reconcile productivity, bioenergy targets, and ecosystem protection. Policy frameworks, market incentives, and socioeconomic factors play a critical role in shaping feasibility. While the literature supports the technical feasibility of remote sensing-based assessments, further research is needed on long-term environmental impacts, ground-truth validation, and region-specific sustainability guidelines. Overall, remote sensing provides robust tools to quantify bioenergy potential from crop residues, but sustainable implementation depends on integrated approaches that balance technical, environmental, and socioeconomic dimensions.

Seed to Fuel Initiative: Evaluating Moringa oleifera as a Sustainable Feedstock for Biodiesel and Aviation Biofuels

Avni Gupta[1], Richard Webster[1], Baoxiu Qi[2]. N Manikanda Boopathi[3], Vineet Munjal[4], Rachael Catherine Symonds[1]

[1]School of Biological and Environmental Sciences Liverpool John Moores University, , Byrom St, Liverpool L3 3AF, Merseyside, UK
[2]School of Pharmacy and Biomolecular Sciences Liverpool John Moores University, Byrom Street, Liverpool, L3 3AF, UK
[3]Department of Plant Biotechnology, Centre for Plant Molecular Biology and Biotechnology, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, 641 003, India
[4]Avalon Bioenergy Private limited-, Chennai Tamil Nadu, 600031, India

Background: The growing global energy demand and environmental concerns associated with fossil fuel dependency have intensified the search for renewable and sustainable bioenergy sources. Moringa oleifera, a resilient, fast-growing tree with high oil content, offers potential as a feedstock for biodiesel and sustainable aviation fuel (SAF).

Objectives: This study, part of the Seed to Fuel Initiative, aims to evaluate the potential of Moringa oleifera for large-scale bioenergy applications by assessing its genetic variability, oil quality, and propagation efficiency under controlled conditions.

Methods: An integrated approach combining genetic, biochemical, and tissue culture analyses was employed. Diverse Moringa ecotypes were evaluated for their oil yield and composition using Fatty Acid Methyl Ester (FAME) profiling, while in vitro culture experiments assessed regeneration potential under different plant growth regulator combinations.

Results: Preliminary results revealed significant genetic and biochemical diversity among ecotypes, with several lines exhibiting favourable fatty acid profiles characterized by high oleic acid content, making them suitable for biodiesel and SAF conversion. Tissue culture studies demonstrated effective regeneration responses across multiple combinations, indicating strong potential for mass propagation of elite lines.

Conclusions: The findings highlight Moringa oleifera as a promising candidate for sustainable biofuel production, aligning with global goals of reducing carbon emissions and promoting renewable energy. This work contributes to the development of a scalable, climate-positive “Seed to Fuel” model that integrates plant biotechnology, sustainable agriculture, and clean energy solutions to advance low-carbon, circular bioeconomy strategies.

Experimental Study on the Upgrading of Synthetic CH_4/CO_2 Biogas Mixtures Using a Carbon-Based Ceramic Membrane

Pedro Miguel Rodrigues, Tiago Mendes, A. Catarina Faria*

Fraunhofer Portugal AWAM – Research Center for Advanced Water, Energy and Resource Management, Vila Real, Portugal

Biogas upgrading aims to remove CO_2 from the raw biogas, so that it meets the quality specifications required for injection into natural gas grids or underground storage systems – typically demanding methane concentrations above 90%.

In this work, a carbon-based ceramic membrane (250 mm in length) was investigated for the selective separation of CO_2 from typical biogas mixtures containing 50/50 (v/v%) and 65/35 (v/v%) CH_4/CO_2. The experiments were conducted at different operating absolute pressures (up to 5 bar), temperatures (ambient and ~150 °C) and total feed volumetric flow rates (up to 1000 mLN min-1). No sweep gas was applied.

The performance membrane indicators include CO_2 and CH_4 permeance, separation factor and concentration of CO_2 and CH_4 in the permeate and retentate side, respectively. The outlet of each side was analyzed intermittently, one at a time, and average values were calculated once the performance indicators stabilized, showing a variation <0.5% over 1 minute. A baseline test was periodically performed throughout the experimental campaign to assess the membranes' stability during continuous operation and to ensure the reliability of the results when evaluating the effect of operating conditions.

The average CO_2 and CH_4 permeance obtained under the baseline test conditions (50/50 (v/v %) CH_4/CO_2; 5 bar; room temperature) were (2.95±0.57)x10-8 and (5.55±0.13)x10-10 mol m^{-2} s^{-1} Pa^{-1}, respectively. Among the experimental conditions tested, the temperature appeared to have the strongest influence; increasing it up to 150 °C negatively affected the CO_2/CH_4 selectivity. The CH_4 concentration in the retentate was still below the level required for biogas injection or storage, likely due to the limited membrane permeation area. Future work will focus on system optimization and operational strategies to increase methane concentrations at the retentate and to evaluate the long-term stability of the membrane.

Selective Electromigration of Acetate from Olive-Pomace Lignocellulosic Hydrolysate Using an Anion-Exchange Membrane

A. I. Arroyo-Escoto[1,2,3*], S. de Souza Queiroz[4], B. Li[5], S. I. Mussatto[4], M. C. Fernandes[1,2], Y. Zhang[5]

[1]Alentejo Biotechnology Center for Agriculture and Agro-Food (CEBAL), Polytechnic Institute of Beja (IPBeja), Apartado 6158, 7801-908 Beja, Portugal.
[2]Mediterranean Institute for Agriculture, Environment and Development & CHANGE—Global Change and Sustainability Institute, CEBAL—Centro de Biotecnologia Agrícola e Agro-Alimentar do Alentejo, 7801-908 Beja, Portugal.
[3]Mediterranean Institute for Agriculture, Environment and Development & CHANGE—Global Change and Sustainability Institute, Institute for Advanced Studies and Research (IIFA), University of Évora, Polo da Mitra, Ap. 94, 7006-554 Évora, Portugal.
[4]Department of Biotechnology and Biomedicine, Section for Synthetic Biology, Biomass Conversion Bioprocess Technology, Technical University of Denmark (DTU), Søltofts Plads 223, 2800 Kgs. Lyngby, Denmark.
[5]Department of Environmental and Resource Engineering (DTU Sustain), Water Technology & Processes, Technical University of Denmark (DTU), Bygningstorvet, Building 115, 2800 Kgs. Lyngby, Denmark.

Detoxifying lignocellulosic hydrolysates without losing fermentable sugars is imperative for low-cost bioconversion. It was evaluated a low-voltage anion-exchange-membrane (AEM) electrodialysis step to selectively recover acetate from olive-pomace hydrolysates while preserving fermentation readiness. A factorial design compared (i) membrane history (pristine vs reused), (ii) receiving-phase chemistry (phosphate vs citrate buffers), and (iii) applied potential (1.0–2.5 V), with pre-filtration to mitigate fouling. Performance was tracked by HPLC of organic acids and sugars, pH, and fouling indices. AEM transport confirmed acetate/sugar separation, yet performance did not increase with voltage; although such voltages typically trigger water electrolysis, no gas evolved. This indicates the need to verify electrode materials, cell architecture, and drive protocols. Membrane identity was not limiting, although reused membranes showed lower acetate flux and earlier polarization than pristine ones. Buffer choice mattered: phosphate receiving phases achieved higher acetate capture and steadier pH than citrate. Hexoses and pentoses remained within analytical variability, preserving carbon for immediate fermentation. Although acetate removal was incomplete, it was identified that levers and next steps: membrane state, pre-treatment/filtration, buffer selection, and voltage protocols; anti-fouling pre-treatments and refined cell materials to enhance acetate flux without sugar bleed-through, strengthening integrated biorefineries and co-product valorization.

Acknowledgements: This work was supported by Fundação para a Ciência e a Tecnologia (FCT) by CHANGE (DOI: https://doi.org/10.54499/LA/P/0121/2020). The authors also acknowledge funding from MED (DOI: https://doi.org/10.54499/UIDB/05183/2020 and DOI: https://doi.org/10.54499/UIDP/05183/2020). A.I. Arroyo-Escoto acknowledges support from the PhD grant UI/BD/153579/2022.

Improving Biodiesel Sustainability by Double-Cropping Oilseed and Oil-Less Seed Cake Recovery: A Field Approach in Northern Italy

Matteo Ceriani[1], Giuliana D'Imporzano[1], Patrizia De Nisi[1], Martina Ghidoli[2], Irene Rapone[3] Salvatore Pilu[2*], Fabrizio Adani[1*]

[1]Gruppo Ricicla labs., Dipartimento di Scienze Agrarie e Ambientali - Produzione, Territorio, Agroenergia (DiSAA), Università degli studi di Milano, Via Celoria 2, 20133, Italy.
[2]CROSS Lab, Dipartimento di Scienze Agrarie e Ambientali - Produzione, Territorio, Agroenergia (DiSAA), Università degli studi di Milano, Via Celoria 2, 20133, Italy.
[3]ENI - Renewable, New Energies and Material Science Research Center (DE-R&D), Novara, Italy

This study presents a novel bioenergy supply chain based on the double-cropping of second-generation oil crops, i.e., Camelina sativa and Ricinus communis, in Northern Italy, aiming to produce biodiesel from seed oil and biogas from defatted seed cakes (DSCs). The crops were cultivated over two consecutive seasons on silty-sandy soils, with irrigation provided during summer. Average seed yield was 6,948 ± 330 kg TS ha^{-1} $year^{-1}$. After milling, oil and DSCs were characterised.

The oils obtained from *C. sativa* and *R. communis* were considered suitable for biodiesel synthesis. The DSCs, representing a substantial portion of seed mass (~50%), were evaluated for biomethane potential (BMP), yielding 239–337 Nml CH_4 g TS^{-1}, comparable to conventional energy crops such as maize silage. Life cycle assessment (LCA) indicated a 75% reduction in greenhouse gas (GHG) emissions compared to fossil diesel when double cropping, biogas production, and digestate application as fertiliser, were considered. Moreover, a potential improvement to 81% can be obtained using nitrification inhibitors (NIs), well above the 65% threshold set by RED II.

Economic analysis suggests that double-cropping combined with co-product valorisation can enhance profitability by increasing annual production per hectare while reducing input costs, including fertilizers and energy consumption.

This approach integrates multiple sustainability strategies: optimizing crop rotation, recovering oilseed co-products for energy, and closing nutrient cycles through digestate application. By demonstrating both environmental and economic benefits, the proposed system provides a circular bioenergy model adaptable to Mediterranean agricultural contexts. Furthermore, the study provides baseline data for double-cropping systems involving second-generation oil crops such as C. sativa and R. communis, supporting knowledge-based strategies for sustainable biofuel production within a circular economy framework.

~ Go to Contribution List

Biotechnological Potential of Antarctic Yeast Strains for Xylose-to-Xylitol Conversion

Bárbara do Nascimento[1]*, Daiane Meneguzzi, Marília dos Santos Ferreira [1], Fanny Machado Jofre [1], Lara Durães Sette[2], Adalberto Pessoa Junior[3], Valker Araújo Feitosa[3], Maria das Graças de Almeida Felipe[1]

[1]Department of Industrial Biotechnology, Engineering School of Lorena, University of São Paulo (USP), Lorena, São Paulo, Brazil.
[2]Department of General and Applied Biology, Institute of Biosciences, São Paulo State University (UNESP), Rio Claro, São Paulo, Brazil.
[3]Department of Biochemical and Pharmaceutical Technology, School of Pharmaceutical Sciences, University of São Paulo (USP), São Paulo, Brazil.

The advancement of sustainable technologies has become a global priority in light of the growing environmental and economic challenges. In this context, industrial biotechnology emerges as a promising alternative by employing microorganisms to convert renewable raw materials into high-value products. Microorganisms adapted to extreme conditions, particularly those from Antarctica, stand out as strategic resources for sustainable bioprocesses due to their metabolic plasticity and high tolerance to environmental stress. This study evaluated the growth of three Antarctic yeast strains in a semi-defined medium containing xylose as the sole carbon source, with emphasis on their potential application in xylitol production, which can be applied to the food and pharmaceutical industries.. The strains analyzed were Candida glaebosa (LAMAI 795, isolated from penguin soil), Meyerozyma guilliermondii (LAMAI 832, isolated from an isopod), and Wickerhamomyces anomalus (LAMAI 801, isolated from an ascidian). The highest cell growth (OD600, corrected by the dilution factor) was observed at 48 h for M. guilliermondii (14.664) and W. anomalus (10.295), and at 72 h for C. glaebosa (15.561). However, xylitol quantification by high-performance liquid chromatography (HPLC) revealed higher yields for M. guilliermondii (6.89 $g \cdot L^{-1}$ at 72 h), W. anomalus (3.86 $g \cdot L^{-1}$ at 48 h), and C. glaebosa (0.94 $g \cdot L^{-1}$ at 72 h). These preliminary results highlight not only the physiological robustness of Antarctic yeast strains but also their potential as viable alternatives to conventional microorganisms used in hemicellulosic hydrolysate-based bioprocesses.

Acknowledgements: We thank São Paulo Research Foundation (FAPESP) for the grants 2023/18416-0 and 2021/12590-3 (MicroBioBank project).

The Biotechnological Production of HMFO (5-Hydroxymethylfurfural Oxidase) Enzyme Paves the Way for a Sustainable Bioplastics Industry

Aroa Carballido[1]*, Ana Arias[1], Juan Carro[2], Ángel T. Martínez[2], Francisco Javier Ruiz-Dueñas[2], Gloria Caminal[3], Gloria González[3], Marina Guillen[3], Oscar Romero[3], Kirian Bonet[3], Garazi Ortiz-Orruño[3], Darly Concha[3], Gumersindo Feijoo[1], Maria Teresa Moreira[1]

[1]CRETUS, Department of Chemical Engineering. Universidade de Santiago de Compostela, Santiago de Compostela, 15782, Spain
[2]Centro de Investigaciones Biológicas Margarita Salas, Consejo superior de Investigaciones Científicas, Madrid, 28040, Spain
[3]Department of Chemical, Biological and Environmental Engineering, Engineering School, Universitat Autònoma de Barcelona, 08193 Barcelona, Spain.

Polyethylene furanoate (PEF) is a bio-based polymer regarded as a sustainable alternative to polyethylene terephthalate (PET) due to its excellent barrier properties and biodegradability. Its production relies on the polymerization of 2,5-furandicarboxylic acid (FDCA) and ethylene glycol (EG), with a critical step being the synthesis of FDCA from 5-hydroxymethylfurfural (HMF). In this pathway, the enzyme HMF oxidase (HMFO) plays a key role, offering mild reaction conditions, high specificity, and energy efficiency. Nevertheless, the overall sustainability of this approach depends on technical feasibility, efficiency, and the magnitude of direct and indirect emissions.

This study explores the conceptual design and environmental performance of biotechnological HMFO production. Experimental data at the laboratory scale were used and subsequently scaled up to different fermentation capacities (5 L, 25 L, 50 L, and 1 m^3). The Life Cycle Assessment (LCA) methodology was applied under a cradle-to-gate approach, covering pre-inoculum, inoculum, fermentation, and downstream processing. Additionally, the Greenness Grid (GG) methodology was employed, addressing green chemistry principles such as risk, productivity, and process efficiency.

Results show that electricity consumption is the main environmental hotspot, followed by the use of K_2HPO_4 and glucose in the culture medium. In downstream processing, cellulose used for enzyme immobilization contributed the highest environmental burden. Scaling up to 1 m^3 significantly reduced environmental loads per unit of product, attributed to economies of scale, since energy and material demand do not increase proportionally with production volume. The GG assessment rated the process as “potentially sustainable.” Sensitivity analysis indicated that renewable energy could reduce impacts by 20%, a 10% reduction in K_2HPO_4 concentration could lower burdens by 10%, and full enzyme immobilization could decrease them by 5%. Overall, the HMFO-based pathway represents a promising step toward the industrial adoption of PEF and the development of a sustainable bioplastics industry.

Research funded by FURENPOL (PLEC2021-007690) project funded by MICIU/AEI/10.13039/501100011033 and by the European Union NextGenerationEU/PRTR.

Small-Scale Biorefineries Based on Integral Use of Local Fruit in the Colombian Forests

Carlos Ariel Cardona[1], Carlos Eduardo Orrego[1], Arturo Samuel Gómez[2], Mariana Ortiz[1], Juan David Galvis[1], Natalia Salgado[1], Jaime Andres Carmona[1], Gineth Ismar De la Cruz[3], Johan Manuel Duran[2], Jose Vidal Castañeda[3], Olga Alexandra Mimalchi[1]

[1]Departamento de Ingeniería Química. Instituto de Biotecnología y Agroindustria. Universidad Nacional de Colombia sede Manizales
[2]Universidad Nacional de Colombia sede Amazonía
[3]ASPROCAT, Asociación de Productores Cacaoteros de Tumaco

The forest in Colombia is not only the synonym of carbon capture and environmental health. The communities living there usually are limited in the integral use of their resources, just producing food and leaving enormous quantities of residues in bad disposal remaining as pollutants. Small scale biorefineries are the real solution for them. In the case of two forest regions in the south of Colombia (Tumaco in the Choco Biogeographic region and Leticia in the Amazon) three fruits are analyzed. The cocoa with high consumption and processing is studied in Tumaco and the Aguaje and Makambo in the Amazon. All the fruit and the residues are used to obtain pulps, oils, essential oils, antioxidants, biochar, food products, fibers and pectin. Experimental work and simulations demonstrated in detail the advantage of using this strategy.

Identification and Cloning of a Termite Endoglucanase for Sustainable Nanocellulose Production and Its Application in Advanced Materials

Lucía Feijoo-Siota, María Dolores Pejenaute- Ochoa, Xabier Roldán- Rodríguez, Noelia Loureiro, Julio Fierro Fernández and Cristina Martínez-García

CETIM, Multisectoral Technological Research Center, Parque empresarial de Alvedro, Rúa H, 20, 15180 Culleredo, A Coruña.

The development of sustainable advanced materials is essential for the next generation of lithium-ion batteries (LIBs). Nanocellulose particles (NFCs) have emerged as a highly promising resource to enhance the efficiency and sustainability of anodes and electrolytes. Within the framework of the NanomatIA project, this study aimed to identify and characterize novel endoglucanases from termites or their microbiota. These xylophagous insects produce enzymes adapted to lignocellulose degradation, making them suitable candidates for environmentally friendly and sustainable NFC production. In this work, degenerate oligonucleotides were designed based on database sequences of endoglucanases to target and amplify the corresponding genes from Reticulitermes grassei cDNA. Using this approach, a ~1347 bp fragment corresponding to a novel β-1,4-endoglucanase gene was obtained, which displayed high homology with previously described termite endoglucanases. The gene was cloned into the pET-28a(+) vector and expressed in E. coli BL21 (DE3)pLysS for functional characterization. This strategy provides a foundation for developing more sustainable NFC production processes, with potential applications in LIB anodes and semi-solid electrolytes.

Sustainable Analysis of Processes for Avocado Waste Through Life Cycle Assessment

Carolina João[1], Henrique A. Matos[1,2]

[1]Departamento de Engenharia Química, Instituto Superior Técnico, Universidade de Lisboa, Av. Rovisco Pais 1, 1049-001 Lisboa, Portugal

[2]Centro de Recursos Naturais e Ambiente, Instituto Superior Técnico, Universidade de Lisboa, Av. Rovisco Pais 1, 1049-001 Lisboa, Portugal

The increasing popularity of avocados has led to increased production and, consequently, a significant rise in avocado waste including peels and seeds. Traditionally, these byproducts are discarded, leading to environmental concerns such as greenhouse gas emissions and resource wastage.

This work explores and compares various processes for utilizing avocado waste, as seed and peel, to evaluate their environmental impacts through a detailed life cycle assessment.

For the evaluation of environmental impacts of different avocado waste management strategies was applied the Life Cycle Assessment (LCA) methodology by using the SimaPro software. Three alternatives were assessed: A.1, Biorefinery process of avocado waste for production of xylitol, ethanol and electricity; A.2, an optimized version of A.1 with efficiency and energy consumption improvements; B, conventional method that consists in landfill disposal.

For the analysis the EF 3.0 method was used in the SimaPro software, since it is followed by the PEF rules. This method was applied on the characterization, normalization, weighting and single score phases.

The results demonstrate that alternative A.1 and A.2 had a positive impact on the overall environmental impact, standing out alternative A.2. Confirming the importance of the optimization in level of heat integration of the biorefinery process. In contrast, alternative B, was dominated by a negative impact on the overall environment, especially in fossil and mineral resource use and water consumption.

Virtual Presentation

Engineering More Green Gas and GGRs Through AD Pretreatment and Optimisation

Jack Dyer-Jones

Operations Director, ALPS Ecoscience UK Ltd, United Kingdom

Biomethane is an immediately deployable, low-regret route for renewable energy and greenhouse-gas removals in Europe, with the UK alone able to deliver about 50 TWh by 2030 and around 120 TWh by 2050 based on available feedstock. Constraints are therefore shifting from feedstock to delivery and optimisation. That makes pretreatment and process intensification essential to raise yields, free up digester headroom, and improve whole-plant carbon performance.

This talk sets out practical options across the main feedstock classes. AI-assisted optimisation stabilises plants, reduces inhibition risk, and boosts gas per tonne. Mechanical, chemical, and biological pretreatments, including hydrodynamic cavitation, bio-organic catalysts (BOC), and dark fermentation, accelerate hydrolysis and increase asset productivity. We share field experience, practical impacts, and technology readiness for each pathway.

Expected impacts include higher site-level renewable energy output, increased throughput from shorter effective HRT, cleaner centrate with lower return loads and aeration demand, reduced chemical use, reduced transport emissions, and improved net-energy performance. Scaling these measures across the UK and Europe can convert proven feedstock headroom into reliable green power and measurable emissions reductions and removals at meaningful TWh scale.

Biography:

Jack Dyer-Jones is Operations Director at ALPS Ecoscience UK Ltd and a chartered biochemical engineer. He leads programmes that help biogas operators and developers maximise green-gas output through process optimisation, pretreatment integration, and data-led operations. His background spans water treatment, energy and resource recovery, with a focus on translating lab evidence into robust plant-level results. Jack's recent work covers feedstock characterisation, AD pilot trial design and management, and net-energy/carbon assessments for utility and industry clients.

~ Go to Contribution List

Organizing Partners

ConfColl

BIZWYNK

Conference Venue

ISEC Lisboa - Instituto Superior de Educacao e Ciencias
Address: Alameda das Linhas de Torres 179, 1750-142 Lisboa, Portugal

Please drop a message on WhatsApp (+91 7675083208) for any inquiries related to the program, logistics, venue, or to know any other important information. Immediate assistance will be provided.