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Editorial: Recent development in energy conversion systems

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Editorial on the Research Topic
Recent development in energy conversion systems

In this industrial and technological age, energy plays a principal role in sustainable development. This is connected to Research Topic regarding availability, production processes, utilization and environmental impact. Due to the increasing population growth rate, the global energy demand will get to an unsustain level shortly if serious measures are not initiated to address the situation, especially from research and development perspectives. "None of the millennium development goals (MDGs) can be completed without considerable improvements in the quality and quantity of energy services in developing countries," according to the United Nations Development Programme (UNDP). Based on this fact, UNDP is making efforts, especially in developing countries, to ensure people have access to sustainable sources of clean, reliable, and affordable energy since this vital resource impacts every aspect of human development.

The available energy conversion systems have limited efficiencies, high operating costs, and environmental effects. Sustainable energy systems are expected to minimize the environmental impact during their design and operation, to provide economically affordable energy to maximize their benefits to a large population and help mitigate emissions to the environment. Based on the above, the Frontiers in Energy Research Journal agreed to host a Research Topic about Recent Developments in Energy Conversion Systems. This Research Topic collects articles that examine research and development towards achieving sustainable energy conversion systems. Nearly 29 papers have been submitted to this Research Topic, and 10 have been finally accepted, including 4 original research papers and 6 review papers. This Research Topic received very positive and supportive responses from various stakeholders globally. Since it began in 2022, there were 22,020 total views; 21,001 article views; 4,428 article downloads, 1,019 Research Topic views as of 30 January 2024. Ten articles published within this Research Topic can be found at: https://www.frontiersin.org/research-topics/39922/recent-development-in-energy-conversion-systems.

The first paper on this Research Topic was by Ogbonna et al. The review study centres on piezoelectric materials to better understand the properties of different piezoelectric materials (ceramic) when placed under mechanical stress or vibration and electrical field during energy harvesting using transducer devices. The study concludes that lead-free piezoelectric materials, such as zinc oxide and barium titanate, remain the best conducive piezoelectric material over lead zirconate titanate, which affects the human environment due to its toxicity.

The second paper on this Research Topic by Alao et al. carries out a comprehensive review on the utilization of green inhibitors as a sustainable corrosion control method for steel in the energy (oil and gas) industries. This study elaborates on the inhibitory mechanism of organic inhibitors, mainly plant extracts, amino acids, drugs, and biomass waste. The study reveals that the phytochemicals generated from plant derivatives, the amino group (NH_2) present in the molecular structure of amino groups and drugs' molecular weights, and the shielding effect of biomass wastes are the major inhibitory properties of these organic inhibitors against corrosion. It was observed that some organic inhibitors could thrive under any circumstances (temperatures, pressure, and other parameters), whereas others may not sustain their inhibition at specific parameters. Therefore, the study concludes that judicious parameters should be considered before selecting and using any organic inhibitor as a corrosion inhibitor for different pipeline steel.

The third paper is by (Awelewa et al.). The authors present a hybrid estimator that combines the extended Kalman filter (EKF) and sliding mode observer (SMO) via a switching function and tracking closed loop to achieve the qualities of noise cancellation and disturbance rejection. The study demonstrates the quality of the hybrid technique in estimating multi-cell lithium-ion batteries. It offers more research opportunities to design adaptive estimators for complex disturbances from other battery types.

The fourth paper on this Research Topic by Babayomi et al. reviews renewable off-grid mini-grids in Sub-Saharan Africa. The study evaluates the current status of the level of deployment of off-grid mini-grids. Multi-criteria decision-making models were considered for optimizing engineering, economics, and management interests in mini-grid siting and design in Sub-Saharan Africa (SSA). It covers current research and technological developments, policy tariffs, design techniques, and energy justice in SSA's off-grid mini-grids. The review indicates that solar PV is the most common and easiest renewable to deploy for mini-grids in SSA.

Alabi et al. review "Materials for Electrocatalysts in Proton Exchange Membrane Fuel Cell". This review study highlights recent research efforts to replace platinum and carbon support with other cost-effective and durable materials in proton exchange membrane fuel cell electrocatalysts. Overview of promising materials such as alloy-based (binary, ternary, quaternary and high-entropy alloys), single atom and metal-free electrocatalysts were discussed, as the research areas are still in their infancy and have many open questions that need to be answered to gain insight into their intrinsic requirements that will inform the recommendation for outlook in selecting them as electrocatalysts for oxygen reduction reaction in proton exchange membrane fuel cell.

"Flexible Dielectric Polymer Nanocomposites with Improved Thermal Energy Management for Energy-Power Applications" is authored by Uyor et al. The study investigates the poor thermal energy management and low energy density of poly (vinylidene fluoride) (PVDF) while maintaining its flexible property using low content of hybrid carbon nanotubes (CNTs–0.05wt%, 0.1wt%) and boron nitride (BN–5wt%, 10wt %) nano-reinforcements. It was noted that adding the CNTs and BN to the PVDF matrix improved its melting and crystallization temperatures, enhancing thermal properties. This was attributed to the high thermal energy required to decompose the bond between the polymer matrix and the nanoparticles. Therefore, the polymer dielectric nanocomposites developed in this study can find advanced applications in the energy-power sector owing to their enhanced performances.

In "Functional Materials for Solar Thermophotovoltaic Devices in Energy Conversion Applications: A Review", Dada et al. conduct a thorough investigation of solar thermophotovoltaic devices and the high-tech materials used in solar thermophotovoltaic systems as a solution to the conversion challenges encountered in conventional conversion methods. The study reveals that nanomaterials as advanced functional materials can enhance the efficiency of solar thermophotovoltaic devices.

The eighth paper on this Research Topic by Dada and Popoola is on high-entropy nanomaterials for energy storage and catalysis applications. The paper discusses the production of high entropy alloy nanoparticles (HE-NPs) and the impact of synthesis on the structure of the resulting nanomaterial for newly emerging components like HEA-NPs. The study reveals that the linkages between synthesis, structure, and property are essential for creating HEA-NP-based applications for energy storage applications, requiring the creation of a fundamental protocol to enable their mass manufacture and efficiency in service. Moreover, the study presents a straightforward review of high entropy alloys, recent advances in high entropy nanoparticles and their various syntheses for energy and catalysis applications.

Attabo et al. present "Assessment of the Wind Energy Potential and Economic Viability of Selected Sites Along Nigeria's Coastal and Offshore Locations". The wind energy potential and the economic viability of using wind turbines to generate electricity in some selected sites along Nigeria's coastline and offshore locations were evaluated. Using the statistical two-parameter Weibull probability density function method, wind speed data retrieved from an indigenous oceanography company and global information system (GIS) were analyzed for wind energy harvest. The energy output, unit cost of electricity generated by three commercially available wind turbine models (3 MW, 4 MW, and 6 MW), net present value (NPV), and payback period were evaluated. Levelized cost of electricity (LCOE) sensitivity to the discount rate, foundation cost, and turbine lifespan were also examined. The study reveals that the offshore sites have four times greater wind power potential than the coastal sites. It is also noted that discount rates and foundation cost reductions positively affect the LCOE.

The last article on this Research Topic, "Optimal design and control of permanent magnet assisted dual rotor motor" is authored by Kong et al. They examine a method to reduce the cogging torque

of the permanent magnet rotor of the permanent magnet-assisted double rotor motor. By analyzing the motor power equation, it is concluded that the pole arc coefficient, the magnetic steel's thickness, the air gap's length, and the stator's slot width have four influences on the teeth's rotor. For the parameters of the slot torque, the upper and lower limits of the parameter value are obtained according to the size of the motor. The study further designs a fuzzy controller based on granular functions, and the fuzzy rules of the fuzzy controller are to perform feature sampling and fit the response function, eliminating fuzzification and defuzzification, improve the response speed of fuzzy control, and simplifying the control system.

In summary, the collective knowledge and research on this Research Topic provide valuable insights and motivation for ongoing endeavours toward a more sustainable and energy-efficient future.

Author contributions

SO: Conceptualization, Methodology, Supervision, Writing–original draft, Writing–review and editing. FA: Investigation, Project administration, Writing–original draft, Writing–review and editing. OA: Investigation, Methodology, Writing–original draft, Writing–review and editing. OS: Investigation, Methodology, Writing–original draft. D-AB-T: Methodology, Writing–original draft, Writing–review and editing. AP: Investigation, Supervision, Writing–original draft, Writing–review and editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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