WIRE

Waste biorefinery technologies for accelerating sustainable energy processes

Book of abstracts

WIRE's 7th Working Groups Workshop

University of Algarve

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Roberta Panizio, Catarina Nobre, Diogo Santos and Paulo Brito

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Foreword

Welcome to the abstract book of the WIRE COST Action 7th Working Groups Workshop, hosted in Faro, Portugal. This event brought together participants from diverse backgrounds who presented in oral and poster sessions. The workshop emphasized inclusive and international collaboration, reflecting WIRE COST Action's commitment to fostering knowledge sharing and innovation across borders.

As global environmental challenges such as climate change and waste accumulation intensify, the need for sustainable and innovative solutions remains urgent. The extensive use of fossil fuels has significantly increased carbon emissions, accelerating global warming. At the same time, population growth has contributed to waste generation pressures. Sustainable approaches focusing on carbon-neutral energy sources and renewable fuel production are essential. Biorefineries, converting biomass and organic waste into valuable products, offer a promising route toward minimizing carbon footprints compared to fossil fuels. They are key to Europe's path toward carbon neutrality by 2050.

The recent WIRE COST Action workshop in Faro served as a pivotal platform to strengthen knowledge exchange and collaboration between academia and industry. These joint efforts are critical to developing sustainable solutions with positive impacts on the environment, economy, and society.

Thank you to all contributors and participants. Together, we advance toward a greener, more sustainable future.

The editors:

Roberta Panizio, Catarina Nobre, Diogo Santos and Paulo Brito

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Introduction

By 2030, the bio-based economy is expected to have grown significantly in Europe. One of the pillars of this bioeconomy is the concept of BIOREFINERY, the sustainable processing of several kinds of waste and biomass into a spectrum of marketable products and energy. While in the past many research efforts have been conducted toward understanding, modeling, and designing conversion processes that can sustain a true circular economy, this KNOWLEDGE IS QUITE FRAGMENTED and UNEVENLY DISTRIBUTED across Europe. Several countries lack proper policies and public engagement to address the challenges ahead. HARMONIZATION must start with ROBUST KNOWLEDGE and the ability to cover the WHOLE VALUE-CHAIN, from source materials up to the marketable products… and that is WIRE's mission.

The WIRE COST Action broadly organizes into 4 KEY WORKING GROUPS (WG) that bring together experts from ACADEMIA, INDUSTRY and TECHNOLOGY TRANSFER organizations:

- WG 1: Raw Materials
- WG 2: Biorefinery Conversion Technologies
- WG 3: Biorefinery Applications
- WG 4: Communication and Dissemination

WIRE's MC Meeting & 7th Working Groups Workshop was held in Faro (Portugal) at the University of Faro from 3 to 4 July 2025.

The main objective of this workshop was to increase the participation of WIRE members through sessions and industry tours, poster presentations by participants, as well as two lectures and WG meetings.

This event contributed to advancing the goals and deliverables of each WGs and promoting interaction between WG´s participants and stakeholders.

WIRE's MC Meeting & 7th Working Groups Workshop had 46 papers presented as oral and poster communications, divided among the different WGs.

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Jânio Monteiro is a professor at the Institute of Engineering of the University of Algarve, Portugal. He holds a PhD in Electrical and Computer Engineering from the Instituto Superior Técnico of the University of Lisbon, Portugal. He is Chairman of the Board of Directors of CINTAL, a Technology Research Centre in Algarve. He has participated in 14 European R&D projects funded by the European Union, 5 as Principal Investigator (PI), and 8 national projects with local companies, 2 as PI. He is also a member of the coordination team for the Culatra 2030 project, a pilot project supported by the EU Clean Energy Secretariat for Islands, which aims to create a Sustainable Community on the island of Culatra, Portugal. Orcid ID: 0000-0002-4203-1679

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Gokhan TURKER is working as Ass. Prof. at Engineering Fundamental Sciences Department in Istanbul Medeniyet University. He is also co-founder and technical manager of two R&D Company located in Bogazici University Dudullu Teknopark. Having long years of business and academic experience in the fields of renewable energy and environmental problems, he has specifically focused on biomass to energy projects as well as valorization of biomass. Mr. TURKER has also experience in the fields of energy efficiency and management, sustainable environment, GHG emissions, renewable energy sources, environmental biotechnology and microbial ecology. Mr. TURKER holds a bachelor's degree in Molecular Biology and Genetics, Master's and PhD in Environmental Sciences from Bogazici University, Turkey. Currently, he is positioned as Ass. Prof. at Engineering Fundamental Sciences Department in Istanbul Medeniyet University. He also was lecturer in various national and international workshops on uses of molecular techniques in environmental biotechnology organized by Microbial Ecology Group (MEG).

Currently, he has published two book chapters, two books and twelve scientific articles in different journals. He has also performed ten oral and six poster presentations in international symposiums.

Development of Sustainable Bio-Based Polymers from Natural Rosin

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Abstract: The shift toward a circular bioeconomy and the urgent need to reduce dependence on fossil-derived materials have intensified global research into sustainable alternatives. Among various renewable resources, natural resins—particularly rosin have emerged as a versatile and abundant feedstock for the development of bio-based polymers. The se resins, obtained from plant exudates or wood distillation processes, possess unique chemical functionalities such as carboxylic acids, double bonds, and aromatic structures, which make them ideal candidates for chemical modification and polymer synthesis. This study focuses on the development of sustainable bio-based polymers derived from natural resins through a series of physical and chemical transformations. The process includes resin extraction, purification, and subsequent functionalization via esterification, polymer grafting, and cross-linking reactions to enhance their structural, mechanical, and barrier properties. Particular emphasis is placed on optimizing the polymerization conditions to achieve high performance in terms of thermal stability, biodegradability, and mechanical strength.The resulting materials are evaluated for potential applications in environmentally friendly packaging, protective coatings, adhesives, and high-value composites. Advanced characterization techniques such as FTIR, TGA, SEM, and mechanical testing were employed to assess the material properties. Preliminary results indicate that modified natural resin-based polymers can successfully replace petroleum-derived plastics in several industrial applications, offering a sustainable and eco-efficient alternative.

In summary, this research contributes to the growing field of green chemistry and materials science by valorizing natural resins into functional, high-performance polymers. The findings pave the way for broader utilization of bio-resources in industrial polymer production while supporting sustainability goals and environmental protection.

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Short biography (should not exceed 100 words): Bilge Yılmaz is an Assistant Professor and Deputy Head of the Department of Forest Industrial Engineering at Karadeniz Technical University (KTU), Türkiye. She completed her undergraduate studies as the top graduate of the Faculty of Forestry at Istanbul University, followed by her MSc and PhD degrees in Fiber and Paper Technology at KTU. Her academic expertise lies in the chemical modification of natural resins, development of biodegradable polymers, electrospun nanofibrous membranes, and sustainable material technologies. Her research particularly focuses on the modification of rosin derivatives and their applications in air filtration, wood-based panel, eco-friendly thermoplastic paint and biobased packaging materials production. Dr. Yılmaz has served as a principal investigator and researcher in several national and international research projects funded by TÜBİTAK, Horizon and COST Actions. She has authored numerous peer-reviewed articles and conference presentations and has filed patent applications in both Türkiye and Italy. Her scientific achievements have been recognized with various awards, and she continues to pursue interdisciplinary collaborations aimed at developing sustainable biopolymer-based solutions.

Wood biomass thermodynamic and chemical properties data and pathways for advanced liquid biofuels and SAF production

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Abstract: For the production of biomass-based advanced liquid biofuels and sustainable aviation fuels (SAF) it is imperative to select biomass feedstock that is widely available at large scale, notably wood biomass, because of environmental reasons, as well as strict European Union (EU) emissions regulations in place for challenging EU targets to reduce CO2 emissions and reach net-zero CO2 emissions by the year 2050. The first objective of the present work is to collect and analyse data of different types of wood biomass feedstock occurring widely in EU countries, including feedstock properties and composition, in order to identify the involved chemical pathways for biofuels and SAF production. The second objective is to review published research data which underscore the most efficient type of biomass feedstock in terms of biofuel production yield in combination with the relevant biorefinery systems and involved process and technology readiness. The third objective is to present recently published chemical kinetics mechanisms and reactions for different types of wood biomass, including cellulose, hemicellulose and lignin components, and the dominant reactions occurring within candidate thermochemical processes. The ultimate objective is to discuss the biomass feedstock quality for biofuels and SAF production, as well as provide a comparison of the wood biomass-based biofuels and SAF with the conventional hydrogenated vegetable oil (HVO) based ones. The methodology used in the present work includes the thermodynamics and chemical properties data analysis for wood biomass, and the reaction enthalpy balance for calculation of test wood biomass feedstock thermochemistry data, using the dominant chemical reactions for fast pyrolysis and partial oxidation processes. A heat and mass conservation approach in combination with the stoichiometric combustion equation are employed in order to quantify and compare the CO2 emissions towards net-zero, for the test wood biomass feedstock-based fuels and the advanced conventional HVO biofuels and SAF. From the findings of the present work, the requirements for wood biomass feedstock properties are summarised, while pertinent processes from field-to-tank for advanced biofuels and SAF production utilising wood biomass feedstocks are briefly discussed. Recommendations are provided for feedstock quality in order to meet the biofuels standards for urban transportation, as well as to meet the specifications for SAF certification according to strict aviation fuel standards. Furthermore, recommendations for experimental and computational investigations of biomass feedstock utilisation for biofuels and SAF production optimisation using advanced data approaches are briefly described. Wood biomass feedstocks in today developed biorefinery systems are expected to contribute in a more sustainable environment.

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Short biography: Dr. Chasos is Associate Professor in Internal Combustion Engines (ICE) at the Mechanical Engineering Department of Frederick University. Dr. Chasos teaches in undergraduate and postgraduate programs of studies, and his research focused on development of two-phase flow models for direct-injection gasoline spray injection and atomisation, and the application of the computational fluid dynamics (CFD) methodology for the prediction and validation of two-phase flows and combustion processes in the cylinders of ICE, and the production and testing of first-generation biofuels in ICE. Dr. Chasos is member of the Management Committee of COST Action WIRE, CA20127.

Life Cycle Assessment of Microbial Protein Production Using Hybrid Living Materials

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Abstract:

Hybrid living materials (HLMs) are systems that integrate artificial components, such as porous membranes, with living elements, such as microbial biofilm consortia. This study aims to design and develop HLMs that capture and utilise greenhouse gases (GHGs) – carbon dioxide (CO_2) and methane (CH_4), while producing protein-rich microbial biomass suitable for use in animal feed. To assemble an optimum synthetic microbial consortium for microbial protein production, porous recycled PET membrane and microbial consortia of photoautotrophic and methanotrophic strains are utilised. Methanotrophs utilise CH_4 as a carbon and energy source, while photoautotrophs use energy from light and CO_2. This addresses global challenges including plastic pollution, climate change and food security.

In addition to designing and developing the HLMs, this study also assesses the environmental performance of producing the HLMs through life cycle assessment (LCA). In particular, this study (1) identifies environmental hotspots at lab-scale and proposes scenarios to reduce environmental impact; (2) assesses conditions under which environmental performance outperforms alternative phototrophic and methanotrophic processes; and (3) establishes a baseline scenario for comparison with conventional protein production processes, such as fishmeal and soymeal.

LCA is based on two interlinked production processes: the development of recycled PET membrane and the production of microbial proteins. These processes are modelled separately. The microbial protein production model is the core process. The LCA covers life cycle stages from raw material extraction and processing, pre-cultivation of microbial cultures, biofilm formation, to biomass harvesting (by mechanical scraping) and drying, following the *cradle-to-gate* system boundary. In turn, the production of recycled PET membrane includes the processing of recycled PET and the preparation and modification of the membrane.

Two functional units (FUs) were defined: production of 1 kg of microbial protein using HLM (FU1), and production of a product providing 1kg of protein equivalent to the protein content found in fishmeal (FU2). FU1 is used to identify environmental impact hotspots within the HLM production process, and FU2 is used for comparison with conventional protein sources. The LCA model was built using *SimaPro* software. The *Ecoinvent 3.10* database was used for the life cycle impact assessment and the *ReCiPe 2016* Midpoint method was used to assess the environmental impact.

The environmental impact assessment results of the development of recycled PET membrane identified membrane preparation as the dominant contributor (48%) to the overall impact, followed by membrane modification (30%) and PET processing (22%). The main impacts arise from N-methyl-2-pyrrolidone, which is used as a solvent or casting agent in composite formulations or

surface treatments to form the membrane structure (membrane preparation), and from electricity consumption during the membrane modification stages. The microbial protein production module, in turn, showed high environmental impacts due to electricity consumption, which accounted for 73% of the total impact. Benchmarking against fishmeal and soymeal showed that microbial protein offered environmental advantages only in terms of land use and water consumption. Soymeal had the highest impact on land use, while HLM protein demonstrated a net positive impact on water-related categories due to water being returned via wastewater treatment.

The LCA results obtained are based on empirical data from the lab-scale experiments. Further steps will include process optimisation by reducing electricity consumption in energy-intensive steps, such as drying and biofilm cultivation. Other steps will involve investigating the durability of recycled PET membrane and exploring alternative methods for biomass harvesting. In addition, a carbon footprint analysis will be conducted to assess the potential of the proposed carbon capture and utilisation solution to mitigate GHG emissions.

Acknowledgments: This research is funded by the Latvian State Budget (Latvian Council of Science) in the frame of M-Era.Net project "Recycling plastic and developing hybrid living materials by capturing greenhouse gases to produce value-added products" (REPLACER), grant number ES RTD/2023/12.

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Short biography: Elina Dace holds a PhD degree in environmental engineering and a master’s degree in social sciences. Her research work is characterized by multi-disciplinary and integrated application of quantitative and qualitative research approaches to study transition towards circular economy and climate change mitigation. She applies knowledge from environmental engineering, industrial biotechnology, and computational modelling to support decision makers in selecting valorization pathways of biowaste and bio-based side streams into value added products. She has published widely on modelling and assessment applications to various socio-technical systems as agricultural, forestry, waste management and energy systems.

Agri-food wastes as a rich source for novel material solutions in a circular economy framework

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Abstract: Agricultural wastes have been highlighted as important resources in the last decade, not only for energy generation but also as starting materials for the synthesis of new biomaterials. The biopolymers present in agricultural wastes, such as protein, starch, cellulose, hemicellulose, and lignin, represent valuable components for newly designed biocomposite materials for a wide range of industrial applications. These can be high volume and low value applications, such as biodegradable shoppers or mulching foils, but also low volume and high value materials for i.e., biomedical, pharmaceutical, or electronic applications. Some research cases highlight the utilization of one specific biopolymer extracted from the respective agricultural waste source, while others focus on a cascade use of the utilized resource in order to develop a zero-waste concept of waste utilization. The range of agri-food waste resources that are available for extraction is enormous, and resources of which waste streams have been used in research in the last decade include, just to name a few, sugar beet, carrot, papaya, mango, banana, olive, grape, blueberry, potato, avocado, coffee, rice, wheat, oat, sugar palm, oil palm, lime, orange, lemon, pomelo, and many more (Awasthi et al. 2022; Merino et al. 2022).

This work shall give a broad overview of examples of original research that combine the vast assortment of biopolymers that can be recovered from agricultural wastes, with the requirements that are demanded from modern-day solutions for material applications, avoiding the creation of new waste streams and following circular economy concepts.

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Short biography: Florian Zikeli has been working with lignocellulosics since his PhD thesis in 2010, which he conducted both at TU Wien and KTH Stockholm. He was working especially with lignin isolation and characterization using NMR spectroscopy, UV spectroscopy, molar mass analysis via HPSEC, and wet chemistry methods. From 2017, he has worked as a Post-Doc in Italy, University of Tuscia in Viterbo, studying lignin nanoparticles for wood-related applications such as biocide delivery systems or surface treatments. From 2020, he was a research assistant at TU Wien for almost two years, before he went back to University of Tuscia to start in a researcher position.

Effect of Pretreatment Strategies on Biogas and Bioethanol Production from Waste-Derived Lignocellulosic Substrates

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Abstract: The production of renewable biofuels from organic waste plays a critical role in the transition to a circular and low-carbon economy. However, one of the main challenges in biogas and bioethanol generation from agricultural and food industry residues lies in the recalcitrant nature of lignocellulosic biomass. The complex structure of lignin, cellulose, and hemicellulose makes these materials difficult to degrade through chemical or biological means, thus significantly limiting conversion efficiency.

To overcome this barrier, various pretreatment methods are employed to enhance the availability of fermentable sugars and improve process yields. Effective pretreatment should not only be economically viable but also ensure a high degree of cellulose breakdown, minimize the formation of inhibitory compounds, and require minimal chemical input. Strategies include mechanical size reduction—commonly applied to food and agricultural waste—thermal treatment, chemical processing, and enzymatic hydrolysis. Each of these techniques aims to increase substrate surface area, disrupt structural integrity, or remove fermentation inhibitors to facilitate microbial access to carbohydrates.

Enzymatic hydrolysis has gained particular interest due to its environmentally friendly profile and relatively high sugar yields (75–85%). Unlike acid or alkaline hydrolysis, enzymatic methods operate under mild conditions, reducing equipment corrosion and overall process costs. These advances make it a promising approach for converting complex organic materials such as food waste, animal manure, and lignocellulosic residues into biofuels.

Utilizing lignocellulosic and food-derived waste for biofuel production not only addresses the growing issue of organic waste management but also supports sustainable energy development. With appropriate pretreatment and process optimization, these underutilized substrates have the potential to serve as valuable feedstocks for biorefinery systems.

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Short biography: **Izabela Konkol** is a research assistant at the Institute of Fluid-Flow Machinery, Polish Academy of Sciences. Her research focuses on the impact of pretreatment methods for various types of substrates on anaerobic digestion. She investigates the quantity and quality of biogas produced from materials such as animal manure, lignocellulosic waste, and food waste. Her scientific interests include optimizing biological processes for efficient energy recovery from organic waste.

Phosphoric Acid-Activated Carbon from *Pinus nigra* Biomass for Reinforced Guar Gum Insulation Foams

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Abstract: The rise of the circular economy and bio-based industries has made the conversion of biomass and waste into value-added product using environmentally friendly processes a strategic priority in accordance with sustainable development goals. Although the knowledge of these transformation processes is still incomplete and limited in terms of application, the efficient use of resources, advanced recycling technologies and the integration of natural raw materials into multifunctional products offer great potential for holistic solutions covering the entire value chain. In this context, this study presents a sustainable approach to converting biomass waste into value-added products. In the first stage of the research, black pine (*Pinus nigra*) waste was converted into activated carbon by phosphoric acid activation and controlled pyrolysis. As a result of this process, activated carbon with a high surface area (836 m²/g) and a yield of 33.81% is obtained, presenting an effective example of environmentally friendly material conversion. In the second stage, the different rate of activated carbon (0%, 1%, 3% and 5%) was added to cellulose which is reinforcing material and guar gum which is matrix material. The aim is to develop biodegradable alternatives with increased mechanical and thermal performance for insulation applications. Compressive strength was improved with the addition of 3% activated carbon; At 5% activated carbon addition , fire resistance increased (limited oxygen index: 28.2%). With low thermal conductivity values (0.045–0.078 W/mK), these foams offer the potential for energy-efficient and sustainable building materials. This study provides a holistic approach to the conversion of biomass waste, the development of functional products based on natural materials and environmentally friendly production processes, thus making significant contributions to the circular economy and sustainable development.

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A comprehensive comparative study of ultrasound-alkaline and thermal-alkaline hydrolysis of duck feather

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Abstract: The poultry industry generates substantial quantities of feather waste, representing an abundant but underutilized source of keratin—a high-value biopolymer with potential applications in bio-based materials and sustainable energy processes. Conventional keratin extraction methods often suffer from high energy consumption, long processing times, and the use of severe chemicals, posing both economic and environmental challenges for large-scale valorization. Therefore, the development of scalable, efficient, and greener extraction technologies is critical to unlocking the full potential of feather waste within circular bioeconomy models.

In this study, we investigate ultrasound-assisted alkaline hydrolysis as a sustainable alternative for keratin recovery from feathers, surpassing the performance of traditional thermal alkaline hydrolysis. The study compares the hydrolysis time, yield, and chemical properties of keratin extracted using ultrasound-assisted alkaline hydrolysis and thermal alkaline hydrolysis (hot plate method). The influence of factors such as particle size, alkali concentration, liquid-to-solid ratio, reactor geometry, temperature of the keratin colloid upon precipitation, precipitation pH, and the type of precipitating acid was investigated. Favorable conditions for ultrasound-assisted alkaline hydrolysis were found to be 3% NaOH, a 10:100 (w/v) solid-to-liquid ratio, using a cylindrical vessel, and an ultrasonic energy density of 360 kJ/L, with pH adjustment to 4.5 using citric acid after cooling to room temperature. This method outperformed the thermal approach, yielding 70% keratin in 25 minutes, compared to 23% in 90 minutes using a hot plate, mainly due to the exothermic effects of cavitation.

The process demonstrates clear advantages in terms of energy efficiency, processing time, and environmental compatibility, offering a promising pathway for integrating feather waste into emerging biorefinery schemes. By transforming a challenging waste stream into a valuable bioresource, ultrasound-assisted hydrolysis contributes to advancing waste valorization, resource efficiency, and sustainability in the context of circular biobased industries and green energy value chains.

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Transforming food waste into sustainable soil solutions

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Abstract: Food processing residues (FPRs) represent a significant and often overlooked resource. Typically, these byproducts from the food industry, ranging from vineyard trimmings and beer bagasse to dairy waste and meat processing residues, are discarded, predominantly ending up in landfills. This conventional disposal method not only incurs economic costs but also contributes to environmental burdens, including greenhouse gas (GHG) emissions and potential contamination of soil and water. However, a fundamental shift in perspective is now emerging, recognizing the inherent value previously overlooked in these residues. FPRs are rich in essential nutrients such as nitrogen, phosphorus, and carbon, all of which are vital for healthy plant growth and robust soil ecosystems. This rich nutrient profile positions them as a promising raw material for creating high-quality soil improvers and fertilizers, offering a sustainable alternative to synthetic fertilizers.

The Waste4Soil project stands at the forefront of this transformative effort. Its core mission is to revolutionize the perception and management of FPRs by actively enhancing existing valorization pathways and developing novel ones. The goal is to convert these discarded materials into valuable soil improvers, thereby closing critical nutrient loops within the food production system. A distinctive feature of Waste4Soil is its adoption of a Living Lab (LL) approach. This innovative methodology fosters a dynamic, real-world environment where stakeholders, including farmers, food processors, researchers, and waste managers, collaborate to experiment, test, and refine new solutions directly in operational settings. This ensures that the developed technologies and processes are practical, effective, and tailored to real-world needs.

The project's comprehensive work involves several key initiatives. Initially, extensive mapping and characterization of FPR streams are conducted within the various LLs. This process provides a detailed understanding of the composition, volume, and seasonal availability of different residue types, which is crucial for optimizing their subsequent processing. Furthermore, Waste4Soil is developing advanced sensors for precise monitoring of GHG emissions generated during the transport and storage of FPRs. This data is vital for identifying emission hotspots and implementing strategies to minimize the environmental footprint. To streamline the entire process, an integrated FPR management platform is also under development. This platform aims to

optimize the collection, sorting, and distribution of FPRs, ensuring efficient resource utilization. Crucially, the soil improvers derived from these innovative valorization pathways are applied in agricultural fields. To assess their efficacy and environmental impact, the soil health is meticulously monitored using advanced sensors. This real-time data collection provides invaluable insights into the overall soil vitality. By integrating these diverse components, Waste4Soil strives to create a truly circular economy within the food chain, fostering sustainable agricultural practices by closing nutrient, organic matter, and water loops, ultimately contributing to a more resilient and environmentally friendly food system.

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Energy and Exergy Assessment of a Landfill Gas Power Generation System in Bayburt, Türkiye

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Abstract: This study presents a comprehensive thermodynamic and thermoeconomic analysis of the Biogas Power Plant operated by the Bayburt-Gümüşhane Provincial Municipalities Solid Waste Management Union (BAY-GÜ-KAB), located in Bayburt, Türkiye. The facility produces electrical power by combusting landfill gas (LFG) generated from municipal solid waste (MSW) collected from surrounding municipalities. The LFG is utilized as a fuel source in a gas engine, converting chemical energy into electricity. Real operational data from the plant were employed throughout the study to ensure accuracy and reliability of the results. These data included measurements related to fuel consumption, electricity generation, and environmental conditions. Based on these real-world values, both thermodynamic (energy and exergy) and thermoeconomic performance metrics of the system were evaluated in detail. The energy efficiency of the plant was determined to be 42.71%, indicating the proportion of input energy successfully converted into useful electrical output. Meanwhile, the exergy efficiency was calculated as 59.29%, reflecting the system's effectiveness in converting available energy into work while accounting for irreversibilities and losses. Overall, this analysis provides valuable insights into the operational effectiveness and economic viability of biogas-based power generation from landfill gas, contributing to the optimization of waste-to-energy systems in municipal applications.

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Innovative Framework for Circular Economy-Based Integrated Organic Waste Management

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Abstract: This study presents a scientifically grounded framework for the development of an integrated model for organic waste management based on the principles of circular economy. The primary objective is to establish a closed-loop system that enhances the recovery of material and energy resources, mitigates environmental impacts, and aligns with the global objectives of sustainable development. The study begins with a comprehensive characterization of organic waste streams generated in agricultural, municipal, and industrial sectors. Analytical methods are employed to quantify key parameters such as carbon-to-nitrogen ratios, moisture content, and nutrient composition. These parameters inform the optimization of treatment processes, including anaerobic digestion and composting, which are pivotal in transforming organic waste into renewable energy (e.g., biogas) and nutrient-rich soil amendments. A mathematical model is developed to simulate the material and energy flows within the system, integrating variables such as feedstock availability, treatment conditions, and output quality. The model also incorporates circular economy indicators, enabling the assessment of the system's performance in terms of resource recovery, energy self-sufficiency, and nutrient cycling. Special attention is given to the role of nutrient recovery in improving soil health, thereby closing the loop between organic waste generation and agricultural productivity. The practical applicability of the proposed model is validated through experimental and scenario analyses. Results demonstrate the system's potential to significantly reduce the quantity of organic waste disposed of in landfills, mitigate greenhouse gas emissions, and provide renewable energy solutions. Additionally, the model emphasizes the importance of optimizing collection and transport logistics to enhance the overall efficiency and sustainability of waste management practices. This study contributes to the theoretical and practical advancements in the field of waste management by proposing a holistic approach that integrates environmental, economic, and social dimensions. The findings underscore the necessity of transitioning from linear to circular resource flows, advocating for the systemic adoption of circular economy principles in waste management policy and practice. By advancing the understanding of circular economy applications in organic waste management, this study provides actionable insights for policymakers, industry stakeholders, and researchers. The proposed model serves as a blueprint for establishing sustainable waste management systems that align with contemporary environmental imperatives and support the global transition toward a circular and regenerative economy.

Keywords: organic waste, circular economy, waste management

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Utilization of Tea Industry Wastes in Biofuel Production

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Abstract: The tea industry generates significant amounts of lignocellulosic waste worldwide, including tea leaves, stems, and processing residues. These wastes, traditionally disposed of through burning, constitute a valuable feedstock source for biofuel production. Tea wastes are suitable for ethanol production due to their high cellulose (30-40%) and hemicellulose (20-25%) content. Additionally, their high lignin content (25-30%) makes them applicable for biodiesel and biogas production. High-efficiency biofuel can be obtained by optimizing pretreatment methods for lignocellulosic structure breakdown, enzymatic hydrolysis, and fermentation processes. Biofuels produced from tea wastes serve as alternatives to fossil fuels, reducing carbon emissions and providing sustainable energy production. This study evaluates the biofuel potential of tea industry wastes and presents economic feasibility analyses. In conclusion, the utilization of tea wastes both reduces environmental problems and offers significant opportunities in renewable energy production.

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Sustainable Valorization of Bioethanol Production Residues via Xanthan Bioprocessing

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Abstract: Growing industrialization is a response to the increasing demands of the consumer public, exploiting resources on a large scale and generating large amounts of waste alongside the desired products. Biofuel production generates significant amounts of waste, representing a challenge as well as an opportunity for sustainable resource management. Production of different biofuels constantly generates by-products, such as glycerol from biodiesel or liquid effluent stillage from bioethanol production, which can pose an environmental issue if not adequately managed. Large amounts of waste and effluents from biofuel production represent a significant problem and with the present trend of increasing the qualitative and quantitative load, it will undoubtedly remain the problem in the future. Numerous solutions are offered to address the aforementioned problems, but only a comprehensive and meaningful approach with apparent economic benefits can be sustained. Waste management in biotechnological processes reduces harmful environmental emissions and produces significant amounts of high-value products, such as biopolymer xanthan. This work aims to further develop the bioprocess of xanthan production from biofuel industry effluents by generating a simulation model of this bioprocess by applying a bioprocess simulation software package. A simulation model for xanthan production was developed to evaluate the process and economic parameters of this biotechnological process. The results of this research provide reliable information for defining the conceptual design of the proposed bioprocess.

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Modeling of Thermodynamic Data Relevant for Sustainable Processing of (Bio)Waste

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Abstract: The transition from a fossil fuel-based economy to a circular bioeconomy is challenging, as both resources and products have changed, waste is considered a resource, and special attention is paid to environmental protection [1]. The sustainable processing of bio(waste) requires the development of highly accurate microkinetic models of various reactions that occur during the biorafining. The development of such models is based on reliable data on thermodynamic and transport properties of all components present in a reaction mixture at different pressure and temperature conditions. Modeling of thermodynamic data plays a crucial role in process design and optimization by predicting system behavior, and ensuring environmental sustainability.

Most of the available data on thermodynamic and transport properties are determined for the components and systems relate to the processing of fossil fuels. Similarly, most of the models currently used in process simulators were developed for the petrochemical industry. The question arises whether models developed for the needs of production in the fossil-based economy are suitable for the processes planned in the bioeconomy. If those models are not reliable for the processing of (bio)waste, can they be adapted for the needs of optimizing such processes?

The application of existing models in prediction of the thermodynamic and transport properties of new systems present in the biorefining process does not yield good results. Therefore, it is necessary to define the interactions between the components present in the aforementioned systems, which requires large databases of thermodynamic and transport properties of these components. Phase-equilibrium behavior is particularly difficult to predict, especially when poorly soluble gases such as hydrogen are present in the system. Our research showed that the Soave–Redlich-Kwong and Peng-Robinson equations of state significantly overestimate the solubility of hydrogen in furan- and benzene-based compounds, whereas the PC-SAFT model significantly underestimates the solubility. Furthermore, the binary interaction parameters optimized for the cubic Soave–Redlich-Kwong and Peng-Robinson equations of state varied with temperature. On the other hand, binary interaction parameters optimized for the PC-SAFT were temperature independent which enables the accurate prediction of hydrogen solubility in the studied solvents in the entire examined temperature and pressure ranges.

[1] De Hemptinne et al. Ind. Eng. Chem. Res. (2022) 61, 14664−14680.

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ULTRASONIC-ASSISTED EXTRACTION OF FERMENTABLE SUGAR FORM LIGNOCELLULOSE BIOMASS for BIOFUEL PRODUCTION

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Abstract: The valorization of lignocellulosic biomass (LCB) into valuable products or energy sources stands as a promising strategy for achieving waste-to-wealth, circular economy goals, and carbon neutrality. Traditional techniques for extracting fermentable sugars from LCB are associated with high energy and time consumption, leading to increased costs. Ultrasonic-assisted extraction (UAE) offers a sustainable alternative, requiring a moderate investment of time and energy. UAE operates on the principle that subjecting a biomass suspension to high-intensity ultrasound induces acoustic cavitation, a phenomenon capable of lignin deconstruction and facilitating the release of soluble sugars. This study aims to explore the impact of UAE on fermentable sugar yield and supernatant recovery from apple pomace waste. The Box-Behnken Statistical Experimental Design model was employed for the optimization of process parameters, with particle diameter (Dp = 90 – 181 µm), time (t = 2 – 8 min), and power (P = 60 – 100%) as independent variables. Dependent variables were total sugar content (TSC) and supernatant recovery. The fit statistics for the TSC response model were as follows: $R^2 = 0.9481$, adjusted $R^2 = 0.8962$, and predicted $R^2 = 0.7068$. Similarly, the fit statistics for the supernatant recovery response model were $R^2 = 0.9847$, adjusted $R^2 = 0.9642$, and predicted $R^2 = 0.814$. Optimum conditions for maximum TSC (25.91±1.22 g/L) with a corresponding supernatant recovery of 55% were determined as Dp = 181 µm, t = 6.5 min, and P = 90%. Validation experiments using point prediction demonstrated good agreement between model predictions and observed responses. The findings of this study suggest UAE as a sustainable approach for obtaining fermentable sugar from organic waste.

Keywords: Lignocellulosic waste, pretreatment, sugar extraction, biorefinery.

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Improvement of bioethanol production sustainability through biotechnological valorization of distillery stillage

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Abstract: The issue of sustainable development within the environmental, economic, and social dimensions is relevant in all developed countries. The EU has accepted the obligations of the Kyoto Protocol and included them in its energy policy, according to which the strategic goal is to reduce greenhouse gas emissions by 80-95% by 2050, which is also binding for countries aspiring to membership in this community. Accordingly, there is a tendency to substitute liquid fossil fuels with renewable ones, among which bioethanol is gaining increasing popularity. However, over the last fifty years, bioethanol has not only been produced as a biofuel but also as an industrial chemical, and most recently as an active ingredient in disinfectants. Various areas of application require that bioethanol has the appropriate quality, which is directly related to the production technology and raw materials, among which agro-industrial intermediates, by-products, and waste streams are widely utilized. Intensification of bioethanol production leads to the generation of significant amounts of effluents, primarily stillage. Its characteristics largely depend on the raw material used for bioethanol production and the method of selected raw material processing during the fermentation media preparation. Since the disposal of untreated distillery stillage into the environment is irresponsible and unacceptable, the business of bioethanol manufacturers in the concept of sustainable development requires the implementation of circular economy principles. Given that the possibilities of biocatalyst cultivation on various substrates are almost unlimited, the valorization of this effluent from the bioethanol industry as a raw material in biotechnological production represents an ideal option from the view-point of economic and environmental sustainability. Therefore, the potential of biotechnological utilization of distillery stillage for the production of value-added bioproducts was evaluated in this study. Special attention was paid to the biopolymers of microbial origin, an important class of renewable biomaterials. Production and application of microbial biopolymers are more sustainable and eco-friendlier than synthetic polymers, and moreover, they are non-toxic, biocompatible and biodegradable. Among them, xanthan, produced by metabolic activity of the bacteria from the genus *Xanthomonas*, is one of the commercially most exploited due to its exceptional rheological behavior. The consideration conducted within this study also includes the overview of research stages necessary for the generation of novel bioprocess solutions for distillery stillage valorization in xanthan production that are in the context of sustainable development and circular economy. The aforementioned stages are aimed to (I) quantify and analyze the distillery stillage in terms of parameters that are used for characterization of raw materials in xanthan production, as well as to map the potential generators, (II) develop lab-scale xanthan production process that includes screening of xanthan-producing microorganisms and standardization of inoculum preparation, formulation of the composition of media for the all stages of xanthan production, optimization of the bioprocess conditions, definition bioreactor configurations and establishment of bioseparation procedure, and (III) simulation and scale up of xanthan production.

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Comparative Methane Production From Cheese Whey at Various Two-Stage Configurations with Biomass Retention Strategy

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Keywords: biogas production, dairy industry, two-stage, combined reactors, biofilm, settling

Abstract: Cheese whey (CW) is the dairy industry's primary waste effluent, and if not adequately handled, it can significantly threat the environment due its high organic content caused by soluble proteins, lactose, lipids, minerals, and fat in the ways of water pollution, soil contamination, and eutrophication risk. On the other hand, it has a potential in sustainable usage areas such as bioenergy production. Speaking of bioenergy, anaerobic digestion (AD) is a well-established technology for testing CW in bioenergy output. However, the CW's high organic acid content and low pH necessitate a distinct method for AD, such as pH adjustment, co-digestion, a two-stage process, and so on. In this work, CW containing 60-90 g COD/L was treated in four distinct two-stage mesophilic (37±2°C) AD processes using the biomass retention method. The effluent of a fermentation reactor (FR) with a hydraulic retention time (HRT) of 5.5 days was shared by i) a continuous stirred tank reactor (CSTR), ii-iii) two combined microbial electrolysis cell and anaerobic digestion ($MECAD_1$, $MECAD_2$) reactors with a voltage application of 0.6 V, and iv) a Biofilm reactor, that is identical to the MECAD, but without a voltage application. The two MECAD reactors differed from each other by the selection of their anode and cathode electrodes. The two-stage reactors were operated at a total HRT of 25.5 days and an OLR of 3.0-4.5 g COD/L/d. To increase the biomass retention in the reactors, the mixing of the reactors was stopped 2 hours before the feeding routine each day to allow the biomass to settle in the reactor. Also, to sustain the biological activities and support the steady pH level in the FR, once a week, one day of effluents from the second-stage reactors were replaced with the medium of the FR once a week. The results demonstrated that the two-stage systems with the biomass retention strategy produced methane without requiring pH adjustment in the reactors. The CSTR, $MECAD_1$, $MECAD_2$, and Biofilm reactors produced 0.95 $L/L_R/d$ (0.26 L CH_4/g COD), 1.09 $L/L_R/d$ (0.30 L CH_4/g COD), 1.19 $L/L_R/d$ (0.33 L CH_4/g COD), and 1.04 $L/L_R/d$ (0.28 L CH_4/g COD) of methane, respectively. Accordingly, the COD removal efficiencies of the CSTR, $MECAD_1$, $MECAD_2$, and Biofilm reactors were around 80-86%, 83-89%, 88-92%, and 83-90%, respectively, when treating the effluent of the FR. Overall, the COD removal efficiencies were highest at the $MECAD_2$ being around 95%. Finally, the current and methane productions of the $MECAD_1$ and $MECAD_2$ reactors showed that the effective mixing near to the anode surface had a substantial impact on the methane production and electron transfer in the reactors.

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Short biography: Dedicated Environmental Engineer with 18 years of experience and expertise on Environmental Law and related regulations at governmental institutions. In addition to this, 15 years of research and experimental work experience on waste treatment, fermentation, and anaerobic digestion processes. For the last 8 years, intense study on the bioelectrochemical technologies and combination of these technologies with anaerobic digestion gave a new perspective on the waste treatment strategy. Controller and participant in Environmental Impact Assessment projects. Skillful in planning and directing investigations and managing environmental due diligence actions. Communicative and organized with exceptional interpersonal abilities.

Integrating Waste-to-Energy into Municipal Energy transition Roadmap for the city of Nis

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Abstract: Energy Transition Roadmap of the city of Nis until 2050, adopts a participatory back-casting approach to drive the city toward climate neutrality by 2050 while emending socio-economic co-benefits to the energy planning methodology, setting circular resource flows and high-efficiency waste-to-energy (WtE) conversion as critical sources for decarbonizing an urban system that today consumes 1.72 TWh of final energy and depends on carbon-intensive, imported electricity.

Municipal solid waste (MSW) management in Niš relies on landfilling 102 819 t/yr at the Bubanj site. Separate collection is limited and the recycling rate is just 0.7 %, while 42 illegal dumps persist across suburban areas. The study performed included a scenario analysis, aligned with which included renewable energy sources and their applications, prediction of possible energy market impact and possible technological development trends. The model was also used to evaluate a modular waste-to-energy (WtE) plant as a pivotal decarbonization resource.

The baseline mass-energy balance shows that a single-line moving-grate incinerator sized for 180 000 t/yr could recover 14.5 MW of electricity and 35 MW of low-grade heat, displacing 6.7 % of present electricity demand and 7.3 % of district-heat demand. Even the conservative roadmap estimate of 211 MWh/ yr electricity from refuse-derived fuel avoids 1 900 t CO_2-equivalent annually. Under the Green Scenario—characterized by accelerated source-separation, organics diversion and full flue-gas heat recovery—electrical output rises to 90 GWh/yr by 2040, while combined heat-and-power utilization pushes overall efficiency above 80 %. The Moderate Scenario attains 52 GWh/yr through incremental retrofits, whereas the Stagnation Scenario yields <20 GWh/yr, insufficient to curb landfill methane.

Levelized-cost assessment places Green-Scenario electricity at 71 €/MWh, competitive with projected wholesale prices after 2035. Sensitivity analysis shows that raising the recycling rate to 25 % cuts feedstock energy by 13 % but lifts specific avoided emissions to 0.79 t CO_2-eq MWh-e.

The study demonstrates that a municipal WtE facility, coupled with district-heat integration and robust materials-recovery policies, can shift Niš from landfill dependence toward a circular-economy trajectory, delivering climate, air-quality and energy-security co-benefits while remaining fiscally attractive for public investment.

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Local Biomethane Supply for District Heating: Feasibility and CO_2 Impact Assessment

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Abstract: The centralized system of heat energy production, commonly known as district heating, has contributed to the reduction of air pollution even when coal and fuel oil were used as primary energy sources. Natural gas-based district heating offers lower emissions, but it does not eliminate carbon dioxide (CO_2), the primary greenhouse gas. Therefore, modern district heating systems aim to partially or completely replace fossil fuels with renewable energy sources: through heat pumps or biomass utilization. Biomass can be used in its raw form, but also in the form of biogas or biomethane. Biogas is produced via anaerobic digestion of agricultural residues, most commonly from livestock farming.

The district heating plant in Bor, Eastern Serbia, transitioned several years ago from coal and fuel oil to compressed natural gas (CNG), which is delivered by specialized trucks. This shift has significantly contributed to the reduction of air pollution in this mining town. The old coal boilers were decommissioned, and a 40 MW fuel oil boiler was upgraded to run on natural gas. In addition, two new 15 MW gas boilers were installed. The total fuel consumption of all three boilers at full capacity amounts to 160,000 kg/day of natural gas.

A pig farm located in the village of Halovo, near Zaječar, Eastern Serbia, has the potential to produce 1,073 to 3,350 kg/day of compressed biomethane from livestock biogas. If this biomethane were transported by truck to Bor (a distance of approximately 40 km), it would reduce CNG consumption by 0.67–2.09% under maximum load conditions. This percentage would be higher under typical operating conditions.

Replacing a portion of natural gas with biomethane would also reduce the carbon footprint. The estimated net CO_2 savings, after accounting for transport emissions, range from 2,923 to 9,125 kg/day, or 526 to 1,642 tons annually. Depending on the supply scale and delivery frequency, additional transport costs range from €3,590 to €10,022 per heating season. Further reductions of CO_2 could be achieved by securing additional biomethane supply.

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Sustainable Valorization of Marine Plastic Waste through Catalytic Pyrolysis

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Abstract: The persistent issue of marine plastic waste, particularly from discarded fishing nets, poses significant environmental threats, contributing to eutrophication and water pollution. In response to these challenges, this study explores sustainable valorization pathways for such waste, aiming to convert it into high-value energy products and recyclable monomers, thereby supporting circular economy strategies. Discarded nylon-6 fishing nets, abundant in coastal and marine environments, were identified as a promising feedstock for pyrolysis. Special focus was given to the recovery of caprolactam, the monomer unit of nylon-6, which can potentially close the material loop in the fishing gear industry.
A comprehensive investigation combining micro-thermal and laboratory-scale pyrolysis was conducted to evaluate the decomposition behavior and product distribution from waste fishing nets composed of nylon-6. Initial thermal and chemical characterization was carried out using TGA-DTG-FTIR analysis, while experimental pyrolysis trials were performed in a mini pyrolysis reactor. Catalytic pyrolysis was studied using Y-type zeolite and ZSM-5 catalysts at mass ratios of 1:3 and 1:8 across three temperatures: 500, 700, and 900 °C. The highest yield of caprolactam recovery determined at 700 °C reaching 96% with the Y-type catalyst.
In conclusion, this study demonstrates the technical viability of converting waste fishing nets into valuable energy carriers and chemical precursors through catalytic pyrolysis. The high recovery of caprolactam suggests an efficient route for monomer recycling, supporting nylon-6 production and reducing environmental burden. Overall, the findings contribute to sustainable waste management by integrating marine plastic waste into the circular economy, simultaneously mitigating pollution and enhancing resource recovery.

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Decision Concepts of a System Dynamics-Driven Biorefinery Roadmap for Bioethanol Production

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Abstract: The shift toward a sustainable bioeconomy requires more than isolated technological breakthroughs—it demands a strategic, system-level roadmap. This roadmap must be grounded in System Dynamics (SD) modeling to enable scalable, resilient deployment of biorefineries for bioethanol production, especially when based on agricultural waste.
SD modeling enables a dynamic view of the biorefinery ecosystem, revealing causal relationships and feedback loops between feedstock supply, industrial integration, policy, and economics. This abstract outlines the core concepts of such an SD-supported roadmap, focusing on three pillars: strategic integration, feedstock versatility, and national policy-economic alignment.
Our model, which uses VENSIM as the software, focuses on strategic integration, Feedstock versality, economic viability and policy alignment of biomass for Türkiye. Official Turkish biomass data from 2000 to 2024 is used for evaluation and modelling. The main components of the model are defined as Strategic integration, Feedstock versatility, Policy alignment and economic viability. A Biomass Supply-Chain Model and system specific design is also embedded into the program.
Strategic integration focused on connecting biorefinery operations with existing industrial infrastructures, such as agriculture (its). SD models simulate how different system components interact—biomass inputs, process energy, water usage, and output flows—enabling optimization of resource use and minimization of waste. Deliverables include "System Dynamics Models for Integrated Biorefinery Design", which provide stakeholders with simulation tools tailored to specific industrial contexts. Feedstock versatility is equally crucial. Biomass availability fluctuates with regional agriculture, forestry, and urban practices. Our SD allowed for modelling of seasonal variability, regional disparities, and logistics. It also simulates how feedstock supply responds to shifts in technology and policy. A key output here is the "Dynamic National Biomass Supply-Chain Model", which forecasts future feedstock availability across different scenarios—climate change, land-use shifts, or technological adoption—ensuring long-term supply stability. On of the challenges that we addressed was the Policy alignment and economic viability – which are often the bottlenecks to industrial scaling. High capital costs, market uncertainty, and fragmented regulation hinder investment. SD modeling can simulate how incentives, subsidies, regulations, and investor behavior interact over time. This produces tools like "National Biorefinery Policy Impact Simulators", which assess the long-term consequences of policy choices, and "Dynamic Techno-Economic Viability Models", which provide forward-looking insights on profitability and risk. Our roadmap includes a dedicated supply and demand module, embedded within the economic modelling layer. This module simulates market behaviour under varying policy, pricing, and capacity scenarios, enabling more accurate forecasts of demand-supply balances for bioethanol. It helps align production planning with real economic drivers, supporting investment and policy decisions with quantifiable projections. This first draft SD-driven roadmap prepared for Türkiye offers a powerful framework for advancing bioethanol biorefineries. It integrates technical,

logistical, economic, and policy dimensions into a living, adaptive model. By accounting for national specificities and simulating real-world dynamics, this approach transforms static analysis into actionable strategies—accelerating the transition to a sustainable, bio-based industrial future.

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Modelling of biogas production from organic fraction of municipal solid waste

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Abstract: Biodegradable waste, such as organic fraction of municipal solid waste, can be used to obtain high-value products and energy, reducing environmental pollution and the total amount of waste. Conversion of waste to energy is an integral part of sustainable waste management. Sustainable bioenergy production is gaining increasing importance in order to reduce resource consumption and global energy usage. Biogas production is an example of converting organic residues and waste into renewable energy sources. Biogas is obtained through anaerobic digestion, a complex microbiological process that involves the decomposition of organic matter, such as organic fraction of municipal solid waste, residues and by-products from agriculture and the food industry, stillage from ethanol production, and sludge created by the treatment of municipal and industrial wastewater. The use of biogas displayed a significant growth trend during the second half of the twentieth century, particularly in developing countries. The production and use of biogas have multiple advantages, among which environmental protection is one of the most significant, in the form of reducing the potential for global warming and conservation of natural resources. Additionally, the production and use of biogas facilitate decentralized energy generation, income generation, and employment opportunities for the local population.
Bioprocess modelling and simulation play an essential role in enhancing process understanding and supporting the development of specific biotechnological applications. This research focused on creating a process and cost model for biogas production from the organic fraction of municipal solid waste. The model was developed using SuperPro Designer v11.0 (Intelligen Inc.) and was used to estimate capital costs, operating costs and production costs for a biogas production facility. The resulting model provides predictions of both process performance and economic indicators for the examined biogas production system. Based on the results, the proposed model is considered feasible and serves as a baseline for further optimization and development of the bioprocess.

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IRON AS H_2 VECTOR: A SOLID-STATE PATHWAY FOR SAFE AND SCALABLE HYDROGEN TRANSPORT

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Abstract: A collaborative research project between Italy and Germany, Hydrogen Iron transport (HIT), is presented. The project is carried out by STEMS-CNR and e-Loop on the Italian side, by RUB, Doosan Lentjes and RWE from the German side. The purpose is to develop a technology for the use of iron ores to store and transport green hydrogen.

Accredited scenarios assume that green hydrogen will be produced in regions with abundant renewable energy sources and iron reserves and transported—either in gaseous or liquid form—through pipelines or other infrastructure across long distances, such as the sea.

The idea behind the project is to use iron as a solid chemical vector of H_2, for an alternative or complementary mode of H_2 transfer. The concept is depicted in Figure 1. The key of the innovative concept is to exploit reduction/oxidation cycles of natural iron ores. Accordingly, at H_2 production sites, green H_2 can be used to reduce iron ores by the reaction $3Fe_2O_3+9H_2 \rightarrow 6Fe+9H_2O$. Iron in its reduced form is stable at room temperature and suitable for transport by ships and trucks. The reduced iron can be, on-demand, re-oxidized with H_2O and produce H_2 ($6Fe+9H_2O \rightarrow 3Fe_2O_3+9H_2$). By this means, H_2 can be stored in relatively cheap and largely available material (iron ores, 100-150 $/ton), carried in the form of a safe and stable solid (reduced Fe), and recovered and used where needed. Fluidized bed reactors are considered elective reactors for the proposed technology.

Scientific issues addressed within the project include the development of models of iron ore reduction and reoxidation from the single particle up to the rector scale. Experimental activity includes kinetic campaigns in TGA and lab scale reactors on a variety of iron ore materials. 3D models of fluidized bed reactors will be developed to assist in reactor design and further scale up. On a parallel route LCA and techno-economic analysis shall allow a sound comparison of the HIT concept against most accredited scenarios of hydrogen transport.

Preliminary findings from the experimental campaign and so far, identified pros and cons of the concept will be presented.

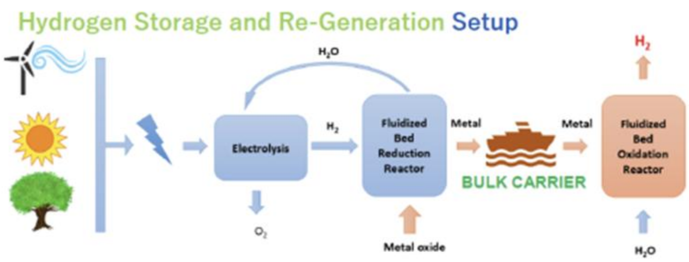

Figure 1. Principle of large-scale H_2 transfer by reduction and oxidation of iron ore.

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Overview of Thermochemical Technologies Coupling with Concentrated Solar Technologies for Renewable Fuel Production

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Abstract: The global push towards decarbonization and energy sustainability has intensified interest in renewable fuel production methods that leverage abundant natural resources, such as solar energy. Thermochemical conversion pathways, including fast and slow pyrolysis, gasification, and hydrothermal liquefaction, offer high energy efficiencies and product versatility, enabling the transformation of biomass, water, or CO_2 into fuels and energy carriers like syngas, hydrogen, and synthetic hydrocarbons. However, these processes typically require high-temperature heat input, often ranging from 400°C to over 1500°C, which is conventionally supplied by fossil-based combustion. Concentrated Solar Technologies (CST) present a promising alternative by providing clean, high-grade thermal energy through optical concentration systems. Parabolic troughs, Linear Fresnel reflectors, parabolic dish concentrators and solar tower systems are the four types of CST, reaching different ranges of temperature, for dedicated applications.

Hydrothermal liquefaction operates at 250-550°C, while the pressure increases up to 300 bar, converting wet biomass into biocrude, a potential liquid biofuel. Both parabolic troughs and Linear Fresnel reflectors temperature range (300-550°C) suitably aligns with HTL thermal requirements, as well as with similar methods, such as biomass pyrolysis/system reforming. The operation temperature in the case of gasification reactors ranges between 700 and 1200°C, lying within the respective range of parabolic dishes achieved temperature. Lastly, solar towers are essential for high temperature systems, thus are considered ideal for thermochemical redox cycles for H_2O/CO_2 splitting and Zn/ZnO cycles, where peak efficiencies and reaction temperatures have been experimentally validated.

CERTH is equipped with an in-house Solar Simulator, acting as the preliminary step of CST testing, a lab-scale Solar Furnace and a mobile platform hosting a custom system of two parabolic troughs, offering multiple potential for several thermochemical applications.

Extensive Hydrothermal Liquefaction experimental tests, coupled with CST have been conducted employing a wide variety of residual biomass, resulting in biocrude yields of up to 80%. Future applications of the solar-related infrastructure are currently being evaluated, based on their thermal needs and the match with the corresponding CST systems.

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Integration of Biogas Upgrading at a Municipal Wastewater Treatment Plant Co-Digesting Primary Sludge with Municipal Solid Waste

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Abstract: Recently, biogas production and utilization has become promising to diminish dependence on fossil fuels and cope with rising oil prices. Biogas is a renewable energy source obtained during anaerobic digestion, a widely used waste management alternative. Biogas generation especially from non-food products (second-generation biofuel), is also considered as a sustainable solution towards mitigating greenhouse gas emissions. Since Turkiye suffers from high gasoline and diesel prices; there is an increased public interest in biofuel production from biomass feedstocks (e.g. woody and forest residues; agricultural, industrial and municipal wastes etc.) as a potential alternative to fossil fuels. Hence, the number of anaerobic digesters in municipal wastewater treatment plants (WWTP) increased notably in the last decades. However, these reactors are mainly operated as mono-digesters with a single substrate (e.g. sewage sludge) and relatively low methane yields are obtained due to insufficient buffering capacity, nutritional imbalance etc. Hence, co-digestion process (i.e. digestion of a mixture of different wastes in a single bioreactor) is recommended to overcome these difficulties during operation and improve biogas production. On the other hand, an average of 18,000 tons of municipal solid waste (MSW) is generated daily in Istanbul alone and ~70% of this waste is disposed of via landfilling, which will no longer be a sustainable disposal alternative in near future. Since the source sorted organic fraction of MSW (SS-OFMSW) is one of the most suitable co-substrates; co-digestion of SS-OFMSW with primary sludge becomes more attractive and feasible in existing digesters of municipal WWTPs without great investments, when considering these wastes which are already produced at large amounts. However, the main biogas component is not only CH_4 (55-65%) which burns easily, but also CO_2 (35-45%), a noncombustible compound that reduces its calorific value as well as trace amounts of other gases dependent on feedstocks. Thus, raw biogas has to be cleaned and upgraded to biomethane ($CH_4 \geq 95\%$) by removing CO_2 and other impurities. Since biomethane is almost equivalent to natural gas; it can be used for direct injection to gas grids or for the transportation sector. In this study, the potential benefit of biogas produced in a mesophilic co-digester (35±2°C) where primary sludge is treated with SS-OFMSW, was evaluated in case of integrating a biomethanation plant in a municipal WWTP to valorise biogas as transportation fuel (i.e. 1 m^3 enriched biogas replaces about 0.8 L of diesel or 1.0 L of gasoline). According to calculation results for a municipal WWTP with a capacity of 100,000 population equivalent (PE); ~26 heavy good vehicles using diesel or ~549 cars using gasoline may be powered per year by upgrading the biogas produced to ~95% CH_4 ($Q_{Biomethane}$=2340 m^3/d; X_{PS}=61 g-TS/PE·d; $X_{SS\text{-}OFMSW}$=50 g-TS/PE·d). However, despite continuous advances in technology; there are still limitations (e.g. modification in engine technologies etc.) that need to be eliminated for biogas to become more cost-effective and commercially viable in vehicles. Besides, government incentives for second-generation biofuel production need to be increased to promote their installations and shorten payback periods.

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Energetically favorable pathways for carbon dioxide fixation in bacteria

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Abstract: The capture and subsequent use of carbon dioxide (CO_2) from the atmosphere is important to combat challenges such as global warming and climate change caused by greenhouse gas emissions. Microbial organisms are important due to their ability to grow on single-carbon substrates such as CO_2 and fix inorganic carbon to organic carbon. Current biotechnological processes are mainly driven by plant-derived sugars. However, non-food and non-feed alternatives are of interest because they are independent of the agricultural product. In addition, the use of CO_2 in the production of various products is a promising alternative, as it has the potential to replace fossil fuels. The most suitable are bio-based processes due to their lower greenhouse gas emissions compared to petrochemical processes, potential for utilizing renewable resources, saving energy and converting CO_2 into various products including food, fuel, bio-plastics, etc. Native CO_2-fixing microorganisms can be directly utilized but they face challenges, such as unstable genetic modifications, complex nutrient needs, and intricate metabolic processes. However, development of innovative processes requires a good understanding of the organism. It is advantageous that many methods in metabolic engineering and systems biology have been developed and applied for *Escherichia coli*, one of the most widely known industrial microorganisms. Engineered *E. coli* strains that can utilize formate and/or methanol are already available, but a systematic approach is required to develop universal CO_2 assimilation pathways. Here, it is aimed to find out common genes that are expressed during growth on C1-compounds such as formate, formaldehyde, methanol, CO and/or CO_2 in relevant organisms through transcriptomic and/or proteomic analyses with computational methods. Then, bacterial homologues will be identified and potential metabolic routes for CO_2 degradation will be investigated via genome scale metabolic model and thermodynamic feasibility analysis, which relies on Gibbs energy calculations.

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Fungal pellet immobilization of modified *Escherichia coli* for enhanced bioethanol production from red grape stalks

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Abstract: The utilization of agricultural residues presents an eco-friendly approach to producing bioethanol. In this research, red grape stalks, a common byproduct of winemaking, were characterized and tested as a carbon source for second-generation bioethanol. The untreated stalks had a dry matter content of 88.53±0.35% and consisted of 18.19±0.06% in dry weight (DW) cellulose, 14.05±0.69% DW hemicellulose, and 14.46±0.40% DW lignin. The biomass was subjected to physicochemical pretreatment followed by enzymatic hydrolysis with celulase Cellic Ctec 2. The resulting hydrolysate contained 14.22±0.16 g/L of fermentable sugars. A novel methods of cell immobilization using biomass in form of pellets from an active cellulolytic filamentous fungus (*Penicillium chrysogenum* H3—were developed and used to immobilize a genetically modified *Escherichia coli* (KO11) able to ferment both pentoses and hexoses to improve fermentation performance. Cell immobilization in the fungal pellets achieved a final efficiency of 22.03±6.54%, and a bioethanol concentration of 1.58±0.39 g/L, whereas bacterial free cells yielded a bioethanol concentration of 6.49±0.32 g/L suggesting that the presence and metabolic activity of the fungus is negatively affecting the ethanol yield. These findings suggest moderate conversion efficiency, likely limited by the low accessibility of cellulose and suboptimal immobilization yields. Limitations of this study include incomplete lignin removal and inefficient enzymatic hydrolysis, which restrict fermentable sugar availability; and the reduced amount of ethanol produced in the immobilization system. Future research should focus on enhancing pretreatment techniques to improve cellulose accessibility and on optimizing cell immobilization maybe by the inactivation of the fungal biomass to boost ethanol production.

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Turquoise & Circular Hydrogen from Plastic Waste and Marine Methane Hydrates

Jean-Bernard MICHEL

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Abstract:

Context & method.

WG 3 needs low-carbon hydrogen and solid-carbon coproducts to decarbonise and valorise biorefinery streams. This review compares two complementary feedstocks—post-consumer plastics and methane contained in ocean-floor gas hydrates—and shows how both can support the WG3 agenda on product road-mapping, scale-up, sustainability metrics and market uptake. We screened peer-reviewed literature (2023-25), pilot-plant reports and corporate filings for mass/energy balances, life-cycle factors and industrial-readiness indicators, normalising all values to lower-heating-value (LHV) energy.

Key findings

Plastic-to-H_2 route.

Continuous screw, plasma or microwave pyrolizers treating unsorted plastics with downstream steam reforming can yield 150–250 kg H_2 t^{-1} while fixing 0.18–0.22 t ASTM-grade carbon black. Commercial ambitions vary: Powerhouse Energy is permitting a 13 kt y^{-1} DMG® plant that would export up to 2 t H_2 d^{-1}, whereas Lummus–Resynergi markets 5 t d^{-1} microwave skids for pyro-oil, not hydrogen. Agilyx is progressing a Houston "Circularity Center" (≤ 150 kt y^{-1} feed) for styrene oil, and Quantafuel (taken over by Viridor) operates a 20 kt y^{-1} demonstration naphtha-recycling plant in Skive, Denmark. Peer-reviewed mass balances are still scarce for all four companies.

Methane-to-H_2 route.

Stoichiometry yields 0.25 t H_2 and 0.75 t solid C t^{-1} CH_4 with high temperature pyrolysis; molten-metal and plasma reactors now reach 80–90 % of that limit. Monolith's Olive Creek-1 plant already sells ≈ 2 kt H_2 y^{-1} and 14 kt y^{-1} carbon black, with a 150 kt y^{-1} expansion under way, arpa-e.energy.gov.

Graphitic Energy commissioned a demonstration unit at Southwest Research Institute in March 2025 that converts pipeline gas into ≈ 1 t graphite d^{-1} and several-hundred kg H_2 d^{-1}

Hydrate resource window.

Global *gas-in-place* is bracketed at 7 000–20 000 Tcm; even 1 % technical recovery doubles present proved gas reserves. TU Delft Research Portal.

China's 2023 Shenhu horizontal-well pilot produced 29 000 m^3 d^{-1} for 30 days, and numerical modelling suggests output could double with optimised Frontiers.

Circular-carbon markets.
Solid carbon from either route sells for 900–1 200 € t^{-1} (tyre, battery grades), trimming levelized hydrogen cost by 20–40 %. Emerging cement and asphalt uses could double offtake by 2030.

Conclusion.
Pyrolytic hydrogen from waste plastics and managed hydrate methane can supply up to 30 Mt H_2 y^{-1} in Europe by 2040, provide a saleable solid-carbon sink, and mitigate fugitive methane—all firmly within WG 3's brief to create integrated, circular biorefinery value chains.

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Exploitation of ceramic membrane technology for hydrogen recovery from biogas reforming effluents

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Keywords: H2-selective ceramic membranes, Biogas reforming, H2 purification system.

Abstract: In the pursuit of sustainable bio-based fuel and chemical production, bio-refineries face significant challenges related to the efficient separation of hydrogen (H_2) and carbon dioxide (CO_2), critical for process optimization and emissions reduction. This work explores the integration of advanced ceramic membranes as a novel solution for H_2/CO_2 separation within bio-refinery processes. Ceramic membranes, renowned for their exceptional thermal and chemical stability, present a promising avenue for selective gas separation under the harsh conditions typical of bio-refinery operations. By leveraging these properties, the proposed approach enables continuous and high-purity hydrogen recovery while mitigating CO_2 emissions, thus aligning with global sustainability goals. The synergistic integration of ceramic membrane technology into bio-refinery systems offers a pathway to enhance process efficiency, reduce environmental impact, and advance the circular bio-economy. In the current study a novel ceramic membrane module was engineered, developed and integrated in a biogas upgrade system for hydrogen production. Commercially available ceramic silica membranes were modified in order to meet design criteria and bolster the performance of the H2/CO2 separation. The nano-porous silica membranes were characterized in the lab prior and after CVI (Chemical Vapor Infiltration) modification in order to evaluate their permselectivity. The best-performing membranes among the ones studies were further tested in H2/CO2 mixtures. The final step was the integration of the ceramic membranes' module in a hydrogen production unit. The hydrogen production unit consisted of a biogas-steam reformer and a water-gas shift reactor as the main processes for hydrogen production and enrichment, and subsequently of membrane modules, namely the CO2-selective polymeric membrane module and the H2-selective ceramic membrane module in series for H2 separation and purification, which is the main focus of the current study, where hydrogen purity reached values of up to 99.28%. Optimization of permeance values was achieved by comparing simulation and experimental results, revealing that ceramic membranes exhibit a high H_2/CO_2 selectivity (>9). An optimization computational scenario of recycling the ceramic module retentate back to the polymeric module inlet significantly improves H_2 recovery (from ~12% to ~68%) while maintaining high purity (>99%), although requiring larger membrane areas. The analysis further underscores the trade-off and relationship between purity and recovery in the membrane cascade scheme, while providing insights for optimal and well-balanced membrane designs.

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membrane systems for the production and recovery of high purity hydrogen, (project code: T1EDK-02992).

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CO_2 Capture at Intermediate Temperatures Using Tailored MgO-Based Sorbents: A Pathway Toward Sustainable Processes

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Abstract: The increasing atmospheric concentration of CO_2 is a key factor in climate change, underlining the urgent need for efficient and cost-effective technologies for carbon capture storage (CCS) and utilization (CCU). Intermediate-temperature CO_2 capture (200-400°C) is particularly appealing for pre- and post-combustion applications, especially in the context of biorefineries, where process integration and material sustainability are crucial. Among the different potential materials, MgO-based sorbents are especially promising due to their high theoretical CO_2 adsorption capacity (1.1 g CO_2/g MgO).[1] However, their practical applications are hindered by challenges such as low cyclic stability, slow carbonation kinetics, and sorbent deactivation over repeated use. To overcome these limitations, recent efforts have focused on improving sorbent performance by introducing chemical modifications that enhance CO_2 uptake, stability, and reusability under realistic operating conditions.[2,3] In this work, we focus on the synthesis and performance of MgO and MgO modified with Ca (10mol%) or Ce (10mol%) or a combination of the two dopants (5mol%, respectively). The sorbents were synthesized using a one-pot hydrothermal method. The samples labelled as MgO, MgO(90%)-CeO_2(10%), MgO(90%)-$CaCO_3$(10%), and MgO(90%)-$CaCO_3$(5%)-CeO_2(5%) were calcined at 450°C for 4 h and, then, were impregnated with a eutectic alkali metal nitrate mixture ($NaNO_3$/KNO_3/$LiNO_3$) to further enhance their performance. Comprehensive characterization was carried out using X-ray diffraction (XRD), scanning electron microscopy (SEM), and N_2 physisorption. The CO_2 uptake performance was evaluated by thermogravimetric analysis (TGA) over multiple carbonation–calcination cycles. Results demonstrate that both strategies, tuning the chemical composition and incorporating alkali salts significantly impact sorbent performance. Among the four synthesized materials, the dual-doped sample (5 mol% Ca, 5 mol% Ce) exhibited the most promising behavior, maintaining almost 50% MgO conversion after five cycles and showing minimal deactivation (ca. 22%). These findings highlight the critical role of oxygen vacancy formation, surface area modification, and alkali molten salt promotion in enhancing CO_2 capture performance.

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Insights into the effect of alkali metal ions on the pyrolytic behavior of biomass-derived acidic polysaccharides

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Abstract: At present, most studies have focused on the pyrolysis of the three main components of lignocellulosic biomass: hemicellulose, cellulose and lignin. However, aquatic plants and algae (e.g. brown algae) and some agricultural wastes also contain large amounts of acidic polysaccharides that can be converted into useful chemicals and fuels through biochemical and thermochemical processes.

The acidic polysaccharides that can be isolated from algae are the alginates, a class of polysaccharides composed of two monomeric units, □-D-mannuronic acid and □-L-guluronic acid, organised in either homo- or hetero-polymeric sequences. Pectin, on the other hand, is a heteropolysaccharide containing as dominant units D-galacturonic acid and its methyl ester derivative linked by a-1,4-glucosidic bonds, which can be isolated in large quantities from citrus waste. The acidic nature, the presence of chain branching, and the heterogeneous structure have a significant influence on the thermal degradation behaviour and the distribution of the pyrolysis products of these polysaccharides. Therefore, it is important to have a comprehensive understanding of the pyrolysis mechanisms of these polysaccharides, especially in the presence of metal ions acting as catalysts. In this work, commercial citrus pectin and alginates from brown algae were selected as model acidic polysaccharides. These polysaccharides were analysed by proximate and ultimate analyses, FTIR-ATR and ICP-MS as received and free from metal contamination, in order to obtain compositional and structural information. Their pyrolytic behaviour was evaluated by TG-DTA and TG-FTIR analyses in a nitrogen atmosphere up to 700°C. Correlations between the structural and compositional properties and the pyrolytic behaviour are reported.

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Sustainable bioethanol production via integrated biorefinery based on microwaves

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Abstract: The shift toward sustainable biofuels demands innovative approaches to maximize the use of agroindustrial biomass. For example, avocados are primarily cultivated for fresh consumption, but the industry is increasingly diversifying into processed products, such as the avocado-based dip guacamole. The peel and stone—together accounting for more than 24% of the fruit's weight—are typically discarded, highlighting the need for alternative valorization strategies.
The aim of the present work was to propose an integrated and energy-efficient valorization strategy for converting avocado stone biomass into high-value bio-based products, utilizing microwaves as a green heating technology. Avocado stone biomass was first characterized, including the coat, seed, and whole stone (seed plus coat). Then, a sustainable pretreatment method using microwave-assisted diluted acid in high-pressure closed vessels was evaluated and optimized via Response Surface Methodology. The evaluated factors were the holding temperature and time, as well as the sulphuric acid concentration. Through multi-criteria optimization, the optimal conditions were identified to maximize glucose yield, minimize inhibitor formation, and reduce energy consumption. The resulting glucose-rich hydrolysate was directly and efficiently fermented into bioethanol (~24 g/L in 12 h) using *Saccharomyces cerevisiae*. In parallel, the process generated a lignin-rich solid residue with an improved higher heating value (22 KJ/g), and a phenolic extract rich in hydroxycinnamic acids was recovered, which can serve as antioxidants and anti-UV compounds. Overall, this study presents a practical and sustainable biorefinery scheme that fully harnesses avocado stones, supporting the green energy transition and advancing circular bioeconomy models.

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A Detailed Chemical Kinetic Model of Biomass Pyrolysis

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Keywords: Biomass, Pyrolysis, Kinetics, Multiphase, Modeling.

Abstract: During a pyrolysis process, organic material undergoes thermal degradation in the absence of oxygen towards the production of solid, liquid and gaseous species. Pyrolysis can be a key component of a biorefinery process, in which the products can be subsequently upgraded into fuels, chemicals and materials, thereby achieving high resource utilization by combining thermal and biochemical processes. The main objectives of this study are to provide insight to the key chemical and physical pathways controlling biomass pyrolysis, identify optimum operating conditions and provide design guidelines of a pyrolysis reactor. A detailed model has been developed that addresses the multiphase and multicomponent characteristics of the pyrolysis process. It consists of two sub-models; the biomass solid decomposition model and the gas phase reaction model. The biomass solid decomposition model consists of a multi-step lumped chemical kinetic mechanism that quantitatively predicts the solid and volatiles species formed. The gas phase reaction model applies a detailed reaction mechanism for the secondary reactions of evolving gases. This step is crucial in order to understand the formation of gas and liquid species following the residence time of the volatiles at high temperatures. The two sub-models are performed in a reactor network approach and carry out thermochemistry calculations across all phases—solid, liquid and gas—present in the process. The model performance was validated against data obtained from fundamental thermogravimetric analysis (TGA) experiments conducted under controlled conditions for kinetic characterization. The experiments utilized for the model validation were conducted within a pyrolysis environment with complete control of the reactor temperature and precise measurements of the sample weight reduction. Two biomass species were pyrolyzed, namely Phalaris arundinacea and Salix. Comparison between the model and experimental results indicate predictive capabilities by the model, as the latter accurately simulates the process performance. The gas phase reaction model validation has been based on an experimental dataset and a relevant model adopted from the literature. From the comparison against literature experimental data, the model was capable of capturing the total volatiles amount produced by the pyrolysis, with a mean absolute error of 2.8% and standard deviation of 1.4%. Compared to the literature model, the concentrations of CO, H_2, CH_4, H_2O, C_2, species with three to five carbon molecules and light oxygenated species were well predicted. However, deviations were observed in the prediction of CO_2 and the phenolic species quantity, albeit within acceptable limits.

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Hydrothermal Liquefaction of Essential Oil Residues: Conventional Process Coupling with Concentrated Solar Thermal Technologies

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Abstract: Hydrothermal liquefaction (HTL) is a thermochemical process that transforms various types of residual biomass into a primary product—biocrude oil—and, in most cases, three byproducts: a nutrient-rich aqueous phase (containing phosphates and nitrates), solid biochar (depending on feedstock and process conditions), and a gaseous mixture mainly consisting of methane (CH_4), carbon monoxide (CO), and carbon dioxide (CO_2). HTL's inherent advantage is the avoidance of the costly drying step, favouring highly moist biomass. Although HTL first emerged in the aftermath of the 1973 Oil Crisis, significant research interest has only re-emerged in the past decade, largely driven by fossil fuel depletion, biomass abundance, and the ever escalating climate crisis [1]. As already mentioned, HTL is particularly suited for wet biomass, as water under subcritical or supercritical conditions (around 374°C and 221 bar) functions simultaneously as a reactant, solvent, and catalyst. This is due to shifts in its dielectric and ionization properties, which enhance reaction efficiency [2]. HTL typically operates under conditions ranging from 250–550°C and 5–25 MPa — parameters that align well with the use of concentrated solar technologies (CST) for the process heating [3].

The current study will present quantitative and qualitative results of the two main phases of the HTL process: The biocrude oil, which is an intermediate step for the production of jet and/or marine fuels and the biochar, a solid material that can be mainly used as soil amendment, activated carbon, or even as an alternative fuel. The residual biomass used for the experimental study comes from selected species from the extraction of essential oils, with the yield in most cases exceeding 50%, which is a highly promising result for the technology scaling, whereas the higher heating values are at comparable levels to the conventional fuels. The results will include the work carried out at CERTH, starting from the conventional (electrical) heating of the process and expanding (for selected feedstocks) to the solar simulator testing, where artificial light resembling the actual sunlight is used to cover the thermal needs of the process [3,4]. An improvement of the biocrude yield is observed when concentrated solar thermal technologies are introduced, which mainly comes as a result of the faster heating/cooling rates achieved.

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A study of manufacturing scalability for supercapacitors using graphene oxide and a sequential HTC activation process

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Abstract: The growing interest in activated carbon (AC) is predominantly driven by its extensive applications in environmental remediation and energy storage. In particular, the integration of graphene oxide with food waste-derived precursors has demonstrated significant potential to enhance the functional properties of AC. These composites offer improvements in surface area, porosity, and chemical functionality, which are critical for efficient performance in water purification, gas adsorption, and electrochemical energy storage systems.

The production of AC typically involves thermal processes, such as physical or chemical activation. These methods enable precise calibration of material properties, contingent upon the selected feedstock, activation parameters, and any subsequent treatments. This versatility facilitates the development of application-specific carbon materials with optimized performance characteristics.

This study investigates the feasibility and performance of producing AC from a combination of graphene oxide and food waste-based model compounds, such as specifically cellulose, chitosan, and brewer's spent grains, using a two-step process. The hydrothermal carbonization (HTC) process was executed at a temperature of 240°C for a duration of 2 hours. This was followed by a steam-assisted physical activation step at 750°C for 30 minutes. Water steam was selected as the activating agent due to its environmental compatibility and effectiveness in pore development. The resulting materials were then subjected to a comprehensive characterization process, which involved the use of several analytical techniques, including Raman spectroscopy, SEM-EDX, FTIR, pH analysis, BET surface area measurement, and thermal stability testing. The objective of the analysis was to evaluate the structural evolution and chemical functionalities of the carbon products. The efficacy of the system was assessed by measuring yields and nitrogen retention under varying input conditions.

It is noteworthy that the results demonstrated that substantial nitrogen retention could be accomplished even in the absence of graphene oxide incorporation. Raman spectroscopy indicated that steam activation promotes the removal of volatiles and facilitates the formation of more ordered carbon structures. SEM imaging revealed that non-activated hydrochars exhibited surfaces populated by carbon microspheres and fragmented particles, indicative of low porosity. Conversely, ACs exhibited cracked, heterogeneous surfaces with well-developed pore networks that resulted from steam activation.

The study offers significant insights into the scalable production of high-performance AC using food waste and graphene oxide. The findings emphasize the potential of integrating hydrothermal carbonization with environmentally friendly activation strategies to produce advanced materials for sustainable energy and environmental applications.

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Ammonia and NO_x emissions controls from biogas oxidation in MILD combustion assisted by non-thermal plasma

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Abstract: Biogases from anaerobic digestions have a low calorific heating value (approximately 20 MJ/m^3). MILD combustion processes can burn efficiently biogases despite this issue. Apart of main components (CO, CO_2, CH4), biogases may contain small amount of ammonia, especially if produced from manures, that, under oxidative condition, may lead to the production of fuel-NO_x species, including N_2O as a potent GHG gases (almost 300xGHG_{CO2}), with a very long-life in the atmosphere (130 years). In recent studies, it was demonstrated MILD combustion can burn ammonia in stable conditions with relatively low NO_x emissions (100 ppm). The possibility to further extent the stable oxidation conditions and control ammonia slip and NO_x emissions has been experimentally addressed through experimental tests in a lab-scale system with the application of non-thermal plasma, with the mutual advantage to use low-plasma Power, as the MILD combustion process is intrinsically stable.

To this purpose, an alumina plug-flow reactor and a lab-scale burner, exercised in MILD combustion conditions, have been equipped with actuators and a non-thermal plasma generator. The experimental campaigns were realized changing the non-thermal plasma deposited energy to ammonia/O_2/N_2 mixtures. Results indicated that the application of non-thermal plasma with low Power (P<50W) can module the ammonia reactivity at high-temperatures (T>1300K) in the classical transition from ammonia low-T to high-T oxidation chemistries, while for lower T, P had to be slightly increased to higher P (80-100W).

With these deposited powers, it was possible to module the ammonia oxidation chemistry also at 1000K, where ammonia oxidation chemistry is extremely low. In addition, the application of plasma resulted to be an efficient way to control both ammonia slip and NO_x emissions, including N_2O.

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A Systematic Analysis of Thermal Dry Reforming of slow pyrolysis bio-oil components

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Abstract: The integration of carbon capture by dry reforming can offer a promising solution to both reduce the carbon dioxide emissions, thus achieving the goals of limited global warming, and to produce valuable gases.

In general, dry reforming is a catalytic process that converts hydrocarbon feeds, mainly methane (CH_4), into syngas over a metal-based catalyst (e.g. nickel, platinum or rhodium). Although the use of catalysts allows to increase the process performance and moderate the operating conditions, deactivation phenomena represent a critical issue, even more if bio-oils, hydrocarbon by-products or heavy hydrocarbon mixtures are considered as feedstocks, due to their higher tendency to form coke. In this respect, it is necessary to resort to an autothermal non-catalytic process, for which fundamental studies are required to identify the operating conditions ensuring significant feeds conversion into syngas and relevant degree of CO_2 capture.

In this work, a preliminary study on the dry reforming of different hydrocarbons and oxygenated compounds was carried out through both numerical analyses and experiments. Specifically, numerical analyses were performed under both equilibrium and perfectly stirred conditions, while experimental investigations in a jet stirred flow reactor, at atmospheric pressure and in the temperature range 1100-1500 K. C_1-C_3 alkanes, alcohols, and aromatic species, were considered to highlight the influence of hydrocarbon chain length, molecular structure, the presence of oxygenated functional groups and the reactant/CO_2 ratio of the dry reforming reaction.

Results showed that at lower temperatures, independently of the specific hydrocarbon, thermal decomposition and recombination reactions occurs through the production of small olefins and hydrogen, while CO_2 capture in the form of CO follows at higher temperatures. The temperature at 10% CO_2 conversion ($T_{CO2=10\%}$) was identified case by case. Pure methane presents the highest $T_{CO2=10\%}$ (1390 K), while it decreases to about 1310 K in case of ethane, remaining almost constant increasing the hydrocarbon molecular. For the investigated alcohols, even though $T_{CO2=10\%}$ is always lower than the methane case, a different trend was identified. Indeed, for methanol $T_{CO2=10\%}$ is about 1270 K and it increases for ethanol and butanol to 1320 K and 1310 K, respectively. These results were confirmed by the preliminary experimental evidences, although further research is needed to analyze the conditions for improving CO_2 capture efficiency.

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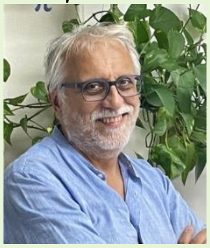

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Synergistic Conversion of Food and Forestry Wastes via Liquefaction

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Abstract: The rapid increase in global waste generation, especially from the food and forestry sectors, presents significant environmental and economic challenges. Innovative waste management strategies are essential for promoting sustainability and resource recovery. Among these strategies, liquefaction and co-liquefaction processes have emerged as promising thermochemical conversion technologies that transform heterogeneous organic wastes into valuable biofuels and biochemicals. This presentation examines the principles, advancements, and potential of liquefaction and co-liquefaction applied to food waste and forestry residues.

Converting wet biomass into bio-crude oil using liquefaction is shown to be an efficient way to reduce the need for energy-intensive drying. The process parameters, including temperature, pressure, reaction time, and catalyst choice, are explored in terms of their impact on product yield and quality. Co-liquefaction, which involves processing food and forestry wastes at the same time, is studied for its synergistic effects, which can boost conversion efficiency and product characteristics due to the complementary nature of the feedstocks. By utilizing these innovative methods, converting food and forestry wastes can significantly contribute to advancing the circular bioeconomy and meeting global sustainability goals.

Case studies and recent research findings are presented to illustrate the optimization of process conditions

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Dr. Rui Galhano dos Santos is a researcher and professor with a chemistry and chemical engineering background. He is an Assistant Professor at Instituto Superior Técnico in Lisbon, where he also heads the Raw Materials Group at CERENA. Rui has published numerous papers and books throughout his career, secured several patents, and mentored many students. He has received multiple awards and has been involved in projects that turn residues and biomass into valuable chemicals and fuels. His research aims to develop new, eco-friendly materials and contribute to the reduction of fossil fuel use and reliance on other resources.

Biogas production from agricultural wastes and invasive plants in Saxony: A Life Cycle Assessment of Two Ecological Pathways for Energy Production

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Abstract: The increasing proliferation of invasive plant species, combined with the partly inadequate management of agricultural residues, poses a serious threat to biodiversity, ecosystem stability, and, consequently, human well-being.

Against this backdrop, the development of efficient and environmentally valorisation technologies is gaining growing importance. Anaerobic digestion (AD) represents an established method for converting organic substrates into biogas and offers promising approaches for addressing these challenges. In the present study, the biogas potential of selected invasive plant species was investigated through batch anaerobic digestion experiments, and their specific methane yields were quantified. Additionally, a method to reduce the duration of batch tests was introduced.

To comprehensively assess the environmental impacts of the energy conversion processes, a life cycle assessment (LCA) was conducted comparing two biomass conversion pathways: the Integrated Generation of Solid Fuel and Biogas from Biomass (IFBB) and conventional anaerobic digestion. The LCA followed a cradle-to-grave approach, encompassing all stages from biomass collection and processing to final energy conversion. The results demonstrate the significant energetic potential of neophytic biomass for biogas production. Furthermore, the LCA identified key emission sources: in AD, methane leakage due to system inefficiencies was found the primary contributor, while not taking into account the performance of the neophytic plants were in a comparable amount. Whereas in the IFBB process, the highest emissions resulted from energy-intensive steps such as pressing, pelletizing, cooling, and drying. These findings contribute to process optimization and provide a scientific basis for selecting resource-efficient technologies for sustainable energy production from biomass.

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Short biography: I am a doctoral researcher funded by the ESF scholarship (Funding code: 100670490 [ESF, SAB]) for the project "Use of Previously Unused Substrates in the Production of Biogas and Biomass as a Renewable Energy Source for Saxony." My research is based at the Professorship for Gas and Heat Technology, Institute of Thermal Engineering, TU Bergakademie Freiberg. I focus on utilizing invasive plants and agricultural residues for biogas production through anaerobic digestion. Additionally, I apply life cycle assessment (LCA) to evaluate environmental impacts. My goal is to develop resource-efficient, sustainable technologies that support renewable energy solutions tailored to regional needs in Saxony.

Upgrading Biogas with Membrane Gas Absorption using Potassium-Based Solvents

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Abstract: Biogas upgrading is a critical process to obtain a high quality biofuel in biorefineries, directly contributing to the circular bioeconomy. This process not only increases the energy value of biogas but also aligns with global efforts to reduce greenhouse gas emissions by capturing and utilizing bio-derived carbon dioxide (CO_2) streams. Traditional CO_2 capture via amine-based solvent absorption in packed columns remains the benchmark technology. However, its high energy demand renders it economically viable only for large-scale applications, thereby limiting its suitability for smaller bio-CO_2-emitting facilities. Membrane gas absorption (MGA) in contactors emerge as a promising alternative, offering advantages such as simple and flexible operation, compact design, modular scalability, and enhanced mass transfer rates [1,2]. In this study, a customized semi-pilot MGA unit, incorporating commercial 3M™ Liqui-Cel membrane contactors, was employed to capture CO_2 from both laboratory-simulated biogas streams and two actual biogas plants in Greece. The investigation focused on evaluating potassium-based solvents as a cost-effective and environmentally friendly alternative to conventional amine solutions. Potassium-based solvents reacting with CO_2 yield potassium bicarbonate species, which also present the potential for further direct electrochemical conversion into potassium formate, a promising energy carrier with long-term energy storage capabilities [3]. The experimental gas and liquid flow rates, as well as the upstream and downstream CO_2 concentrations, were continuously monitored to parameterize the process and assess the performance under varying operational conditions. Additionally, a steady state mass transfer model has been developed which describes the gas mixture flow in the fibers in 2D formulation, and the solvent flow outside of the fibers in the shell side, where an overall second-order reaction takes place between CO_2 and OH^-. The two computational compartments, fiber and shell, are coupled by applying consistent mass-flux boundary conditions at the fiber-wall accounting for all relevant transport resistances in the membrane pores and in the shell-side film layer including appropriate enhancement factors. The overall model is validated against the experimental data confirming previously reported membrane-wetting patterns [2]. Experimental results demonstrated the high efficiency and adaptability of the MGA process, highlighting its potential as a viable CO_2 capture technology for biorefinery applications.

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Science in a Minute: Promoting WIRE COST Action Research through Short Videos

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Abstract: In the era of digital communication, science dissemination must evolve to meet the habits and expectations of modern audiences. This initiative aims to promote the goals and research activities of the WIRE COST Action through a dedicated YouTube channel featuring short, engaging, and informative videos.

Each video, approximately one minute in length, will highlight a specific research topic, methodology, or innovation aligned with WIRE's thematic areas. The format is designed to be accessible to a broad audience, including researchers, students, industry stakeholders, and the general public. The videos will present key scientific principles in a clear and visually appealing way, using animations, interviews, and real lab footage where appropriate.

The project seeks to:

- ✓ Popularize science by translating complex research into understandable and relatable content;
- ✓ Foster community building by showcasing the work of WIRE researchers and encouraging collaboration;
- ✓ Enhance visibility of COST Action activities and outcomes;
- ✓ Engage the public in discussions about sustainable materials, circular economy, and innovation.
- ✓ By leveraging the power of social media and short-form video, this initiative will serve as a bridge between science and society, making WIRE research more visible, approachable, and impactful.

WIRE's YouTube channel project aims to publish at least four videos per month, one per each WIRE Working Group. Working Group Leaders will assist in selecting WIRE members to record their videos and send them to the project coordinator, who will then upload them to the YouTube channel. This project will be ongoing until WIRE's completion.

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Communicate and Disseminate to Transform: Applying Life Cycle Thinking in Sustainable Development

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Abstract: The valorisation of residual biomass is an essential strategy to meet the European Union's sustainability and circular economy targets. Achieving true sustainability requires not only environmental and economic assessments but also a thorough understanding of social impacts. Life Cycle Assessment (LCA) methodologies have traditionally emphasized environmental and economic dimensions, while Social Life Cycle Assessment (S-LCA) has emerged as a complementary approach to evaluate social aspects throughout the biomass value chain.
This work presents a review of integrated life cycle approaches applied to the valorisation of residual biomass, focusing on how their outcomes are communicated and disseminated to enhance stakeholder engagement and support decision-making processes. Beyond methodological considerations, effective communication strategies and networking methodologies—such as participatory workshops, multi-stakeholder platforms, and multidisciplinary collaborations—are identified as key enablers to translate technical results into meaningful knowledge for diverse audiences. The review highlights the challenges in aligning complex sustainability assessments with accessible dissemination practices, particularly in sectors such as agriculture and forestry, where small producers and local communities play a crucial role. The study highlights the importance of integrating communication and collaboration into sustainability frameworks to promote social learning and foster systemic change. This integrated approach not only enhances the relevance and impact of life cycle assessments but also contributes to building a more inclusive and sustainable society.

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Strategic Project Management in Biorefinery Development in Serbia within the Transition to a Sustainable Bioeconomy

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Abstract: The transition to a sustainable bioeconomy requires the development of innovative, resource-efficient systems that can convert biomass and waste into valuable products and energy. Biorefineries represent one of the most promising pathways toward this goal. In Serbia, however, the development of such systems remains limited due to fragmented knowledge, insufficient intersectoral collaboration, and a lack of structured, innovation-driven project management practices. This work explores the potential for applying strategic project management methodologies to support the development of biorefineries in Serbia. By integrating principles of innovation management, circular economy, and stakeholder engagement, it proposes a project-based framework that connects raw material providers, technology developers, and end users. The paper emphasizes the importance of capacity building, pilot initiatives, and long-term planning in fostering regional bio-based value chains. Through analysis of existing barriers and opportunities, this work aims to contribute to the design of practical, scalable models for biorefinery development in Serbia and to support the country's alignment with broader European sustainability objectives.

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The gender balance in the EU - Trends in R&D

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Abstract: Recognising there is still a way to go, in March 2020, the European Union adopted its Gender Equality Strategy 2020-2025, which provides a framework to advance gender equality in Research, recognizing the benefits of incorporating the gender dimension in research include increased scientific creativity and excellence, as well as inclusion of all potential users of products and services. Since 2022, the EU has created an award, the 'Champions of Gender Equality in Research and Innovation', through Horizon Europe, to foster gender balance in R&D. Recently, on the 7th March 2025, the European Commission published a roadmap for women's rights, to reaffirm the EU's commitment to gender equality, speed up progress in this area, and counteract political movements that contest EU gender equality policies. So, since our last communication on the 'Gender Dimension in R&D', the EU has produced several reports on the subject in various areas of activity, whose main findings and conclusions we will present. In this communication, we will analyse what is happening in the EU in terms of gender balance, including the legislative framework and the main actions planned to implement it, as well as the main indicators, especially those related to R&D.

Since the benefits of incorporating the gender dimension into R&D are factual but still subject to discussion, we will review this topic. According to the principles of Responsible Research and Innovation, it is essential to involve the key stakeholders in the research process from the outset of the project. Stakeholders, including policymakers, the research community, the education community, business and industry, and civil society organisations, should therefore be aware of this. Is the scientific community addressing this issue? How? What are the main difficulties experienced? What challenges do we identify in WIRE? In conclusion, we aim to present the current context and contribute to building a path that effectively leads to the creation of opportunities for all.

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Podcasting as a Tool for Enhanced Scientific Communication and Dissemination

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Abstract: Effective communication and broad dissemination are essential for maximising the societal impact of scientific research. While traditional channels, such as peer-reviewed journals, academic conferences, and institutional reports, remain central to scholarly exchange, they often cater to a specialised audience and limit accessibility for the wider public. In today's digital era, platforms like Instagram, Facebook, Twitter, and LinkedIn have expanded the options for science communication. However, the use of podcasting, which can also play a pivotal role in scientific outreach, remains underexplored.

This abstract proposes podcasting as a dynamic and engaging medium for scientific communication and public outreach. Podcasts offer distinct advantages: they are easily accessible, highly flexible in format, and capable of reaching diverse audiences, including policymakers, industry practitioners, students, and the general public. By featuring expert voices that align with the mission of the WIRE COST Action, supporting the deployment of innovative, low-carbon technologies for waste valorisation and clean energy generation, podcasts can effectively translate WIRE members' complex scientific findings into clear, conversational narratives.

In addition to making science more relatable, podcasts can translate public understanding, promote informed decision-making, and amplify the relevance of research in real-world contexts. Their production in English or local languages can further enhance reach and inclusivity, particularly in multilingual and underserved regions. Moreover, episodes can be conveniently recorded via virtual platforms such as Zoom or Teams, allowing interviewers to engage with experts on specific WIRE topics remotely. These audio recordings can then be uploaded to platforms such as Spotify or YouTube, ensuring wide accessibility and continued audience engagement.

We propose incorporating podcasting into the WIRE project through a structured series of short interviews with experts from each of WIRE's Working Groups. These interviews, lasting between 5 and 10 minutes, will be based on a set of five core questions. We aim to produce 3-4 episodes per month, with Working Group leaders actively involved in selecting participants to ensure diversity and relevance.

This presentation will explore the educational and outreach potential of research-based podcasting. It will outline best practices for content development, audience engagement, and impact measurement, supported by successful examples of science communication via podcasting. Finally, it will present a practical framework for researchers and institutions to adopt podcasting as a strategic tool for enhancing the accessibility, inclusivity, and societal relevance of scientific research.

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Promoting Collaboration and Open Access Publishing through the WIRE Network

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Abstract: The WIRE network, under the framework of COST Action CA20127, plays a crucial role in promoting interdisciplinary collaboration in the development of waste biorefinery technologies for accelerating sustainable energy processes. It does so by supporting researchers through activities such as training schools, workshops, and short-term scientific missions (STSMs). A key objective of Working Group 4 (WG4) is to enhance the visibility, dissemination, and long-term impact of WIRE's scientific output across Europe.
This work presents a WG4-focused initiative that aims to systematically identify and catalogue scientific publications that acknowledge support from WIRE. These publications—often resulting from WIRE-sponsored STSMs and collaborations—provide tangible evidence of the network's scientific productivity. Using bibliometric tools such as Scopus, a detailed search strategy is implemented to track publications referencing WIRE, particularly in the Acknowledgements section, using keywords and the official COST Action number (CA20127).
In parallel, this work supports WG4's dissemination strategy by promoting open access publishing opportunities. WIRE members actively organize special issues in scientific journals, often as guest editors, and can provide publication fee waivers to facilitate equitable access for researchers who are affiliated with WIRE. These opportunities are publicized via the WIRE website and help increase the reach of research aligned with WIRE's goals.
The resulting list of WIRE-acknowledging publications will be added to the WIRE website and maintained under the "Publications" section, with regular periodic updates, providing a centralized and transparent record of the network's academic contributions. This work not only strengthens WIRE's dissemination infrastructure but also supports WG4's mission to assess and communicate the impact of the Action.
By combining bibliometric analysis with open access promotion and strategic dissemination, this contribution reinforces the sustainability and visibility of WIRE's research community, helping to secure its legacy beyond the lifetime of WIRE COST Action.

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From Molecules to Mindsets: Communicating CO_2 Capture and Conversion in Biorefineries for a Circular Bioeconomy

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Abstract: Technological advances in CO_2 capture and conversion within waste biorefineries, and beyond, are driving innovation in sustainable energy and material systems. However, for these innovations to achieve global impact, they must be understood, accepted, and integrated across diverse academic, social, industrial, and political contexts. A critical yet often overlooked challenge lies in communicating these complex technologies in a way that resonates with diverse audiences. Communication can serve not only as a dissemination tool but also as a catalyst for behavioural and institutional change, tailoring strategies to translate the scientific processes behind CO_2 capture and valorisation into narratives, metaphors, and data visualizations that are both engaging and audience-specific.

Communication strategies must leverage innovative approaches. The focus should extend beyond improving how communication is adapted to different stakeholders and consider reimagining the form, timing, and purpose of engagement itself. For academic audiences, immersive simulations and gamified environments are being deployed to transform abstract CO_2 pathways into tangible experiences, fostering systems thinking through visual and interactive exploration. For civil society, participatory speculative design can engage communities in collectively imagining everyday futures shaped by emerging technologies, transforming passive audiences into co-authors of climate narratives. In industrial contexts, storytelling must align with ESG (Environmental, Social, and Governance) frameworks, positioning carbon valorization as a driver of competitive advantage, social reputation building, and strategies that prioritize environmental policies aligned with corporate objectives. Government engagement is supported by adaptive, real-time policy dashboards that go beyond static reports, becoming dynamic tools for decision-making, transparency, and scenario planning.

The work presents practical examples, mapping levels of complexity and technical diversity according to the target audience, and highlighting the guidelines followed during the development of these examples. Communication about carbon capture and conversion, as well as any other socially relevant topic, is not merely an exercise in technical translation—it is a cultural and strategic intervention.

Differentiated communication is not a minor concern, but an essential factor for long-term change. Incorporating communication design into the research process itself, in the context of the COST WIRE action, can help translate technological promise into public understanding, political support, and market adoption. Remember, it is all about advancing the circular economy, the bioeconomy, biorefining and bioenergy, valorising waste and effluents, and promoting research and innovation in advanced technologies for converting diverse biomass into new processes and products.

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Integrating Hydrogen Education into the Biorefinery Landscape: The Role of IPPortalegre in Advancing Circular and Sustainable Energy Systems

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Abstract: The transition towards a circular and sustainable energy economy demands not only technological innovation but also a well-prepared workforce capable of navigating complex biorefinery and renewable energy systems. The Polytechnic Institute of Portalegre (IPPortalegre) contributes to this transition through a strategic focus on hydrogen technologies as a key vector within integrated biorefinery concepts.
This poster presents IPPortalegre's experience in embedding hydrogen education and applied research into broader biorefinery frameworks through three interlinked initiatives: H2Excellence, Futuretech_H2, and the Academy for Hydrogen (A4H2). These projects address critical gaps in skills, regional innovation, and cross-border collaboration, all of which align with WIRE's goals of harmonizing knowledge and fostering applied research across Europe.
H2Excellence establishes transnational Centers of Vocational Excellence (CoVEs) focused on hydrogen and fuel cell technologies. By developing curricula and promoting teacher-student exchanges, the project integrates education with real-world energy systems and regional ecosystems. Futuretech_H2 focuses on strengthening the hydrogen supply chain in cross-border regions, directly linking innovation with industrial competitiveness and economic revitalization. Finally, A4H2 aims to create a knowledge hub for hydrogen education and biorefinery integration, leveraging IPPortalegre's VALORIZA research center to develop experimental learning spaces and applied research projects.
These initiatives transcend traditional academic boundaries by embracing both technical and non-technical aspects of energy systems, ranging from thermochemical waste conversion to policy, sustainability, and regional development. As hydrogen increasingly intersects with biomass valorization and waste-based energy production, IPPortalegre's holistic educational approach provides a replicable model for embedding hydrogen knowledge within the biorefinery value chain.
By aligning its educational and research efforts with the goals of WIRE, IPPortalegre supports the harmonization of scientific approaches, fosters industry engagement, and helps accelerate the implementation of sustainable, waste-based energy systems throughout Europe.

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Reflections on editing a book: A personal experience

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Abstract: A more recent trend in publishing focuses on books with multiple authors and several coordinating editors. The objective of this approach is to produce volumes that involve key specialists in various scientific areas, contributing updated knowledge and identifying relevant future directions. This paper presents insights into the editorial process of such a project, namely "Geomicrobiology: Natural and anthropogenic settings", edited by Lucian Staicu and Larry Barton (2024), Springer, ISBN 978-3-031-54305-0 (link). The volume brings together leading international experts in the field of Geomicrobiology. The chapters address interactions of marine and freshwater microorganisms that contribute to geochemical cycles, including biochemical mechanisms for mineralization and transformation of solid minerals and dissolved metals. Additionally, the resilience and physiological elasticity of specific bacteria in extreme environments are discussed, including mechanisms of metal homeostasis and electrochemistry (e.g., extracellular electron flow). Further coverage includes resource recovery (metals, minerals) using microbial-driven processes and technologies, aiming to contribute to a better understanding of microbial potential within the framework of the circular economy. This presentation covers aspects related to writing the proposal for a future book, recruiting contributors, and maintaining contact with them throughout the writing stage, including collecting and revising the chapters, ultimately leading to the final step: submitting the manuscript to the editor and publication. Relevant key information and insights will be presented, alongside the personal experiences of the two editors involved. The goal of this communication is to inform and stimulate conference participants to embark on such an editorial project, contributing their expertise and scientific knowledge to advance their research fields.

References: Staicu LC, Barton LL (2024) Geomicrobiology: Natural and anthropogenic settings. Springer, Cham (link), pp. 338; ISBN 978-3-031-54305-0

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Details of presenting author

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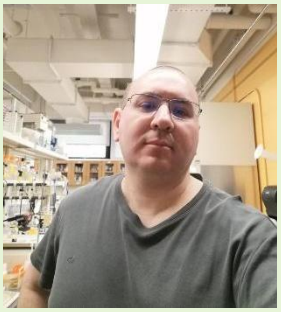

Short biography:
I am a researcher at the Department of Bacterial Genetics, Faculty of Biology, University of Warsaw (Poland), working on microbial biotechnology and geomicrobiology. I am particularly interested in the interaction of bacteria with metals (biomineralization, detoxification, and respiration) and the production of (bio)minerals having high-industrial value (e.g., Se^0, PbS, $BaSO_4$). Another research direction we are pursuing is the bioremediation of metal-rich industrial effluents such as those generated by the mining industry and the chemical recovery of barite ($BaSO_4$), a Critical Raw Material (CRM) in the European Union. More info about our research interests and output can be found at https://staiculab.com/

Bridging Policy, Innovation and Industry for a Sustainable Biorefinery Future

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Abstract:
As the WIRE COST Action is addressing the fragmentation of biorefinery knowledge by connecting experts across sectors to enable a **circular and sustainable bioeconomy**, as a participant that is particularly engaged in supporting the integration of policy, innovation, and stakeholder dialogue, I am bridging research with application across the waste-to-biorefinery value chain —spanning raw material valorisation, advanced conversion technologies, and industrial applications—promoting cross-sectoral collaboration.

My contribution focuses on strengthening science-policy-industry alignment, with an emphasis on promoting regulatory frameworks and market adoption of bio-based solutions. I also support dissemination and stakeholder engagement activities, including workshops and strategic communications, to ensure uptake of research outputs by policymakers, SMEs, and end-users.

Participating in WIRE enables me to advance innovative models that combine environmental goals with economic and societal value. By leveraging WIRE's collaborative ecosystem, I aim to contribute to the development of harmonised standards, support digital tools for process optimisation, and help shape Europe's leadership in sustainable biorefinery systems.

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Short biography (should not exceed 100 words): Theo Zacharis is an Innovation & Strategy Advisor and Executive Director of the Kinesis Innovation Center. As the founder of the Greek Scientists Society, he coordinates over 33,000 scientists globally. Theo advises EU-funded consortia on tech transfer, sustainability, dissemination, and exploitation, especially through COST Actions. His expertise lies in aligning research with regulatory and market frameworks, ensuring long-term impact through policy engagement, industrial uptake, and open science.