Clean Technologies and Environmental Policy (2024) 26:1–9
https://doi.org/10.1007/s10098-023-02734-6

GUEST EDITORIAL

A view of recent advances in the field of sustainability: overview dedicated to 2022 SDEWES conferences

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Received: 11 December 2023 / Accepted: 26 December 2023 / Published online: 22 January 2024

Abstract
This paper presents an overview for the Special Issue of Clean Technology and Environmental Policy journal (CTEP), and it includes accepted papers from: 5th South East European Conferences on Sustainable Development of Energy, Water and Environment Systems (SDEWES) held from May 22–26, 2022, in Vlore, Albania. 3rd Latin American Conferences on Sustainable Development of Energy, Water and Environment Systems (SDEWES) held from July 24–28, 2022, in Sao Paulo, Brazil. 17th Conferences on Sustainable Development of Energy, Water and Environment Systems (SDEWES) held from November 6–10, 2022, in Paphos, Cyprus. Considering CTEP's policy of high-quality research papers, guest editors have invited 35 research articles, presented at the SDEWES 2022 conference. After a vigorous review process, 13 papers have been accepted for publication in this special issue. All 13 accepted papers are briefly presented in this overview together with a wider view that presents research efforts within the SDEWES community published through previous SDEWES special issues.

Introduction

SDEWES conferences always focus on the interdisciplinarity of sustainability issues allowing a wide range of topics. This presents an excellent opportunity for scientists from various research fields to discuss sustainability more holistically. In general, SDEWES conferences cover various topics from economic, engineering, environmental, and social studies, to the studies which assess and measure the sustainability of energy, transport, water, environment, and food production. In this year's special issue, the following topics can be identified.

- Sustainable development of urban areas and industrial sector.
- Sustainable technologies development: multidisciplinary approach.

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Sustainable development of urban areas and industrial

The escalating demands of human activity contribute to the depletion of natural resources and exacerbate climate change, prompting a critical focus on sustainable development in the twenty-first century. Cities, playing a pivotal role in this endeavor, require well-informed transformation plans. In Brglez et al. (2023), a content analysis utilizing concept mapping examines smart, circular, and green city models, shedding light on challenges in transitioning to circularity and providing insights for decision-makers. Urbanization's profound impact on the water cycle increases vulnerability to floods when natural water dynamics are overlooked in urban planning. Sustainable urban drainage techniques offer a solution, aligning urban and natural demands while preserving environmental functions. Cellura et al. (2013) presents a methodology for assessing the integration of photovoltaic technology in urban areas, focusing on the percentage of electricity demand covered by grid-connected photovoltaic systems on building roofs in Palermo. Using satellite images, roofs were classified based on shape, orientation, and pitch, and the productivity-to-consumption ratio was analyzed. The study concludes that the economic feasibility of grid-connected photovoltaic systems depends on factors such as system size, energy production, and cost recovery, with systems showing disadvantageous economic values being rejected. Nieuwenhuis et al. (2021) addresses the challenges of traditional wastewater practices in the face of climate change, urbanization, and environmental concerns, emphasizing the need for integrated solutions in urban water systems management. The article introduces a typology of urban water systems integration, categorizing it into geographical, physical, informational, and project-based forms. The study highlights the complexity and uncertainty involved in implementing integrated solutions and outlines decision-making challenges for urban water system integration, offering potential approaches for addressing them. Brandoni and Bošnjaković (2017) explores the challenges of water quantity and quality in Sub-Saharan Africa due to climate change and urbanization. The study proposes integrating renewable energy technologies into wastewater treatment facilities to address electricity demand barriers, making the process cost-effective and contributing to socio-political security in the region. Using HOMER software, the optimal combination of photovoltaic panels, a wind turbine, and a biogas-fuelled internal combustion engine is identified, covering 33–55% of electricity demand for wastewater treatment.

Acknowledging the significance of small and medium-sized enterprises (SMEs) as the backbone of the European economy, Herce et al. (2023) developed a methodology for characterizing energy consumption in European SMEs. The study emphasizes the need for harmonized strategies to monitor energy audits, enabling a comprehensive understanding of energy consumption distribution between large enterprises and SMEs. Chofreh et al. (2018) emphasizes the need for an integrated information system, specifically a Sustainability Enterprise Resource Planning (S-ERP) system, to effectively implement sustainability within organizations. The study proposes an evaluation of the S-ERP framework through expert review methods, involving twelve experts in assessing its content and usefulness. Results suggest dividing the initial framework into sustainability and system implementation components, with experts affirming its applicability across diverse industries. Pusnik et al. (2014) introduces a novel approach, the 3EMT tool, for assessing the sustainability of small and medium-sized enterprises (SMEs) in Central Europe. Focused on promoting energy-efficient technologies, economic and social benefits of sustainability, and positive changes in employee behavior, the tool provides normalized quantitative indicators and benchmarks for evaluating SMEs' energy and environmental performance, supporting regional sustainability assessments. Chofreh et al. (2020) addresses the implementation challenges of Sustainable Enterprise Resource Planning (S-ERP) systems, emphasizing the need for comprehensive guidelines. The study develops guidelines through a conceptual research method, integrating sustainability aspects, project management, organizational decision levels, and strategic management. These guidelines provide practitioners with a formal direction for the efficient implementation of S-ERP systems in their corporate value chains, considering factors such as planning, resources, and commitment.

Sustainable technologies development: multidisciplinary approach

In Marković et al. (2023) authors conducted the numerical analysis of trioxymethylene dimethyl ether (OME-3) e-fuel on an industrial compression ignition engine, as a viable replacement for diesel fuel. The performed simulations examined single-injection and multi-injection operating conditions of OME-3, varying injection rates and timing. Both approaches confirmed that a higher amount of OME-3 and a longer injection time are needed to achieve equivalent output power as diesel fuel since OME-3 has a lower net calorific value. It is established that multi-injection case with an adapted injection timing is the optimal choice for OME-3 combustion since it achieves a 15% higher mean pressure peak compared to the diesel case. Wang et al. (2015) conducted a three-dimensional large-eddy simulation of a spark ignition engine, employing combustion and ignition models to study the interaction between flame and in-cylinder turbulence for various methane, hydrogen, and carbon dioxide mixtures. The results show that in engines fuelled with methane and carbon dioxide, the dominant influence on flame-induced turbulence is the gas heating effect. Additionally, varying the volume fraction of hydrogen affects turbulent flame speed, with high fractions leading to dominant flame-induced turbulence. Sjerić et al. (2016) presents a numerical analysis of a highly boosted four-cylinder spark-ignition engine at full load, focusing on high-pressure exhaust gas recirculation (EGR) to control limiting factors like knock and turbine inlet temperature. The study utilizes a comprehensive cycle-simulation model covering the entire engine flow path, flame growth, combustion, turbulence, and more. By introducing EGR and optimizing operating parameters, a notable improvement in fuel consumption by 8.7%, 11.2%, and 1.5% at engine speeds of 2000 rpm, 3500 rpm, and 5000 rpm, respectively, is achieved, demonstrating the effectiveness of exhaust gas recirculation. Gonca et al. (2022) investigates the impact of dual fuel mixtures on the theoretical performance of a spark ignition engine. By adding liquefied hydrogen, methane, butane, and propane to various primary fuels, the study explores variations in power, indicating mean effective pressure, thermal efficiency, and exergy efficiency. Results show significant effects, with a maximum power increase of 82.59% using 50% toluene, and a maximum thermal and exergy efficiency increase of 26.75% and 32.23%, respectively, with benzene-hydrogen mixtures.

The important topic in sustainable technologies assessment is the circular usage of waste, both natural and synthetic. Thus, the research from Aikas et al. (2023) investigated the gasification of wood pellets in a thermal air plasma environment, analyzing the impact of plasma torch power, gas flow rate, and equivalence ratio on biomass gasification. The study found that 20.73 kg/h of wood pellets could generate 15–18 kWh of electrical energy and 111–114 kWh of thermal energy, with 28–33% of the electricity required for air plasma formation available for use in an internal combustion engine and microturbine. Additionally, waste management systems are modeled to meet environmental sustainability requirements at an acceptable cost. Pyrolysis, highlighted as a promising technology, converts plastic waste into valuable products, including fuels and chemicals. Mínguez et al. (2013) addresses the issue of high carbon dioxide emissions from power generation by exploring biofuels in gas turbine systems, particularly through biomass waste gasification. The study conducts an energetic, exergetic, and environmental analysis of an integrated gasification combined cycle (IGCC) plant using various biomass waste types, revealing promising technical and environmental benefits. While acknowledging the need for further gasification technology development, the results indicate the high potential of biomass integrated gasification combined cycle (BioIGCC) systems for large-scale, environmentally friendly power generation from biomass waste. Yu et al. (2022) explores the utilization of coal gasification fine slag, a byproduct rich in residual carbon, through a spiral separator. The study demonstrates the efficiency of the separator in removing ash and enriching carbonaceous components, resulting in a concentrated product with enhanced combustion reactivity and market potential as both fuel and adsorbent. The developed process offers an eco-friendly solution for managing coal gasification fine slag and recovering valuable residual carbon in the coal chemical industry. Ancona et al. (2019) explores the fluidized-bed gasification of poplar biomass pruning residues from a multi-contaminated area treated with plant-assisted bioremediation. The study demonstrates that gasification of contaminated biomass, where contaminants are concentrated mainly in the roots, produces syngas with characteristics similar to non-contaminated biomass. The results indicate that specific pollutant capture treatment is necessary only when roots, where contaminants concentrate, are used for gasification, highlighting the potential for using biomass from a contaminated site for energy purposes without environmental impact.

Addressing industrial carbon dioxide (CO_2) emissions is imperative due to its contribution to global warming. Transitioning toward more sustainable processes, CO_2 conversion technologies hold promise in generating high-value chemicals. Santos et al. (2023) delve into the recent advancements in employing ILs for converting CO_2 into CO or C_{2+} hydrocarbons. Performance metrics of various catalysts, both with and without ILs, involved in the reverse water–gas shift (RWGS) reaction, are presented. Despite the limited availability of studies, the use of IL + metal catalysts for CO_2 reduction to CO or C_{2+} has shown considerable promise. These advancements predominantly involve lowering the operational temperature of the reactor and enabling the production of C_{2+} hydrocarbons in a single unit. This study provides a comprehensive understanding of the potential and challenges of IL-enhanced CO_2 conversion, propelling future research in this field. Barbosa et al. (2020) introduce a novel natural gas decarbonisation process using the ionic liquid [Bmim][NTf_2], showcasing its advantages such as high-pressure stripping, reducing carbon dioxide compression power for enhanced oil recovery, and offering a cleaner production alternative. The study employs a multi-criterial screening to confirm [Bmim][NTf_2] as the most suitable ionic liquid based on various properties and a sustainability assessment, revealing the [Bmim][NTf_2] decarbonisation process to be five times cleaner and more sustainable than the amine-based counterpart. The assessment considers qualitative heuristic criteria and quantitative sustainability metrics, culminating in a sustainability degree for process ranking. Sari et al. (2019) investigated the efficacy of composting with yard waste and rumen residue amendments to reduce soil pollution by total petroleum hydrocarbon in oil-contaminated soil from Wonocolo public oilfields. The study found that the mixture significantly increased the degradation efficiency of total petroleum hydrocarbon, achieving a level 31 times higher than that of contaminated soil and meeting soil quality standards. The composting process was shown to be facilitated by Bacillus sp. and Bacillus cereus, indicating the potential use of yard waste and rumen residue as effective substrates for accelerating the degradation of petroleum hydrocarbons in contaminated soil. Varga and Csaba (2018) present a study evaluating isobutane, butane, isopentane, and pentane as potential working fluids for an organic Rankine cycle utilizing heat from an air cooler. The ranking of these fluids is based on criteria such as maximum achievable power output, cycle efficiency, heat recovery, required heat exchanger area, CO_2 emission reduction, and payback period. Isobutane emerges as the most promising choice, providing the best results in terms of extractable turbine power, CO_2 emission reduction, and economic feasibility with a payback period of around 3.4 years.

Boa Morte et al. (2023) explores a novel approach for the energy transition toward a low-emission floating gas-to-wire system co-firing CO_2-rich natural gas and blue-H_2. The study compares this innovative design with a conventional low-emission gas-to-wire system firing only CO_2-rich natural gas, using a sustainability assessment method. Results indicate that the new design, with varying percentages of blue-H_2 in the fuel blend, outperforms the conventional system in net power and net present value, demonstrating its higher sustainability. Brigagão et al. (2019) introduces an alternative cryogenic distillation process for large-scale gaseous oxygen supply, optimizing air separation units for oxyfuel carbon capture. The proposed method utilizes top vapor recompression in a single atmospheric cryogenic air distillation double-reboiler column, achieving a low specific power requirement of 139.0 kWh/t for atmospheric oxygen production at 95% mol purity. The economic viability of the new air separation unit is demonstrated by successfully supplying low-pressure oxygen to an oxyfuel natural gas combined-cycle Gas-To-Wire plant, showcasing superior profitability under carbon taxation above 13.5 USD/t. Carminati et al. (2020) introduces a novel high-pressure temperature-swing hydrogen decarbonisation process using 1-Butyl-3-methylimidazolium bis(trifluoromethyl sulfonyl)-imide ionic-liquid physical absorption, which significantly reduces carbon dioxide compression costs. The proposed method requires 5.5 times less heat for high-pressure carbon dioxide stripping and reduces compression power by 4.3 times compared to conventional aqueous amine decarbonation. The economic assessment demonstrates that the ionic-liquid gas-to-wire approach not only exports 35.6% more electricity but also has 36% higher revenues, resulting in a net value 2.5 times higher (US$ 390.2 × 106) and a 5-year shorter payback time compared to the aqueous-amine counterpart. Interlenghi et al. (2019) explore the feasibility of offshore Gas-To-Wire for remote oil–gas fields with high gas–oil ratios and elevated carbon dioxide content. The study investigates a comprehensive system involving natural gas processing, power generation, post-combustion carbon capture, and enhanced oil recovery. The economic analysis, including offshore rig and electricity transmission, demonstrates a positive Net Present Value with a 20% return on investment, competitive Levelized Cost of Energy comparable to onshore power plants with carbon capture and storage, and sensitivity to factors such as electricity prices and oil recovery yield. The study emphasizes the effectiveness of a supersonic separator for fuel-gas decarbonisation but recommends 100% post-combustion carbon capture for optimized economic performance.

Chemical looping combustion (CLC) offers innovative carbon capture via oxygen carrier (OC) circulation between separate reactors. A novel approach to CLC is proposed by Sandu et al. (2023) by considering a packed bed system with stationary OC particles undergoing periodic reduction and oxidation stages by shifting feed gas streams. The major design benefit lies in the prospect of process operation at high pressure. Finding optimal operating conditions is a mandatory step before implementing the process at the industrial level. In this work, COMSOL Multiphysics was used for computational fluid dynamics (CFD) modeling to simulate the syngas based CLC process with ilmenite OC in a packed bed reactor configuration. Model results agree with published literature and provide additional understanding regarding the process to contribute toward the design of a flexible and energy-efficient power plant concept. Pozo et al. (2020) explore the potential of Gas Switching Combustion (GSC) technology in Integrated Gasification Combined Cycle (IGCC) plants for efficient power production from solid fuels. The study introduces a Gas Switching (GS) reactor cluster technology that operates alternately in reduction and oxidation stages, aiming to replace energy-intensive air separation units with Chemical Looping Oxygen Production (CLOP). Exergy analyzes of GSC IGCC and GSOP–GSC IGCC plants are conducted, offering insights into irreversible loss distribution, and identifying pathways for improved utilization of exergy in the reduction gases outlet. Cao et al. (2022) propose a Natural Gas Chemical Loop Reforming (CLR) process as an alternative to Steam Methane Reforming (SMR) for hydrogen production, aiming to avoid the environmental impact and energy penalties associated with SMR. In this Chemical Loop Reforming, the chemical looping combustion of metal oxides replaces direct natural gas combustion, and Fe3O4 is used as an oxygen carrier. The process, involving both reduction and oxidation reactions, enables high-rate hydrogen production at temperatures between 500 and 600 °C under atmospheric pressure, with simultaneous CO2 absorption and capture. Cormos et al. (2020) evaluate two innovative gas–solid systems in pre-combustion designs for decarbonizing Integrated Gasification Combined Cycle (IGCC) power plants. The chemical and calcium looping systems achieve a high degree of plant decarbonization (> 90%) and produce approximately 435–592 MW net electricity, with adjustable hydrogen production up to 200 MW thermal output. The study emphasizes the assessment of mass and energy integration elements to enhance overall energy conversion efficiency, demonstrating the promising potential of gasification technology coupled with innovative looping cycles for improved efficiency, carbon capture, economics, and operational flexibility compared to Selexol™ gas–liquid absorption.

The study by Frolich et al. (2023) explores the use of active Mg–Al mixed oxides with copper or cobalt in a microflow reactor for the Guerbet reaction, a crucial process for ethanol transformation into 1-butanol. Conducted at temperatures ranging from 280 to 350 °C, the research employs statistical analysis to correlate catalyst structure and surface characterization with catalysis results, offering a more nuanced perspective on ethanol valorisation. The findings reveal that Mg–Al catalysts with copper exhibit higher ethanol conversion and selectivity to butanol than those with cobalt, confirming a multi-step mechanism involving aldol condensation in the Guerbet reaction under the tested conditions. Meramo-Hurtado et al. (2021) conduct a comprehensive assessment of two biorefinery configurations for butanol production, emphasizing chemical process sustainability. The study involves techno-economic, sensitivity, and exergetic analyses for Acetone-Butanol-Ethanol (ABE) fermentation biorefineries. Both biorefinery designs demonstrate economic viability, with Net Present Values (NPV) of 908.74 mil. USD for topology 1 and 879.03 mil. USD for topology 2, and efficient exergetic performance, with exergy efficiencies of 26.03% for topology 1 and 39.89% for topology 2. Machado et al. (2018) explore the utilization of carbon dioxide as a feedstock for chemicals in an industrial ecopole associated with a sugarcane biorefinery. This innovative approach, aiming to reduce environmental impacts, uses carbon dioxide from sugarcane fermentation and bioethanol production. The Eco-Pole, while showing promising sustainability in raw material and energy consumption, faces economic challenges, with varying performance among its chemical production units, with dimethyl carbonate identified as the most sustainable and propylene as the least efficient. Milão et al. (2021) investigate innovative distillation schemes for large-scale sugarcane-ethanol biorefineries, aiming to enhance energy efficiency and reduce steam consumption. Three schemes are analyzed, with Scheme No.2, featuring five heat-integrated columns, showing the highest steam savings (63%) compared to conventional distillation. Scheme No.3, incorporating an innovative Petlyuk column for bioethanol distillation, achieves the highest thermodynamic efficiency (11.1%), outperforming other schemes.

Abreu et al. (2023) investigates the impact of three ionic liquids ([BMIm][BF_4], [BMIm][PF_6], and [BMIm][NTf_2]) on the equilibrium of CO_2 hydrogenation to carbon monoxide (CO) via the Reverse Water–Gas Shift (RWGS) reaction. Utilizing both predictive and non-predictive methods, the research explores the thermodynamic effects of temperature, pressure, and IL content on the reaction. Higher IL molar ratios enhance equilibrium conversion, while pressure changes and temperature variations affect CO_2 conversion differently based on the nature of the IL. The study emphasizes the crucial role of thermodynamics in advancing ionic liquid-based CO_2 conversion technologies for sustainable industrial processes. Wiesberg et al. (2016) explore the chemical conversion of carbon dioxide to methanol as a sustainable solution for replacing fossil raw materials and mitigating greenhouse gas emissions. They investigate two routes: direct conversion through carbon dioxide hydrogenation (HYDROGENATION) and indirect conversion via carbon dioxide to syngas through bi-reforming (BI-REFORMING). The study suggests that HYDROGENATION is economically viable with superior environmental performance in a Brazilian scenario, especially when the hydrogen price is below 1000 US$/t. Alternatively, BI-REFORMING becomes favorable in a scenario with cheap natural gas. Both routes contribute to reducing global warming potential, with HYDROGENATION showing significant emission reductions, particularly with a clean energy source (Feng et al. 2022), Mg-based metal hydrides, including Mg_2NiH_4, MgH_2, and LaH_3, are investigated for the hydrogenation of dibenzyl-toluene (DBT), a significant process for liquid organic hydrogen carriers (LOHCs). The researchers find that ball-milling these hydrides for 500 min results in optimal catalytic activity, with a hydrogen uptake of DBT reaching 5.70 wt% after 20 h, showcasing the potential of using hydrogen storage materials as catalysts for DBT hydrogenation. The study suggests that Mg-based metal hydrides, particularly Mg_2NiH_4, hold promise as efficient catalysts for LOHC-based hydrogen storage systems, introducing new possibilities for hydride-based catalyst applications. In investigating the hydrogenation of propenal on a silver surface, Andoni and Van Santen (2013) explore the interaction between hydrogen molecules and small silver clusters. Through computational calculations using Density Functional Theory, they find that rhombic silver clusters exhibit stability and, importantly, demonstrate that hydrogen can adsorb on these small particles and step surfaces in a dissociative manner, shedding light on the reaction mechanism. This insight is crucial for understanding catalytic processes, where the balance of adsorbate–surface interaction is a key performance factor.

In (Sharma et al. 2023) the use of paddy straw (PS) is proposed as a reinforcing filler for manufacturing reinforced polymeric composite using polypropylene (PP) and could present a cost-effective and feasible substitute for conventional wood-based plywood. The PS/PP composites could potentially offer a sustainable solution to the abundance and renewability of this waste biomass and huge quantities of recyclable segregated polymer from solid waste processors. Further, the valorisation of paddy straw can potentially diminish the present practice of open burning of this agricultural residue. Thus, the gainful utilization of paddy straw could offer multiple benefits, including a reduction in GHG emissions and deforestation. Ivanova et al. (2016) present a two-part study focused on the interface delamination of bi-material structures, specifically the unit cell of a wind rotor blade, under mechanical loading in real-world conditions such as electricity, temperature, and moisture. The investigation is motivated by the safety concerns of energy industry devices. The second part of the paper addresses the renovation of old buildings using modern composite materials, employing mathematical modeling to assess safety, reliability, and interface delamination based on various parameters. The results are supported by tables and figures, and the study provides recommendations and criteria. Kim et al. (2017) conducted a study on the production of high-quality recycled carbon fibers (R-CFs) by pyrolyzing carbon fibre-reinforced composite wastes with super-heated steam at 550 °C. Surface analysis revealed no matrix char residue on the fibre surfaces, and the R-CFs exhibited 90% tensile strength and 115% interface shear strength (IFSS) compared to virgin carbon fibers (V-CFs). The recycling efficiency of R-CFs from composites was found to be influenced by pyrolysis temperature, reaction time, and super-heated steam feeding rate. Kim et al. (2019) investigated hierarchical desilicated mesoporous ZSM-5 and Beta zeolites for catalytic pyrolysis of wood polymer composites, comparing their performance with microporous counterparts. The desilicated zeolites exhibited higher microporosity, and their catalytic activity was evaluated using thermogravimetric analysis. Among the catalysts, hierarchical desilicated mesoporous Beta demonstrated the lowest decomposition temperatures for wood polymer composites, correlating with its microporosity, shape selectivity, and strong acidity.

Borjigin et al. (2023) introduces a novel blown plate heat exchanger for cabinet cooling systems, comparing its performance to a fixed plate heat exchanger. The study finds that the blown plate heat exchanger performs equally well as the fixed one at the same Reynolds numbers, with the best performance observed for different Reynolds numbers in the blown plate heat exchanger with mixed plates, achieving a maximum temperature reduction of 15.185 K out of a 20 K temperature difference. Pan et al. (2013) explored the optimization of waste heat recovery systems in heavy-duty diesel truck engines using the organic Rankine cycle. The study conducted a two-objective optimization considering power output maximization and total heat exchanger surface area minimization, using various working fluids and configurations. Ethanol was identified as the most favorable fluid for achieving optimal power output with minimal heat exchanger surface area, offering practical insights for the conceptual design and optimization of waste heat recovery units. Arsenyeva et al. (2013) introduced an innovative optimization method for improving energy recovery through the retrofitting of heat exchanger networks (HEN). Unlike previous studies neglecting exchanger geometry, this approach systematically addresses details such as tube passes, shell passes, heat transfer intensification, logarithmic mean temperature difference (LMTD), and LMTD correction factor (FT) in the retrofitting process, enhancing the practicality of HEN debottlenecking. The proposed framework, based on a two-stage optimization approach with a MILP-based iterative method, effectively handles computational challenges associated with nonlinearity, providing realistic solutions for optimizing HEN with comprehensive consideration of exchanger details. Holik et al. (2019) developed a mathematical model for plate heat exchangers (PHE) by decomposing the plate into its main corrugated field and distribution zone. Validated with experimental data, the model facilitates the design of PHEs with minimal heat transfer area for specified pressure drop, temperature program, and heat load. The study demonstrates the model's application in designing plates that optimally meet process conditions, illustrated through a case study in District Heating systems.

In the study by Horváth et al. (2023), thermo-catalytic co-pyrolysis of various high-molecular-weight hydrocarbon mixtures was conducted at 450 °C using Beta zeolite catalyst in a two-zone semi-batch reactor system. The research explored the influence of feedstock, catalyst, and its placement on co-pyrolysis product yields and compositions, comparing results with previous work on catalyst-free or thermal pyrolysis. The two-step pyrolysis, with Beta zeolite placed in the second reactor, led to higher gaseous products with increased hydrogen and methane content. Moreover, the composition of liquid products shifted toward heavier ends, particularly with elevated C21 + and diesel fuel boiling range hydrocarbons, emphasizing the impact of feedstock composition on product formation. In Fekhar et al. (2020) study, waste plastics and papers were pyrolyzed using synthetic zeolite-based catalysts in batch and tubular reactors under mild conditions. The comparison of decomposition reactions and product properties revealed that reactor configurations and catalysts influenced the outcomes. The catalysts, particularly those with alkali characteristics, demonstrated advanced behaviour in reducing oxygenated hydrocarbons, and an accelerated aging test indicated more favorable aging properties for pyrolysis oils from the tubular reactor compared to the batch reactor. In Stančin et al. (2022) study, co-pyrolysis of end-of-life polyurethane foams with sawdust was investigated to assess the resulting product quality for potential use as alternative fuels. The addition of polyurethane led to an increased oil yield, but the study found that a small amount of polyurethane was sufficient to eliminate most oxygenated compounds derived from sawdust. However, the obtained liquid products, mainly benzenamines, did not meet fuel composition criteria. The analysis highlighted a synergistic effect, showing a stronger impact for a small branch of plastic content, promoting liquid yield at the expense of gas, particularly favoring syngas composition with notable hydrogen yield in the gaseous fraction. Park et al. (2019) investigated the catalytic co-pyrolysis of yellow poplar wood and polyethylene terephthalate using basic calcium oxide and acid zeolites. The study found that HZSM-5 exhibited the highest efficiency in producing benzene, toluene, ethylbenzene, and xylenes (BTEXs) due to its strong acidity and appropriate pore size. In a two-stage catalytic co-pyrolysis over in-situ calcium oxide and ex-situ HZSM-5, significantly larger amounts of BTEXs were produced compared to single-stage catalytic co-pyrolysis over ex-situ HZSM-5, demonstrating the effectiveness of the two-stage process.

Conclusion

As already mentioned, SDEWES conferences are a perfect place to present research topics in a holistic surrounding, allowing scientists to have a wider view of sustainability issues. Looking at this overview, an interdisciplinary approach can be seen through various topics; from clean technologies and procedures connected to water and air treatment to various renewable energy technologies. To work on various mitigation policies different research fields, need to work together. Therefore, this overview is used to show the wide range of research papers that present a systematic approach to SDEWES special issues present, in gathering knowledge in the field of sustainable energy, water, and environment systems. All those research topics are at the center of CTEPs interest, making SDEWES conferences fit perfectly.

Acknowledgements The Guest Editors of this SI section have the pleasure of thanking the international team of reviewers who dedicated a great deal of their time and efforts to adjusting the quality of the submitted manuscripts to reach the high standards of the Clean Technologies and Environmental Policy journal. Also, they would like to express their gratitude to the Editor-in-Chief of Clean Technologies and Environmental Policy journal, Subhas K. Sikdar and Ofelia Araujo for his support and advice.

Author contributions JM wrote the main manuscript text. TP gave an input for manuscript text. Also, had a role as a supervisory role. ND had a supervisory role. All authors reviewed the manuscript.

Funding The authors have not disclosed any funding.

Data availability No datasets were generated or analyzed during the current study.

Declarations

Competing interests The authors declare no competing interests.

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