IEEES-2026

17th International Exergy, Energy and Environment Symposium, Nicosia, N. Cyprus, June 1 - 3, 2026

BOOK of ABSTRACTS

17th International Exergy, Energy and Environment Symposium (IEEES-2026)

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of the 17th International Exergy, Energy and Environment Symposium (IEEES-2026)

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PREFACE

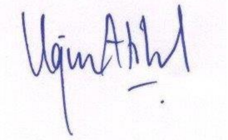
It is with great pleasure that we present the Book of Abstracts for the 17th International Exergy, Energy and Environment Symposium (IEEES-2026), a multidisciplinary and interdisciplinary conference that brings together scientists, engineers, industrialists, and researchers from around the world. This symposium provides a dynamic platform for sharing ideas, research findings, and practical expertise on issues related to sustainable energy and the environment.

Since its inception in 2003, the IEEES conference series has evolved into a well-established and recurring scientific meeting, covering a wide spectrum of topics including renewable energy, energy efficiency, smart grids, green transportation, and climate change technologies. Founded by Prof. Ibrahim Dincer, the symposium reflects a strong vision of advancing knowledge and fostering innovation in the fields of energy and environment. Through keynote lectures, technical sessions, and workshops, IEEES continues to promote the exchange of ideas and the development of forward-looking, cleaner technologies.

The 17th edition of the symposium is hosted in Nicosia and is organized by the Energy Research Center (ERC) of Eastern Mediterranean University in collaboration with the Association of Energy Engineers (AEE) Cyprus Chapter. The abstracts compiled in this volume represent the breadth and depth of current research, highlighting both emerging challenges and innovative solutions in the global transition toward sustainability.

The successful realization of IEEES-2026 would not have been possible without the dedication and hard work of many individuals and institutions. We would like to express our sincere appreciation to the organizing committee for their commitment and professionalism in bringing this event together. We also gratefully acknowledge the valuable support of our sponsors, whose contributions have been instrumental in making this conference possible.

Finally, we extend our heartfelt thanks to all contributors and participants for their valuable input and for making IEEES-2026 a meaningful and impactful gathering. We hope that this Book of Abstracts will serve as a source of inspiration and a catalyst for further collaboration and innovation.



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ABSTRACTS

(Listed by ID numbers)

Ref # BES-01

TWO DECADES OF RESEARCH ON ENERGY EFFICIENCY IN BUILDINGS: A BIBLIOMETRIC AND KEYWORD CO-occurrence ANALYSIS (2005-2025)

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Ref # BES-01

Abstract
This study conducts a bibliometric and keyword co-occurrence analysis of research on energy efficiency in buildings published between 2005 and 2025. Data retrieved from the Web of Science Core Collection were analyzed using VOSviewer to examine publication trends, collaboration networks, citation patterns, and research themes. The results indicate a steady increase in publications over the past two decades, reflecting growing global interest in improving building energy performance in response to climate change and sustainability goals. Co-authorship analysis identifies China, the United States, and Italy as leading contributors. Keyword co-occurrence analysis highlights major research themes such as energy efficiency, sustainability, thermal comfort, performance, and optimization. Overall, the findings provide a concise overview of the intellectual structure and evolving research trends in energy efficiency in buildings, offering a foundation for future research and collaboration toward sustainable building development.

Keywords: Anaerobic digestion, Animal waste, Biogas, Energy analysis, Exergy analysis

Ref # BES-02

THE IMPACT OF MATERIAL USE ON THERMAL COMFORT: A CASE STUDY OF HOUSING RENOVATION IN GHARDAÏA, ALGERIA

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Ref # BES-02

Abstract
Indoor thermal comfort represents a critical challenge in hot–arid climates such as Algerian desert, notably within heritage protected dwellings where external modifications are restricted. This study investigates thermal comfort improvement strategies for a vernacular Ksar house located in Ghardaïa, part of the M'zab Valley World Heritage site. A mixed-method was used, combining real-time indoor temperature and relative humidity measurements, field observations, direct questionnaires covering 73 participants, and dynamic thermal simulations using DesignBuilder software. Hence, results reveal that summer overheating, with indoor temperatures reaching 39°C in July with low relative humidity (HR) registered (≈11%). Furthermore, passive cooling strategies, including evaporative cooling, natural ventilation enhancement, and the application of insulation materials, were evaluated according to ASHRAE Standard 55 (2023) adaptive and PMV models. Evaporative cooling combined with increased air velocity reduced operative temperature by up to 1.6°C, achieving thermal comfort compliance in June, while July and August remain out of comfort zone. Although external insulation materials prove effective, they conflict with heritage conservation regulations. Findings demonstrate that passive measures alone are insufficient under extreme heat conditions. A hybrid cooling system combining evaporative cooling and assisted mechanical air movement such as fans can help perceive comfort, while air-conditioning is still effective to cope with summer overheat. The study proposes a renovation framework balancing thermal comfort, cultural continuity, and energy efficiency using solar panel in Saharan heritage dwellings.

***Keywords**:* Thermal comfort, passive cooling strategies, heritage conservation, hybrid cooling system, renovation framework

Ref # BES-03

FROM "BLUEPRINT" TO "GREEN PRINT" NEW URBAN AGENDA FOR SUSTAINABLE SOCIAL HOUSING DEVELOPMENT IN YAOUNDÉ BASED ON THE UN SUSTAINABLE DEVELOPMENT GOALS

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Ref # BES-03

Abstract

Rapid urbani zation in Yaoundé, Cameroon, has worsened the housing crisis. Conventional "blueprint" social housing relies on imported, standardized concrete designs that ignore the hot-humid tropical climate. This leads to thermal discomfort, heavy dependence on mechanical cooling, higher utility costs, and severe energy poverty among low-income households. This study proposes a shift from inefficient blueprint models to climate-protection settlements through the Green-Print model. The model integrates affordable housing with climate adaptation by combining renewable energy (mainly solar), energy-efficient technologies, passive cooling strategies (natural ventilation, shading), and culturally responsive spatial layouts adapted to Yaoundé's local conditions, cultural practices, and economic realities. The core research question is: How can social housing in Yaoundé be reconfigured into energy-efficient, affordable climate-protection settlements aligned with local tropical, cultural, and economic parameters? Using a User-Centered Design methodology, the research analyzes existing housing through field observations, stakeholder interviews, and energy performance simulations. It develops a replicable decision-making framework with context-specific guidelines for architects, planners, and policymakers. Evaluation of the Green-Print prototype shows significant reductions in energy consumption, improved indoor thermal comfort, lower operational costs, and better alignment with Cameroon's social housing goals and SDGs 7, 11, and 13. The study offers a transferable approach for sustainable, comfortable, and cost-effective social housing in tropical urban environments.

Keywords: Sustainable Social Housing, Green-Print Model, Climate-Responsive Architecture, Renewable Energy Integration, Energy Poverty, User-Centered Design, Affordable Housing, Tropical Urbanism

Ref # BES-04

DYNAMIC SIMULATION OF A SOLAR ASSISTED COOLING SYSTEM FOR RESIDENTIAL PURPOSE IN THREE CITIES IN TURKEY

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Ref # BES-04

Abstract
This paper designs and describes the modeling and dynamic simulation of an absorption solar cooling system. This is performed in the transient TRNSYS environment for a typical single-story residential building and simulated for the climatic conditions of three cities in Turkey: Antalya, Adana and Ankara. Adana and Antalya's hot Mediterranean subtropical climate, and Ankara's solar energy potential make the three cities suitable locations for the operation of solar absorption cooling systems. A 17.6 kW capacity absorption chiller is used in the cooling system with a 120m^2 evacuated tube collector. The findings showed that the energy efficiency of 63.54%, 48.87% and 43.75% were obtained for the proposed cooling system for the cities of Antalya, Adana and Ankara respectively, utilizing an indoor air set point temperature of 24◦C for the considered building.

Keywords: Solar cooling, Dynamic simulation, Absorption chiller, Turkey, TRNSYS

REF # BIO-01

POTENTIAL OF BIOGAS PRODUCTION USING ANIMAL WASTE IN POWER SECTOR: AN ENERGY AND EXERGY ANALYSIS

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REF # BIO-01

Abstract

This study investigates the biogas production potential of animal wastes in through laboratory experiments and energy modeling. Cow dung (CD), egg-laying chicken manure (EC), and meat chicken manure (MC) were evaluated in co-digestion setups under mesophilic conditions (35 °C) using 720 mL batch digesters with a 20-day retention time. Experimental results showed the ternary mixture of (CD+MC+EC) achieved 17.38mL/g TS. The produced biogas was modeled as a fuel input in a Brayton cycle-based power generation system. Energy and exergy analyses were conducted to evaluate system performance, efficiency, and irreversibility distribution. The simulation results indicate a net-work output of 105.3 kJ/kg and a thermal efficiency of 37%, demonstrating the feasibility of utilizing biogas derived from animal waste as a renewable fuel for gas turbine power generation. Because of combustion irreversibilities, the analysis also showed that the combustion chamber accounts for the majority of exergy destruction. Overall, the combination of thermodynamic power cycle analysis and anaerobic digestion offers insightful information on the potential of waste-derived biogas for sustainable energy production.

Keywords: Anaerobic digestion, Animal waste, Biogas, Energy analysis, Exergy analysis

Ref # BIO-02

EFFECT OF BIOMASS TYPE ON ELECTROCHEMICAL BEHAVIOR OF $FESO_4.7H_2O$ ACTIVATED BIOCHARS

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Ref # BIO-02

Abstract

This study investigates the electrochemical performance of biomass-derived biochars magnetically activated using $FeSO_4.7H_2O$. Biochar samples are produced from tea waste, coffee waste, maple leaf, and pinecone, and their electrochemical behaviors are evaluated using cyclic voltammetry (CV) and galvanostatic charge-discharge (GCD) analyses. A comparative assessment is conducted to determine the effect of biomass type on electrochemical performance. The results show that the biochar derived from coffee waste exhibits superior electrochemical behavior compared to the other samples. The CV curves indicate higher current response, with a maximum value of approximately 0.0026 A, suggesting enhanced conductivity and surface activity. In contrast, the pinecone-derived sample shows lower current values, around 0.0012 A, indicating weaker electrochemical performance. The findings demonstrate that the type of biomass plays a critical role in determining the electrochemical properties of magnetically activated biochar. The improved performance of coffee-derived biochar is attributed to its favorable porous structure and enhanced distribution of iron-based active sites. This study highlights the potential of magnetically activated biomass-derived carbons for energy storage applications.

Keywords: Hydrogen storage; Solid state storage; Activated charcoal; Renewable energy; Energy

Ref # CRB-01

FIELD-BASED SCREENING CRITERIA FOR CO_2 STORAGE IN ONSHORE SALINE AQUIFERS: A COMPARATIVE REVIEW OF SIX PROJECTS

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Ref # CRB-01

Abstract

Carbon capture and storage (CCS) have been identified as a key technology for reducing atmospheric carbon emissions and addressing climate change. Saline aquifers are common and have some of the largest potential capacities for CO_2 storage. Therefore, they are considered a promising option for achieving net zero emissions targets. These are underground reservoirs filled with brine solutions and are usually covered by a caprock consisting of low permeability sealing formations. The capacity of a saline aquifer is not a guarantee of its suitability for CO_2 storage. The success of a CO_2 storage project is usually determined by geology and reservoir properties such as porosity, permeability, thickness, depth, pressure conditions and caprock quality. This review paper represents a comparative synthesis of six large-scale CCS onshore saline aquifers worldwide including Quest (Canada), Aquistore (Canada), Illinois Basin-Decatur Project (USA), SECARB Citronelle (USA), Ketzin (Germany), and Gorgon (Australia). Each of these projects was studied in terms of their geological background, characteristics, and injection and storage performances. These projects are important to provide knowledge that is necessary to achieve a future deployment scenario of CCS on a gigaton scale to meet net-zero emission targets.

Keywords: CO_2 storage, CO_2 Saline Aquifers, Carbon storage, Onshore Saline Aquifers CO_2 storage

REF # ENV-01

THE RELATIONSHIP BETWEEN DECARBONIZATION AND EXERGY IN THE TRANSPORTATION SECTOR IN TURKEY

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REF # ENV-01

Abstract
The transportation sector accounts for a significant share of Turkey's total energy consumption and greenhouse gas emissions. The sector's heavy reliance on fossil fuels constitutes a critical problem area for achieving decarbonization goals. Classical energy analyses are insufficient for evaluating energy efficiency; exergy analysis, which considers energy quality and irreversibilities, offers a more comprehensive approach. This study examines the main energy sources used in the Turkish transportation sector from an exergy perspective and evaluates the relationship between exergy destruction and carbon emissions. Furthermore, the decarbonization potential of electric and alternative fuel transportation systems in terms of exergy efficiency is discussed. This study demonstrates that exergy analysis is a critical decision-support tool in determining decarbonization strategies in the Turkish transportation sector and emphasizes the necessity of a holistic approach based on energy quality for transitioning to a sustainable and low-carbon transportation system.

Keywords: Transportation sector, Exergy analysis, Decarbonization, Energy efficiency

Ref # EST-02

THERMAL ANALYSIS OF A VANADIUM REDOX FLOW BATTERY WITH A GRADED POROSITY ELECTRODE

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Ref # EST-02

Abstract
Vanadium redox flow batteries (VRFBs) are a promising energy storage system for large-scale, efficient energy storage. In VRFBs, thermal analysis is essential for maintaining proper electrolyte temperatures, reducing vanadium precipitation, and ensuring high efficiency. The current study numerically investigates the thermal effects of porosity variation in the porous electrode on VRFB performance. To do this, a two-dimensional, single-phase model is developed using COMSOL Multiphysics 5.5 and validated with experimental data. The porosity distribution in the porous electrode is examined in four different cases. Case 1 fixes the porosity of both the positive and negative electrodes at 94%. In Case 2, the positive electrode's porosity remains fixed at 94%, while the negative electrode's porosity gradually increases from 64% to 94% in 10% steps along the electrode thickness toward the membrane. In Case 3, the negative electrode's porosity is held constant, while the positive electrode's porosity increases gradually from 64% to 94% in 10% steps. Finally, in Case 4, both electrodes' porosities gradually increase from 64% to 94% in 10% steps toward the membrane. The results show that Case 4 demonstrates good performance and produces less heat during charging and discharging.

Keywords: Thermal Analysis, Electrode Porosity, Vanadium Redox Flow Battery

Ref # EST-03

A LEARNING-FREE EXPLAINABLE INTELLIGENT AGENT FOR REAL-TIME HOME ENERGY MANAGEMENT WITH PHOTOVOLTAIC AND BATTERY STORAGE

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Ref # EST-03

Abstarct

Home energy management systems (HEMS) integrating photovoltaic (PV) generation and battery energy storage systems (BESS) are essential for maximizing self-consumption, reducing grid dependency, and minimizing costs under time-of-use (ToU) tariffs. This paper proposes a lightweight, learning-free intelligent agent based on transparent utility-score maximization for real-time decision-making in residential HEMS. The agent evaluates three discrete actions—grid interaction, battery discharge, and charging—using a weighted utility function that balances electricity cost savings, grid relief, and state-of-charge (SOC) preservation. Inherent explainability is achieved through per-timestamp utility score visualizations, enabling clear traceability of decisions.

A 24-hour simulation with synthetic yet realistic PV, load, and ToU pricing profiles demonstrates effective arbitrage: charging during low-price midday periods, exporting excess PV, and discharging during evening peaks. Results include a self-consumption rate of 78%, self-sufficiency of 65%, near-zero grid import during high-price hours and estimated 25–35% daily cost savings compared to no-EMS baselines. The approach provides a computationally efficient, interpretable alternative to black-box reinforcement learning methods, suitable for edge devices in smart homes.

Keywords: Home energy management system, explainable artificial intelligence, battery energy storage, photovoltaic integration, real-time optimization

Ref # EST-04

COMPARATIVE PERFORMANCE ASSESSMENT OF EAF SLAG AND SINTERED ORE AS PACKED-BED THERMAL ENERGY STORAGE FILLERS FOR ORGANIC RANKINE CYCLE WASTE HEAT-TO-POWER CONVERSION

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Ref # EST-04

Abstract
This study presents a performance assessment of a packed-bed sensible thermal energy storage (PBSTES) system which was integrated with an Organic Rankine Cycle (ORC) for waste heat-to-power conversion from Electric Arc Furnace (EAF). EAF slag and Sintered ore were chosen as the filler materials and investigated under identical bed geometry, transient boundary conditions, and ORC configuration. Using a one-dimensional, two-phase packed-bed model with Wakao–Funazkri and Ergun correlations, sintered ore delivered 37% greater thermal storage capacity and a longer discharge window of 2.13hr, which directly *translated to 39% greater cumulative ORC electrical output per cycle* when compared with EAF slag. However, both systems exhibited comparable discharge efficiencies of 80.23% and 78.17% respectively, ORC thermal efficiency of 21.07% and pressure drop of 878.1 Pa. This shows that the discharge quality is primarily governed by the thermocline propagation dynamics rather than by the absolute storage capacity. This similarity is further compounded by the similar particle diameter and thermal conductivity of both fillers. Although sintered ore is the more superior filler thermodynamically, EAF slag emerges as a technically equivalent and zero-procurement-cost sustainable alternative, thereby strongly supporting circular economy as well as industrial decarbonization objectives within steelmaking industries.

Keywords: Electric Arc Furnace, Energy efficiency, Sustainable Energy, EAF Slag, Sintered Ore

Ref # EST-05

COMPUTATIONAL THERMODYNAMIC AND DFT ANALYSIS OF A LANTHANUM MANGANITE–BASED REDOX CYCLE FOR THERMOCHEMICAL ENERGY STORAGE

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Ref # EST-05

Abstract

Density functional theory-based quantum chemical calculations and computational non-stoichiometric thermodynamic analysis were used to systematically analyze the redox characteristics of lanthanum manganite ($LaMnO_3$) in order to evaluate its potential for use in high-temperature solar thermochemical energy storage (TCES). Equilibrium calculations spanning a range of oxygen partial pressures (0.05–0.0001 atm) and reduction temperatures (1073–1473 K) were used to calculate oxygen evolution and the related oxygen non-stoichiometry (δ). According to the analysis, oxygen release gradually rises with temperature, especially in severely reducing environments. The material had δ values close to 0.1045 at 1473 K and an oxygen partial pressure of 0.0001 atm. These results show that under different thermodynamic settings, lanthanum manganite exhibits variable redox behavior, indicating that it may be a suitable redox material for high-temperature TCES systems.

Keywords: Lanthanum Manganite, Thermochemical, Energy Storage, DFT, Thermodynamic Analysis

Ref # EST-06

THERMOCHEMICAL ENERGY STORAGE USING CALCIUM FERRATE: THERMODYNAMIC AND DFT ANALYSIS

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Ref # EST-06

Abstract
To assess the potential of calcium ferrate (CaFeO3) for use in high-temperature solar thermochemical energy storage (TCES), its redox characteristics were systematically analyzed via density functional theory-based quantum chemical computations as well as computational thermodynamic analysis. Oxygen evolution and the associated oxygen non-stoichiometry (δ) were determined using equilibrium calculations performed over a range of oxygen partial pressures (0.05–0.0001 atm) and reduction temperatures (1073–1473 K). The analysis shows that oxygen release increases progressively with temperature, particularly under strongly reducing conditions. At 1473 K and an oxygen partial pressure of 0.0001 atm, the material exhibited δ values approaching 0.2175. These findings demonstrate that calcium ferrate possesses tunable redox behavior under varying thermodynamic conditions, suggesting its potential suitability as a redox material for high-temperature TCES systems.

Keywords: Calcium Ferrate, DFT, Thermodynamics, Energy Storage, Solar Energy

Ref # EST-07

AN EXPERIMENTAL INVESTIGATION OF CHARGING TEMPERATURE EFFECTS ON THE ENERGY PERFORMANCE OF A PUMICE–CACL$_2$ COMPOSITE THERMOCHEMICAL MATERIAL

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Ref # EST-07

Abstract

In this study, the effect of charging temperature on the energy performance of the Pumice–$CaCl_2$ (P-$CaCl_2$) composite thermochemical material (TCM) was experimentally investigated. System performance is evaluated using both conventional efficiency and a newly defined effective energy efficiency. The conventional approach is based on the ratio of total heat output during discharging to total heat input during charging. In contrast, the effective energy efficiency accounts for both heat and mass transfer by relating the heat output per unit mass of moisture absorbed to the heat input per unit mass of moisture desorbed, thereby incorporating the desorption–absorption mass ratio in addition to heat flow effects for a more representative assessment. According to the testing results, the conventional and effective cyclic efficiencies dropped between 86.6-57.9% and 49.7-39%, respectively, with increasing charging temperatures of 71.2-84.2 °C. On the other hand, the moisture desorption rate increased from 56.6% to 75.2% with increasing charging temperature. The results showed that charging temperature plays a decisive role in cyclic efficiency, specific heat consumption and moisture desorption behaviour. Accordingly, the present study provides important insights into the selection and optimisation of charging temperatures in TCES systems.

Keywords: Thermochemical energy storage, Charging temperature, Sorption, Desorption, Energy efficiency

Ref # EVT-01

ELECTRIC VS FUEL: NIGERIA'S WELL TO WHEEL VEHICLE STUDY

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Ref # EVT-01

Abstract
The transport sector of Nigeria is a major emissions source due to its reliance on imported fossil fuels. This study quantifies the environmental impact of existing vehicle segments, by applying a well to wheel analysis to European segment A to F petrol benchmark. By integrating upstream fuel logistics and direct combustion data, the analysis establishes a baseline carbon intensity ranging from 4.02 tonnes CO_2/yr for segment C to 6.86 tonnes CO_2/yr for segment F in internal combustion engine vehicles. In terms of battery electric vehicles, the well to wheel results ranges from 1.40 tonnes CO_2/yr for segment A to 1.87 tonnes CO_2/yr for segment F. The results show that the adoption of battery electric vehicles is one of the viable pathways to eliminate the high carbon floor and fulfil Nigeria's energy transition plans.

Keywords: Well to Wheel, Internal combustion engine, Greenhouse Gas Emission, Electric Mobility

Ref # EVT-02

PREDICTIVE CO-OPTIMIZATION OF ENERGY AND THERMAL MANAGEMENT IN HEAVY-DUTY FUEL CELL VEHICLES

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Ref # EVT-02

Abstract
The advancement of heavy-duty fuel cell electric vehicles (FCEVs) in hilly or mountainous terrain challenges fuel-economy and component-lifetime targets under packaging constraints. This paper proposes a predictive co-optimization that integrates energy management and battery thermal management on a unified decision level. Unlike hierarchical approaches, where fuel-optimal energy management is computed first and thermal management subsequently allocates cooling for a fixed power split, the proposed method allows limited energy-management adaptation to support thermal conditioning. Compared to the hierarchical baseline, the co-optimization substantially improves thermal conditions in demanding route topographies by mitigating critical temperature peaks while maintaining near-optimal fuel economy. By keeping charge and temperature within limits, the approach enhances vehicle operability and favors overall component lifetime. It can also inform system dimensioning by potentially enabling reduced component sizes without compromising performance.

Keywords: Fuel cell electric vehicles, Heavy-duty transportation, Predictive energy management, Predictive battery thermal management, Co-optimization

Ref # FCT-01

MULTIFUNCTIONAL CE-DOPED LANIO$_3$ PEROVSKITE FOR DIREC AMMONIA-FUELED SOLID OXIDE FUEL CELLS

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Ref # FCT-01

Abstract

Direct ammonia-fueled solid oxide fuel cells (AFSOFCs) are promising electrochemical energy conversion devices for carbon-free power generation. In this study, a series of Ce-doped $LaNiO_3$ (Ce-LNO) perovskite oxides with nominal compositions $Ce_xLa_{1-x}NiO_3$ (x = 0–0.30) were synthesized and evaluated as multifunctional anodes for AFSOFCs. XRD analyses indicates that the $LaNiO_3$ perovskite structure is retained at low Ce contents, while fluorite CeO_2 appears as a secondary phase with increasing dopant concentration. FESEM reveals that Ce incorporation effectively suppresses Ni grain growth, resulting in a porous microstructure favorable for gas diffusion and catalytic reactions. EDS mapping confirms a homogeneous distribution of La, Ni, Ce, and O, indicating intimate interfacial contact between the $LaNiO_3$-derived matrix and CeO_2. Half-cell electrochemical measurements demonstrate that Ce doping markedly enhances power density under both H_2 and NH_3 fuels, with a pronounced improvement under direct ammonia fuel operation. The optimal composition, 0.30Ce–LNO, delivers the highest peak power density, reflecting synergistic function among Ni segregation, increased oxygen vacancy concentration associated with Ce^{4+}/Ce^{3+} redox changes, and catalytically active Ni–CeO_2 interfacial sites for ammonia cracking. These results demonstrate that Ce-doped $LaNiO_3$ is a highly promising anode material for efficient and durable direct ammonia-fueled SOFCs.

Keywords: Direct ammonia-fuel, $LaNiO_3$ perovskite, Ce doping

Ref # FOR-01

DEEP LEARNING–BASED WEATHER FORECASTING FOR PAKISTAN

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Ref # FOR-01

Abstract

Accurate weather forecasting is critical for energy planning, agriculture, and climate-resilient infrastructure in climate-vulnerable regions such as Pakistan. This study presents a data-driven short-term weather forecasting framework based on statistical and machine learning models applied to long-term historical meteorological data. Daily temperature, relative humidity, solar irradiance, and precipitation records are obtained from the NASA POWER dataset and complementary weather sources for multiple Pakistani cities. Linear Regression, Random Forest, Extreme Gradient Boosting (XGBoost), and Autoregressive Integrated Moving Average (ARIMA) models are developed and evaluated using a chronological train–validation–test strategy. Model performance is assessed using Mean Absolute Error (MAE), Mean Squared Error (MSE), and the coefficient of determination (R^2). Results show that XGBoost consistently achieves the highest accuracy for one-day-ahead temperature forecasting, with average MAE of approximately 1.4 °C and R^2 exceeding 0.94 across cities, while Random Forest and Linear Regression provide competitive performance. In contrast, the univariate ARIMA model exhibits limited predictive capability, particularly for highly variable precipitation. The findings highlight the effectiveness of ensemble machine learning models for short-term weather forecasting and their potential to support sustainable energy and environmental planning in Pakistan.

Keywords: Deep learning, Energy and Environment, Pakistan climate, Time-series modelling, Weather forecasting

Ref # HES-02

EXPLORING THE CHALLENGES OF DEVELOPING LOW-EMISSION HYDROGEN PRODUCTION TECHNOLOGIES IN TÜRKİYE: A PESTEL PERSPECTIVE

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Ref # HES-02

Abstract
Low-emission hydrogen is critical for decarbonizing hard-to-abate sectors in emerging economies such as Türkiye. This study identifies and examines political, economic, social, technological, environmental, and legal challenges to developing low-emission hydrogen production technologies in Türkiye by combining a PESTEL framework with the fuzzy DEMATEL method. Fifteen challenges were defined from the literature and expert input, and their causal relationships were mapped. The results show that low technology readiness, regulatory uncertainties, and high investment costs are core drivers, while lack of subsidies and harmonised international standards act as important additional causes. Infrastructure gaps and lengthy patenting and licensing processes emerge mainly as downstream effects, highlighting priority areas for targeted policy intervention.

Keywords: Green production, low-emission hydrogen, Fuzzy DEMANTEL, Multi-criteria decision making

Ref # HES-03

EXPERIMENTAL ASSESSMENT OF TITANIA AND FERRIC OXIDE-BASED CATALYSTS FOR PHOTOCATALYTIC HYDROGEN Production

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Ref # HES-03

Abstract
In this work, transition metal oxide-based photocatalysts are utilized for photocatalytic hydrogen production assessment, namely Titania, Ferric Oxide, and a mixture between Titania and Ferric Oxide. For the mixed photocatalyst case, the mass ratio of Titania to Ferric Oxide is maintained at 1:1. The results indicate that ferric oxide achieves a hydrogen concentration of 9 ppm, while titania reaches 14 ppm, corresponding to a 55% enhancement. The mixture of Titania and Ferric Oxide demonstrates a higher performance with a hydrogen concentration of 16 ppm, representing a 14% enhancement over sole Titania and 77% over Ferric Oxide. The highest energy efficiency achieved is 0.169%, which is attributed to the mixture of Titania and Ferric Oxide.

Keywords: Hydrogen, Hydrogen production, Photocatalyst, Solar Energy

Ref # HES-04

GREEN BIOELECTROLYTE DERIVED FROM TEA WASTE FOR HYDROGEN PRODUCTION USING ACIDIC WATER ELECTROLYSIS

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Ref # HES-04

Abstract
Investigations for efficient and clean energy sources have accelerated as a result of the shift to sustainable energy systems, and hydrogen (H_2) is considered a promising energy carrier due to its high energy density and zero carbon emissions. Water electrolysis is one of the most reliable manufacturing methods for producing high-purity H_2, especially when combined with renewable energy sources. However, purified water and synthetic electrolytes are usually needed for electrolysis operations, which raises operating costs and restricts the sustainability of large-scale applications. As a result, designing substitute electrolyte systems using inexpensive, renewable resources has emerged as a key area of research. In this regard, an acid-assisted extraction method was used for producing a bioelectrolyte obtained from tea waste, and its potential to produce H_2 by electrolysis was evaluated in this study. The 1 M bioelectrolyte achieved a current density of about 280 mA/cm^2 at 0.75 V using carbon-based electrodes, and this is much higher than the 60 mA/cm^2 obtained with 1 M KOH. Overall, these findings show that bioelectrolyte formed from tea waste can both increase electrochemical activity and facilitate waste valorization. Consequently, the suggested strategy offers an appealing path for economical and sustainable H_2 production in electrolysis processes.

Keywords: Bioelectrolyte, Tea waste, Hydrogen production, Waste management, Sustainability

REF # HES-05

AN INTEGRATED HYDROGEN PRODUCTION AND ENERGY RECOVERY SYSTEM FOR WASTEWATER TREATMENT PLANTS

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REF # HES-05

Abstract
This study proposes a novel integrated energy system for wastewater treatment plants to simultaneously produce electricity, hydrogen, and useful heat. The proposed configuration integrates dark fermentation, sludge incineration, a Brayton cycle gas turbine, an integrated bioelectrochemical reactor composed of microbial fuel cells, microbial electrolysis cells, and photoelectrochemical units, together with an alkaline electrolyzer. In this paper, parametric analysis is performed to investigate the effects of effluent biochemical oxygen demand and dissolved oxygen concentration on the oxygen transfer requirement of the aeration process under different wastewater strength conditions. The results show that increasing effluent biochemical oxygen demand from 15 to 30 mg/L reduces the oxygen transfer rate from about 30.73 to 26.49 kg/h. In contrast, increasing the dissolved oxygen concentration from 2 to 4 mg/L increases the oxygen transfer requirement from 29.36 to 39.90 kg/h.

Keywords: Wastewater treatment, Hydrogen, Energy, Exergy, Efficiency

Ref # HES-06

INVESTIGATION OF HYDROGEN PRODUCTION AND SODIUM HYPOCHLORITE FORMATION IN A GRANULAR ACTIVATED CARBON-BASED NACL ELECTROLYSIS SYSTEM

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Ref # HES-06

Abstract
In this study, the effect of applied voltage on hydrogen production and NaOCl formation during the electrolysis of a 0.5 M NaCl solution was experimentally investigated. A two-chambered closed electrolysis cell with granular activated carbon electrodes was used in the experiments. Hydrogen production results showed that the system performed fastest at 3.5 V, achieving higher hydrogen production in a shorter time. NaOCl analysis revealed that the highest formation was obtained at 2.2 V, and the amount of NaOCl decreased significantly as the voltage increased. The findings showed that the applied voltage directly affects product distribution; high voltages support hydrogen production, while low voltages are more favorable for NaOCl formation. In conclusion, it was determined that the operating voltage in activated carbon-based NaCl electrolysis systems should be selected depending on the target product.

Keywords: Hydrogen production, NaCl electrolysis, sodium hypochlorite, activated carbon electrode; Renewable energy; Energy

Ref # MSC-02

NANOFLUIDS AND HYBRID NANOFLUID CONVECTION HEAT TRANSFER IN A TUBE

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Ref # MSC-02

Abstract
A hybrid nanofluid (HNF) is a fluid that contains two or more kinds of chemically-distinct nanoparticles dispersed in a base liquid. HNFs are the new generation of ordinary nanofluids (NFs). HNFs are supposed to be more effective heat transfer fluids than NFs, as they present higher thermal conductivity, low viscosity and synergistic effects among nanoparticles. These effects are caused by different-size nanoparticles forming ordered arrangements around liquid molecules and acting as bridges among little aggregations of smaller nanoparticles. In this paper, simulations of heat transfer of HNFs and NFs in an open pipe are compared. The NFs and HNFs are made from aluminum oxide Al2O3 and TiO2 nanoparticles suspended in deionized water. The comparison is made at the same solid particle volume concentration and hydraulic and thermal conditions. The simulation domain is a circular pipe having an internal diameter 5.25 cm and a length 16.51 cm. The pipe is subjected to constant heat flux of 15518 W/m2. At the inlet, the fluid’s temperature was constant at 298 K, and a Reynolds number of 1798 (entrance velocity 0.029 m/s). The mesh-independent results show that the heat transfer performance of HNFs is superior to that of NFs.

Keywords: Nanofluids, Hybrid nanofluids, Convection, Simulations

Ref # MSC-03

ELECTROLYSIS-BASED HYDROGEN AND AMMONIA AS ELEMENTS OF SUSTAINABLE AGRICULTURAL INTENSIFICATION IN SUB-SAHARAN AFRICA

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Ref # MSC-03

Abstract
Nitrogen fertilizer as a core element of plant nutrition is crucial for improved food security. This is especially important for Sub-Sahara Africa, with extremely low rates of fertilizer application per hectare of arable land, an already high proportion of people with insufficient food intake and a significant population growth in the next decades. Nitrogen fertilizer is today produced in large ammonia synthesis plants applying technologies with very high emissions of greenhouse gases. Technological innovation, specifically small-scale electrolysis-based hydrogen and ammonia production offer a pathway for a paradigm shift in N-fertilizer production. The main difference between traditional and electric Haber-Bosch plants is that the economic logic of the former depends on a continuous supply of natural gas, which leads to a concentration on only a few locations internationally. However, if the process is based on electrolytic hydrogen, it can basically be carried out anywhere where there is a large potential for renewable energies and clean water. This allows ammonia and N fertilisers to be produced closer to the farm gate and with much lower greenhouse gas emissions.

Keywords: Low Emission Hydrogen, Nitrogen fertilizers, Food security, Sub-Sahara Africa

Ref # MSC-05

INTEGRATING ENERGY, EXERGY, AND ENTROPY INTO NATIONAL POLICY AND PROCESS OPTIMIZATION: A THERMODYNAMIC PERSPECTIVE ON SUSTAINABLE DEVELOPMENT

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Ref # MSC-05

Abstract

Sustainable development challenges require integrated approaches linking thermodynamics with policy and engineering. Current frameworks rely mainly on energy-based metrics, often neglecting exergy and entropy, limiting system performance evaluation. This study proposes a framework integrating energy, exergy, and entropy into policy design and process optimization. The approach assesses energy systems in terms of quantity, quality, and irreversibility, identifying sources of exergy destruction and entropy generation. Results show that energy-only metrics lead to inefficiencies, while thermodynamic indicators improve system performance and policy coherence. The study highlights the importance of aligning policy with thermodynamic principles to achieve more efficient and sustainable energy systems.

Keywords; Political Systems, Governance Efficiency, Open Systems, Institutional Dynamics, Sustainability, Energy, Entropy, National Policy Analysis

Ref # PVT-01

PASSIVE COOLING OF PHOTOVOLTAIC CELLS USING CARBON NANO FIBER ENHANCED PHASE CHANGE MATERIAL

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Ref # PVT-01

Abstract

This study investigates the use of carbon nanofiber-enhanced phase change material (NPCM) as a passive cooling system for photovoltaic (PV) panels under indoor conditions. RT25HC PCM was enhanced with 1% carbon nanofibers (CNF) to improve its thermal conductivity and filled into a finned aluminum container attached to the back of the PV panel. Indoor experiments were conducted using a 500 W halogen lamp to simulate solar radiation of approximately 700 W/m². The performance of three cases: reference PV (ref-PV), PV with pure PCM (PCM-PV), and PV with nano-enhanced PCM (NPCM-PV) was evaluated in terms of average panel temperature and electrical efficiency. The results showed that both PCM-based cooling systems reduced PV temperature and improved efficiency compared to the reference case. Faster charging rate is encountered in the NPCM compared to the pure PCM, resulting in lower PV temperature during melting process. The average panel temperature decreased by 9.97% with PCM and 8.27% with NPCM across the complete test period. Correspondingly, the average efficiency increased from 12.9% for the reference PV to 13.2% and 13.1% for the PCM-PV and NPCM-PV, respectively.

Keywords: Photovoltaics, Passive cooling, NPCM

Ref # PVT-02

THERMAL MANAGEMENT OF PV PANELS USING MACHINE LEARNING FOR OPTIMAL PCM TYPE AND THICKNESS SELECTION

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Ref # PVT-02

Abstract

Elevated operating temperatures significantly reduce the performance of photovoltaic (PV) panels, motivating the use of phase change materials (PCMs) for passive thermal management. This study investigates the optimal selection of PCM type and thickness using a machine-learning-based framework under both hot and cold climatic conditions. Four PCMs (RT28, OM37, OM42, and RT54) with thicknesses ranging from 20 to 50 mm are evaluated. A dynamic PV–PCM thermal model is used to generate training data, and several machine-learning algorithms are assessed for PV temperature prediction. Among them, Gaussian Process Regression (GPR) with a Matern 5/2 kernel demonstrates superior accuracy, achieving coefficients of determination exceeding 0.99. The trained GPR model is then applied to identify optimal PCM configurations by minimizing peak PV temperature during critical daytime hours. The results reveal a strong seasonal dependence of PCM performance. During hot months, OM37 achieves the lowest PV temperature at a moderate thickness of 30 mm, whereas higher-melting PCMs (OM42 and RT54) require a thickness of 50 mm for effective cooling. In contrast, during cold months, RT28 performs best with a 20 mm thin layer, with limited benefit from increasing thickness. These findings confirm that climate-specific PCM design is essential for effective PV thermal management.

Keywords: Thermal management, PCM, Machine learning, Energy efficiency, optimization

Ref # REP-01

ENERGY AND EXERGY ASSESSMENT OF A SOLAR PTC-DRIVEN POLYGENERATION SYSTEM FOR POWER, COOLING, FRESHWATER AND HYDROGEN PRODUCTION

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Ref # REP-01

Abstract
This study proposes a novel solar-integrated multigeneration system and addresses the thermodynamic analysis of the system. The proposed system utilizes existing solar energy via parabolic collectors to integrate an organic Rankine cycle for electricity generation, a single-effect absorption refrigeration system for cooling production, a humidification-dehumidification desalination unit for fresh water production, and a proton exchange membrane unit for hydrogen production. One of the main objectives of the study is to examine the effects of the ORC pressure ratio and different working fluids on the useful outputs of the system. Accordingly, five different organic working fluids (r245fa, toluene, R123, n-octane and n-butane) are considered to examine their effects on the system. The results show that increasing the ORC pressure ratio increases the net power output and hydrogen production. However, with the increase in ORC power output, there is a decrease in freshwater and cooling capacity due to the transfer of energy to the ARS and the availability of waste heat energy in the ORC condenser. While fluids with high critical temperatures, such as N-octane and toluene, provide relatively higher power output, fluids with lower critical temperatures, such as R245fa and n-butane, offer advantages in cooling capacity and fresh water production.

Keywords: Sustainable Energy, Solar, Hydrogen, Freshwater, Clean Energy

Ref # REP-03

DESIGN OF A RENEWABLE ENERGY AND WASTE MANAGEMENT SYSTEM FOR HYDROGEN, FRESH WATER AND OXYGEN PRODUCTION

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Ref # REP-03

Abstract
This study introduces a novel waste-integrated multigeneration system that simultaneously produces electricity, green hydrogen, freshwater, high-purity oxygen, and district heating by utilizing municipal wastewater sludge, wind energy, and recovered thermal energy. The system is modeled using detailed mass, energy, and exergy balance equations, achieving 42% energy and 52% exergy efficiencies under steady-state conditions. It annually produces 463.18 kt of hydrogen, 9.21 kt of freshwater, and 3674.28 kt of oxygen, which supports a coupled fish-farming unit for sustainable aquaculture. Overall, the system demonstrates strong alignment with circular economy and sustainability principles by integrating waste management, energy production, water recovery, and food generation within a single efficient platform.

Keywords: Wastewater, Hydrogen, Energy, Exergy

Ref # RES-02

WAVE ENERGY CHALLENGES IN THE MEDITERRANEAN SEA

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Ref # RES-02

Abstract

The Mediterranean Sea presents a unique challenge in the application and development of wave energy. The regional wave energy resources are between low and moderate with variations such as coastal and islands energy transition to consider in its application. This study provides a literature survey of wave energy potential and application of Wave energy converters (WECs) in the Mediterranean Basin. Peer- reviewed resources are considered and the results indicate that Western Mediterranean basin shows comparatively higher mean wave power while eastern regions display a lower mean with higher seasonable variability. Literature further shows that the main applications of wave energy in Mediterranean divided into nearshore, offshore and breakwater-integrated devices with contextual suitability, access to already existing infrastructure and maintenance accessibility. While application of wave energy converters still faces challenges such as economic viability, long term survivability under harsh weather events and long-term operational application with reliable data. The Key barriers to commercially viable wave energy converter can be circumvented with the technology-resource matching and integrated techno-economic evaluation. This is even more apparent for the Mediterranean region.

Keywords: Wave Energy, Mediterranean Sea, Wave Energy converter, Resource assessment, Levelized cost of electricity

Ref # RES-03

SUSTAINABLE ENERGY DEVELOPMENT AND POLICY CHALLENGES: THE CASE OF KANO STATE

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Ref # RES-03

Abstract
Kano State faces growing sustainability challenges driven by rapid urbanization, population growth, and infrastructural deficits. Unreliable electricity supply, environmental degradation, and limited renewable energy deployment continue to hinder sustainable development. This study examines sustainable energy development in Kano State, Nigeria, focusing on electricity access constraints, policy implementation effectiveness, and renewable energy potential. A qualitative literature review was conducted using peer-reviewed studies and official policy documents published between 2020 and 2025. The findings show that persistent electricity shortages increase reliance on fossil fuel–based self-generation, raising economic costs and carbon emissions. Rapid urbanization further intensifies infrastructure pressure, water stress, environmental degradation, and inefficient waste management. Although Kano has strong solar energy potential, deployment remains limited due to financial constraints, regulatory inefficiencies, and weak institutional coordination, highlighting a gap between policy ambition and implementation. The literature further implies that strengthening renewable energy financing mechanisms, improving policy coordination, and promoting energy efficient urban infrastructure could escalate sustainable energy development and reduce environmental impacts in Kano state.

Keywords: Sustainable energy, Renewable energy, Electricity access, Policy implementation, Kano State

Ref # RES-04

DESIGN OF A HOLISTIC ENERGY SYSTEM FOR INUIT OFF-GRID COMMUNITIES

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Ref # RES-04

Abstract

Remote Inuit communities on the shores of Newfoundland and Labrador remain highly dependent on diesel fuel, causing severe energy costs and greenhouse gas emissions (GHG). This study proposes and thermodynamically evaluates a multigeneration integrated renewable energy system designed specifically for these communities. The system combined two locally abundant renewable resources in the area which are tidal energy and wood-waste biomass gasification. The system is used to simultaneously produce electricity, space heating using ground source heat pump and biodiesel for inter-island ferry transport through a microalgae-to-biofuel pathway. Power generation is achieved through combined Brayton and Steam Rankine cycle, along with tidal turbine. The CO_2 from gasification is biologically sequestered through a cyanobacteria photobioreactor. The system is projected to supply approximately 30,000 MWh/yr of electricity, 132,000 MWh/yr of thermal energy, and 30,000 MWh/yr of ferry fuel, reducing community GHG emissions by approximately 92% relative to the diesel-only baseline.

Keywords: Biomass Gasification, Tidal Energy, Hydrogen Storage, Off-grid Communities, Multigeneration Energy Systems

Ref # UTL-01

N EMPIRICAL ANALYSIS OF POWER INTERRUPTIONS AND DEMAND STRESS IN AN ISOLATED ISLAND POWER SYSTEM: EVIDENCE FROM NORTH CYPRUS

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Ref # UTL-01

Abstract
Power system reliability in isolated power systems is heavily influenced by the variability of demands and other operational constraints. However, there is limited empirical evidence based on modern power system operation data. This article presents an investigation of the relationship between daily demand stress and power interruption days in Northern Cyprus using official KIB-TEK utility data for the 2024 calendar year. Daily peak demands, minimum demands, and interruption days are used to create power system reliability indicators and interruption metrics. Comparison of days with and without power outages, and days with low and high demand stress, indicates that days with power outages have slightly higher average peak demands. Moreover, days with high demands alone are not sufficient to explain power interruption days. Most days have no power outages or have only single interruption days. On the other hand, there are few days with multiple interruption days. This indicates that power system reliability is not solely influenced by demands but also by other factors such as power system operations.

Keywords: Demand stress, Electricity reliability, Island power systems, Northern Cyprus, Operation

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