frontiers | Frontiers in Energy Research

TYPE Editorial
PUBLISHED 15 August 2024
DOI 10.3389/fenrg.2024.1456450

OPEN ACCESS

EDITED AND REVIEWED BY
Ellen B. Stechel,
Arizona State University, United States

*CORRESPONDENCE
Salman Ajib,
salman.ajib@th-owl.de

RECEIVED 28 June 2024
ACCEPTED 24 July 2024
PUBLISHED 15 August 2024

CITATION
Ajib S, Alahmer A, Rezk H and Alamayreh MI (2024) Editorial: Advancements and future directions in process design for sustainable energy systems.
Front. Energy Res. 12:1456450.
doi: 10.3389/fenrg.2024.1456450

Editorial: Advancements and future directions in process design for sustainable energy systems

Salman Ajib[1]*, Ali Alahmer[2], Hegazy Rezk[3,4] and Malik I. Alamayreh[5]

[1]Department Renewable Energies and Decentralized Energy Supplying, Technische Hochschule Ostwestfalen-Lippe, Faculty of Umweltingenieurwesen und Angewandte Informatik, Lemgo, Germany, [2]Department of Mechanical Engineering, Tuskegee University, Tuskegee, AL, United States, [3]Department of Electrical Engineering, College of Engineering in Wadi Alddawasir, Prince Sattam Bin Abdulaziz University, Al-Kharj, Saudi Arabia, [4]Department of Electrical Engineering, Faculty of Engineering, Minia University, Minya, Egypt, [5]Department of the Alternative Energy Technology, Faculty of Engineering and Technology, Al-Zaytoonah University, Amman, Jordan

KEYWORDS

optimisation, energy efficiency, energy management, renewable energy systems, MATLAB

Editorial on the Research Topic
Advancements and future directions in process design for sustainable energy systems

1 Introduction

The process design and optimization play a critical role in the development and implementation of sustainable energy systems. It entails the systematic identification, optimization, and integration of various components, technologies, and processes to achieve efficient and environmentally friendly energy production and utilization. The primary objective of process design for sustainable energy systems is to minimize resource consumption, reduce emissions, and maximize overall system performance. The specific objectives can be summerised as follows:

- Presenting research outcomes from multidisciplinary fields, especially through optimizing the process for Sustainable Energy Systems.
- Updating the current state of research in the field based on the special Research Topic.
- Summarizing the findings from the papers reviewed.
- Identifying the future directions for new development.

2 Contributions

In the framework of this special Research Topic, we have received six full papers. All these passed a peer **review**. However, two of these papers were deemed unsuitable for publication within the context of this Research Topic.

The four accepted papers that were received underwent peer review and successfully passed the evaluation process. These papers include:

Motab Turki Almousa et al. (Original research):"*Optimized Equivalent Consumption Minimization Strategy-based Artificial Hummingbird Algorithm for Electric Vehicles*";

In this reserch work, the authors investigated the influence of the energy management strategy (EMS) on the energy efficiency and environmental sustainability of fuel-cell hybrid electric vehicles (FCHEVs). The proposed EMS introduces an integration between the equivalent consumption minimization strategy (ECMS) and the Artificial Hummingbird Algorithm (AHA). The findings demonstrate that the proposed EMS surpasses other optimizers in reducing fuel consumption, potentially achieving a 48.62% reduction, while also enhancing overall system efficiency by 15.45%.

Radwan A. Almasri et. al. (Review): "*A State-of-the-Art Review of Energy-Efficient and Renewable Energy Systems in Higher Education Facilities*";

In this review, the authors analyze the energy demands and increasing environmental concerns within educational institutions. This comprehensive review summarizes the complex relationship between Energy Efficiency and Renewable Energy Systems (EERES) within the sphere of educational institutions. A notable aspect of this research is the innovative correlation drawn between energy consumption metrics and the comfort levels experienced in university environments throughout both summer and winter seasons.

Beyond technical intricacies, this study scrutinizes the economic feasibility, environmental advantages, and educational significance of these integrated systems. Various factors, including the institution's category, energy source, facility nature, building construction, internal activities, weather conditions, and user behavior, significantly impact energy usage. This study offers a nuanced exploration, shedding light not only on the technical dimensions but also on the broader economic, environmental, and educational implications associated with the adoption of EERES.

Mikhail A. Gorkavyy et.al. (Brief research report):"*Automated method based on a neural network model for searching energy efficient complex movement trajectories of industrial robot in a differentiated technological process*";

In this study, the authors have examined the possibility of developing a method to enhance the energy efficiency of a diverse robotic technological process (RTP) in the food industry. The proposed approach is based on principles of object-oriented design and the potential for categorizing RTP. By synthesizing energy consumption models of robots within varied RTP scenarios, such as load stacking, in a simplified format, neural network techniques were employed to identify nonlinear relationships. The training dataset for intelligent modules was established using traditional experimental planning algorithms. The synthesis of methods, models and procedures was implemented on the basis of high level programming languages C++ and MATLAB. As a result, a mathematical model and automated algorithms for its synthesis were introduced, enabling the adjustment of the RTP simulation model to accommodate its specific characteristics and the implementation of a method to determine the optimal operational parameters. The effectiveness of this proposed solution, including the neural network model and optimization technique, was validated through practical application on real RTP systems, with an assessment of the economic benefits of the proposed approach.

In conclusion, the adoption of this methodology has the potential to significantly reduce energy costs associated with robotic operations in the food industry.

Aamir Ali, et.al. (Original research):"*Optimal Site and Size of FACTS Devices with the Integration of Uncertain Wind Generation on a Solution of Stochastic Multi-Objective Optimal Power Flow Problem*";

In this study, the authors investigate the impact of integrating wind energy on the stability and controllability of AC Transmission Systems. The components of the power system can enhance controllability, effectiveness, stability, and sustainability of energy supply. The introduction of uncertainty and variability by Flexible AC Transmission Systems (FACTS) devices and wind generation poses challenges in addressing multi-objective optimal power flow (MOOPF) problems effectively. In order to demonstrate the best combination of control and state variables for the MOOPF problem, the authors present three scenarios involving competing objective functions. These scenarios include minimizing the total power production cost, considering the cost of wind generation, emission rates, and power loss due to transmission lines. The optimization of the power system is conducted under both fixed and variable load conditions in the case studies. The proposed algorithm is tested across three distinct scenarios with varying objective functions. In Case 1, the algorithm achieved an expected cost of $833.014 per hour and an emission rate of 0.665 tons per hour from conventional thermal generators. In Case 2, the algorithm resulted in a minimum cost of $731.419 per hour for active power generation, with a power loss cost of $124.498 per hour. In Case 3, the algorithm simultaneously minimized three objective functions, resulting in costs of $806.6 per hour for emissions, 0.647 tons per hour for emissions, and $214.9 per hour for power loss.

In conclusion, these four accepted papers significantly contribute to the research goal by exploring innovative approaches, technologies, and strategies to enhance energy efficiency, reduce emissions, and optimize sustainable energy systems. Each paper provides valuable insights and solutions that align with the overarching objective of sustainable energy production and utilization through process design and optimization. Specifically, Motab Turki Almousa et al. investigated the impact of the energy management strategy (EMS) on the energy efficiency and environmental sustainability of fuel-cell hybrid electric vehicles (FCHEVs). Building on the theme of energy efficiency, Radwan A. Almasri et. al. conducted a comprehensive review of energy-efficient and renewable energy systems in higher education facilities. By exploring the relationship between energy consumption metrics, comfort levels, economic feasibility, and environmental benefits of Energy

Efficiency and Renewable Energy Systems (EERES) in educational institutions, this paper contributes to a broader understanding of sustainable energy utilization. Extending the discussion to industrial applications, Mikhail A. Gorkavyy et.al. developed an automated method based on a neural network model to search for energy-efficient complex movement trajectories of industrial robots in the food industry. This study highlights the importance of automation and advanced modeling in achieving energy efficiency. Finally, Aamir Ali, et.al. investigated the integration of uncertain wind generation on the stability and controllability of AC Transmission Systems using Flexible AC Transmission Systems (FACTS) devices. By addressing multi-objective optimal power flow (MOOPF) problems under varying load conditions, the authors optimize power system components to enhance controllability, effectiveness, stability, and sustainability of energy supply. Together, these studies offer a comprehensive view of the advancements in sustainable energy systems across different sectors and applications.

3 Conclusion

This Research Topic compiles original research, reviews and research reports in the field of Process Design and Optimization for Sustainable Energy Systems. The contributions within this topic emphasize the significance of this Research Topic, the challenges that need to be addressed, and the necessity for further research to tackle globale climatic issues while considering the energetic, economic, and environmental aspects.

In the context of fuel-cell hybrid electric vehicles (FCHEVs), the implementation of an energy management system plays a pivotal role in reducing fuel consumption and enhancing the overall efficiency of FCHEVs. This innovative energy management system combines the equivalent consumption minimization strategy (ECMS) with the Artificial Hummingbird Algorithm (AHA), leading to an improvement in the overall system efficiency.

In Higher Education Facilities, energy efficiency (EE) and renewable energy systems (RES) are crucial for universities to reduce their environmental impact, foster sustainable, and work towards a low-carbon energy system. The correlation between maintaining comfortable temperatures and energy consumption in main campus buildings and dormitories is significant. By leveraging Energy-Efficient and Renewable Energy Systems (EERES), universities can reduce energy usage, decrease emissions, and advance sustainability in educational settings.

In the domain of Energy-Efficient Robot Movements in food manufacturing, Neural Networks for Optimization are utilized to determine energy-efficient movement paths for industrial robots. This approach leads to substantial reductions in energy costs compared to conventional methods, thereby accelerating the payoff period and enhancing energy savings, particularly beneficial for continuous production lines.

Regarding wind energy generation, optimizing power flow in power systems integrating wind energy poses challenges due to its variability and uncertainty. However, leveraging Flexible AC Transmission Systems (FACTS) can enhance controllability, stability, and efficiency in power delivery. By employing effective optimization algorithms, cost-effective solutions have been identified for power generation, emissions, and power loss reduction under both fixed and variable load conditions.

In the broader context of sustainable energy systems, the integration of process design and optimization methodologies is essential for addressing the complex challenges posed by global climate issues. The research presented in this Research Topic emphasis the critical need to balance energetic, economic, and environmental considerations in the development and implementation of sustainable energy solutions. By focusing on innovative approaches, such as the integration of advanced algorithms, neural networks, and energy management strategies, the accepted papers highlight the potential for significant advancements in energy efficiency, emissions reduction, and overall system performance.

The findings from these studies not only contribute to the existing body of knowledge in sustainable energy but also highlight the importance of continuous research and development efforts to drive progress towards a more sustainable and environmentally conscious energy landscape. As we navigate the transition towards a low-carbon future, the insights and solutions presented in this Research Topic serve as valuable stepping stones towards achieving a more sustainable and resilient energy infrastructure that can meet the challenges of the 21st century.

Author contributions

SA: Conceptualization, Writing–original draft. AA: Methodology, Writing–review and editing. HR: Methodology, Writing–review and editing. MA: Formal Analysis, Writing–review and editing.

Funding

The author(s) declare that no financial support was received for the research, authorship, and/or publication of this article.

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.

Publisher's note