Editorial: HEREM 2025 (11th Edition) Proceedings

Hydrogen Energy, Renewable Energy Integration, and Advanced Materials for Sustainable Energy Transition

The 11th International Symposium on Hydrogen Energy, Renewable Energy, and Materials (HEREM 2025) was successfully organized on 9–10 October 2025 in Singapore. This proceedings volume is published in EPJ Web of Conferences (eISSN: 2100-014X). It presents 17 peer-reviewed and accepted papers, reflecting the scientific scope, quality, and continuity of HEREM as a recognized international symposium series.

HEREM has evolved into a respected research platform bridging hydrogen energy systems, renewable power generation and grid integration, and energy materials and electro-chemical engineering. The symposium has consistently promoted rigorous engineering methods and system-level relevance. It has also encouraged multidisciplinary dialogue connecting researchers, technology developers, and sustainability-driven innovators. The HEREM 2025 papers span seven focused themes, as described in this editorial: DER-integrated renewable networks, renewable electrolysis and hydrogen systems, modern grid stability and protection, advanced power electronic interfaces, electrochemical devices and energy materials, bioenergy and circular processing routes, and building materials for low-energy housing..

This proceedings volume directly contributes to the global agenda of the United Nations Sustainable Development Goals (SDGs). The accepted papers support decarbonization and energy resilience through technical solutions aligned with SDG 7 (Affordable and Clean Energy), SDG 9 (Industry, Innovation and Infrastructure), SDG 11 (Sustainable Cities and Communities), SDG 12 (Responsible Consumption and Production), and SDG 13 (Climate Action). Selected contributions also relate to SDG 6 (Clean Water and Sanitation) through water treatment technologies and sustainable chemical adsorption methods.

HEREM Legacy: 11-Year Journey of Technical Continuity and Global Relevance

HEREM has completed its 11th successful edition with HEREM 2025. This continuity is not simply an operational achievement. It reflects the sustained demand for a focused forum where hydrogen, renewables, and materials innovations are discussed together, not in isolation. In this 11-year journey, HEREM has consistently promoted research that is not only scientifically strong, but also relevant to deployment constraints, system integration, and long-term sustainability metrics.

The progression of HEREM also mirrors the global energy transition itself. Early discussions emphasized renewable energy penetration and converter-based integration. Recent editions increasingly emphasize hydrogen as a strategic energy vector, sector coupling, carbon-aware optimization, and the materials and manufacturing ecosystems required for electrolyzers, fuel cells, and next-generation energy devices. HEREM 2025 continues this trajectory by presenting contributions across component-scale modelling, network-scale planning, and sustainability-driven decision frameworks.

1. Renewable Power Systems, DER Integration, and Intelligent Optimization

The integration of distributed energy resources (DERs) into modern distribution networks is a decisive pathway for accelerating clean electrification. However, it requires robust engineering tools to manage increased uncertainty, bidirectional power flow, and operational constraints such as voltage stability and equipment loading. Several papers in HEREM 2025 address these challenges using advanced optimization and forecasting methods.

Optimal DER Integration using Sensitivity-Based GEPSO

The paper 01001 “Optimal integration of Distributed Energy Resources using a sensitivity-Based GEPSO Approach in Distribution Networks” proposes a structured approach for DER allocation and sizing. The sensitivity-based formulation improves planning transparency. It supports identification of critical buses and network bottlenecks. It also enhances interpretability of optimization outcomes for practical deployment. Such methods are essential when distribution networks evolve into actively managed energy platforms.

This paper aligns strongly with SDG 7 by enabling higher renewable penetration. It supports SDG 9 through smart infrastructure planning. It also benefits SDG 11 by enabling reliable and resilient distribution systems for cities and communities.

Forecasting Load Profiles under EV and DER Penetration

The paper 01016 “Analysis of Load Profile in the presence of EVs & DERs**”** addresses a rapidly emerging system challenge. EV charging introduces stochastic demand. Rooftop PV and prosumer behavior introduce uncertainty on the supply side. Conventional load forecasting becomes insufficient under these conditions. The paper strengthens predictive capability for distribution system operation. It supports improved readiness for voltage regulation and transformer loading constraints.

This contribution supports SDG 7 through reliable electrification. It connects to SDG 11 due to its relevance to sustainable urban mobility and charging infrastructure.

Pythagorean Fuzzy Cognitive Mapping for Electricity Sustainability

The paper 01013 “A Pythagorean Fuzzy Cognitive Mapping Approach for Iran's Electricity Sustainability as a Case Study for Developing Economies” contributes to sustainability-oriented decision support. The work targets multi-criteria electricity sustainability assessment. It recognizes that technical optimization alone is not sufficient for long-term transition planning. Energy systems must be evaluated using interconnected drivers such as economic feasibility, reliability, resource availability, and environmental impact.

This paper contributes to SDG 7 and SDG 13 through sustainability planning. It also supports SDG 9 by strengthening structured innovation pathways in developing economy contexts.

2. Green Hydrogen Systems, Renewable Electrolysis, and Multi-Energy Coupling

Hydrogen is increasingly recognized as a strategic carrier for deep decarbonization. It supports long-duration storage. It enables sector coupling between power, heat, transport, and industry. HEREM 2025 presents contributions across renewable electrolysis performance evaluation and hydrogen-integrated energy system optimization.

Solar vs Wind Powered Electrolysis for Green Hydrogen Production

The paper 01002 “Comparative Performance Evaluation of Solar and Wind based Electrolysis Systems for Green Hydrogen Production” examines a central challenge in hydrogen system deployment. Renewable sources impose distinct intermittency patterns. These patterns directly influence electrolyzer loading profiles, efficiency, and operational stability. The comparative analysis strengthens understanding of resource suitability for hydrogen generation. It also supports more realistic planning of renewable-electrolyzer coupling strategies.

This contribution supports SDG 7 and SDG 13 by accelerating green hydrogen deployment. It also supports SDG 9 by enabling hydrogen infrastructure planning based on engineering evidence.

Stochastic Optimization of Electricity–Heat–Gas–Hydrogen Systems with Carbon Trading

The paper 01004 “A Stochastic Optimization Approach for an Integrated Energy System Synergizing Electricity, Heat, Gas, and Hydrogen Considering Carbon Trading” provides a system-level framework integrating multiple energy carriers. The inclusion of carbon trading adds market realism. It reflects practical decarbonization constraints. The stochastic formulation improves robustness under renewable uncertainty and variable demand. The work highlights hydrogen as a flexibility vector in integrated energy systems.

This contribution advances SDG 7 through clean energy balancing. It supports SDG 13 through carbon-aware operation. It supports SDG 9 by promoting innovation in multi-energy infrastructure.

Region-Specific Enviro-Economic Evaluation of Solar Green Hydrogen

The paper 01005 “Synergistic Enviro-Economic Evaluation of a Solar-Green Hydrogen Hybrid System (SGHHS) for Continuous Clean Energy Using a Region-Specific Techno-Economic and Environmental Framework” provides a valuable pathway toward contextual decision-making. Hydrogen feasibility is highly dependent on regional factors. Solar yield, climate conditions, CAPEX, OPEX, and logistics determine project viability. Region-specific assessment improves the credibility of deployment recommendations. It supports energy transition decisions for real geographic contexts.

This work supports SDG 7 through affordable clean energy planning. It strengthens SDG 13 through emissions mitigation pathways. It connects to SDG 11 by enabling sustainable community-scale adoption.

3. Grid Modernization, Inverter-Based Resources, and Advanced Control Perspectives

Power systems are undergoing a fundamental transition. Conventional synchronous generation is declining in relative contribution. Inverter-based resources are increasing rapidly. This shift has a direct impact on frequency stability, voltage dynamics, fault current contribution, and protection coordination. HEREM 2025 includes focused contributions addressing modernization challenges and control innovations.

Modernizing Power Grids for High Renewable Penetration

The paper 01007 “Modernizing Power Grids for High Renewable Penetration: Challenges and Control Innovations” addresses system-level challenges in high-renewable grids. The work emphasizes operational constraints and modern control needs. It recognizes that renewable integration requires not only converter deployment, but also coordinated control architectures and stability-aware design.

This contribution supports SDG 7 by enabling higher renewable hosting capacity. It supports SDG 9 through modernization of infrastructure and control innovation.

Stability, Protection, and Control in Inverter-Dominant Grids

The paper 01008 **“**Grid Modernization in the Era of Inverter-Based Resources: Stability, Protection, and Control Perspectives**”** complements modernization research through a protection and dynamics viewpoint. Fault currents become limited in inverter-dominated systems. Protection design becomes more complex. The paper highlights the need for adaptive protection strategies and robust inverter control concepts, including grid-supporting functionalities.

This work supports SDG 7 and SDG 9. It also supports SDG 11 by improving grid resilience for sustainable and electrified cities.

4. Power Electronics Innovations and Converter-Enabled Applications

Power electronics remains a critical enabler for renewable energy integration, hydrogen system interfacing, and electrified transport. High efficiency and low distortion conversion is central to future energy systems. HEREM 2025 includes a contribution addressing multilevel inverter innovation with reduced switching complexity.

Modified H-Bridge 25-Level Inverter with Reduced Switch Count

The paper 01006 “A Modified H-Bridge 25 level Inverter with only 11 Switches to improve the sinusoidal nature of the output to enhance the performance of Inverter fed AC loads” targets a practical and impactful design challenge. Multilevel converters provide improved output waveform quality. They reduce harmonic distortion and switching stress. However, they often

increase switch count, complexity, and cost. A reduced-switch 25-level topology offers a technically attractive direction if validated with credible performance metrics and loss analysis.

This paper supports SDG 7 by improving energy conversion efficiency. It supports SDG 9 by enabling scalable power electronic innovation for industrial and infrastructure applications.

5. Energy Materials, Electro-chemical Devices, and Multi-Scale Modelling

Advanced energy materials and electro-chemical engineering determine the performance and durability of hydrogen and fuel cell systems. HEREM 2025 includes several contributions addressing electrolyzer behaviour, fuel cell catalyst layer optimization, and process intensification through microfluidic effects.

Intermediate-Temperature Steam Electrolyzer Modelling

The paper 01009 “Mathematical modeling and numerical analysis of intermediate-temperature water (steam) electrolysis cell performances” contributes to component-scale engineering analysis. The distribution of current density and potential across a stack influences efficiency, thermal gradients, and degradation rates. Numerical insight supports improved design of stack architecture and operating regimes. It strengthens the transition from laboratory designs to scalable electrolyzer assemblies.

This work supports SDG 7 through efficient hydrogen generation. It supports SDG 9 through hydrogen device innovation and industrial scalability.

Agglomerate-Level Catalyst Layer Optimization in PEM Fuel Cells

The paper 01017 “Numerical optimization of PEM fuel cell electrocatalytic layers via an agglomerate level model” addresses one of the most critical internal regions in PEM fuel cells. The catalyst layer governs electrochemical kinetics and transport losses. It also determines water balance and degradation dynamics. Agglomerate-level modelling offers higher fidelity in design exploration. It supports approaches to reduce precious metal loading while maintaining performance.

This contribution supports SDG 7 by enabling clean energy conversion. It supports SDG 9 by strengthening fuel cell engineering foundations for mobility and backup power.

Microfluidic Effects for Reducing Reaction Times

The paper 01015 “Study of the effect of the microfluidic effect on reducing the reaction times” highlights a process intensification method relevant to energy materials synthesis and electrochemical engineering. Microfluidic structures enable improved mixing and controlled transport. Reduced reaction time can lower energy usage. It can improve throughput. It can improve reproducibility of process outcomes.

This contribution supports SDG 9 through innovative process engineering. It supports SDG 12 by contributing to resource-efficient processing.

6. Sustainable Fuels, Biomass Valorization, and Circular Resource Pathways

Sustainable energy transition must also include low-carbon fuels and circular economy approaches. HEREM 2025 presents contributions addressing biodiesel pathways, biomass fractionation, adsorption-based water treatment, and energy-efficient drying systems.

Microalgae Characterization for Sustainable Biodiesel

The paper 01011 “Biochemical characterization of indigenous green microalgae and FAMEs profiling of lipids for sustainable biodiesel production” contributes to alternative fuel development through biomass-derived resources. Microalgae can offer high productivity and non-food competition potential. Lipid profiling and FAME characterization provide essential indicators for biodiesel readiness. Such work supports clean fuel diversification for sectors where electrification may be slower.

This paper supports SDG 7 and SDG 13 through low-carbon fuels. It supports SDG 12 through renewable bioresource utilization.

Cellulose and Lignin Fractionation from Sugarcane Bagasse

The paper 01012 “Fractionation of cellulose and lignin from sugarcane bagasse via the alkaline and acid chemical process” focuses on valorization of agricultural residues. Sugarcane bagasse is an abundant feedstock. Its fractionation enables bioenergy and biomaterials value chains. This improves circular resource use. It reduces fossil dependency in industrial applications.

This contribution supports SDG 12 and SDG 9 through sustainable processing and industrial innovation. It also supports SDG 7 through biomass energy pathways.

Activated Carbon from Biomass Waste for Dye Adsorption

The paper 01010 “Optimization of malachite green adsorption from aqueous solution onto Anchote peel based activated carbon using Box Behnken design” highlights an environmentally relevant and circular approach. It uses biomass waste to produce activated carbon. It applies optimization methods for adsorption efficiency. The work supports wastewater treatment and contamination mitigation.

This paper strongly supports SDG 6 for clean water. It supports SDG 12 for responsible resource use. It contributes to SDG 13 through pollution reduction and sustainability.

3D Drying System under Forced Convection

The paper 01014 “Numerical simulation and experimental investigations of the 3D simultaneous heat and mass transfer in a drying system operating under forced convection mode” addresses energy efficiency in thermal processes. Drying is a major energy consumer across food and biomass processing. The combination of numerical and experimental validation is important for credibility. The work supports process optimization and energy savings.

This paper supports SDG 7 through efficiency improvement. It supports SDG 12 through sustainable industrial processing.

7. Built Environment Materials and Climate-Responsive Housing Systems

Clean energy transition is strongly influenced by building energy demand. Materials selection is a key factor governing thermal performance and lifecycle sustainability. HEREM 2025 includes a contribution on performance-based selection of materials for future housing needs.

Performance-Based Materials for Future Housing

The paper 01003 “Performance-Based Material Selection in Future Housing: A Mediterranean Climate Case” emphasizes climate-specific building design. Housing material selection influences indoor thermal comfort and heating/cooling demand. This research supports passive energy savings. It supports lower operational emissions. It also contributes to climate-responsive infrastructure development.

This paper supports SDG 11 through sustainable housing. It supports SDG 7 through reduced energy consumption. It supports SDG 13 through climate action in the built environment.

Proceedings Contribution: Integrated View of Sustainable Energy Transition

The HEREM 2025 proceedings demonstrate that the clean energy transition is an integrated engineering challenge. The accepted papers provide strong technical depth in modelling, optimization, and experimental validation. It demands coordinated progress across:

- Renewable integration and network modernization, enabling higher renewable hosting capacity under stability and protection constraints.
- Hydrogen generation and multi-energy coupling, addressing production feasibility, operational uncertainty, and market-driven decarbonization.
- Energy materials and electrochemical engineering, enabling efficiency and durability improvements in electrolyzers and fuel cells.
- Circular resource technologies and sustainable fuels, supporting diversified decarbonization pathways and responsible resource utilization.

HEREM will continue to advance high-quality international research with measurable sustainability outcomes. HEREM 2026 should strengthen work on grid-forming control and protection for inverter-dominant networks, power-grid–hydrogen integration and electrolyzer flexibility, durable and recyclable electrochemical materials, large-scale sector coupling under realistic techno-economic constraints, and AI-enabled monitoring, predictive control, and cyber-resilient operation. With 11 successful editions, HEREM remains a trusted platform for impactful collaboration. We look forward to HEREM 2026 with stronger focus on deployable solutions, industrial translation, and SDG-driven energy transition.

We sincerely thank **EPJ Web of Conferences** for publishing the HEREM 2025 proceedings and for their professional support in disseminating these peer-reviewed contributions to the global research community.

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