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Editorial

Energy and Exergy Analysis of Renewable Energy Conversion Systems

Audrius Bagdanavicius

School of Engineering, University of Leicester, Leicester LE1 7RH, UK; ab746@leicester.ac.uk

Rising climate change issues are prompting engineers and scientists to focus more on improving renewable energy conversion systems. Various methods can be used to study and evaluate these systems. In addition, the complexity of some renewable energy conversion systems requires more sophisticated control methods. Therefore, the purpose of the Special Issue, titled "Energy and Exergy Analysis of Renewable Energy Conversion Systems", in *Energies* was to create a platform for scientists to publish original research papers on the development and application of various analysis methods, and to present research on how to improve the controllability and efficiency of renewable energy conversion systems and devices.

Exergy-based thermodynamic analysis methods were used in several studies to investigate energy conversion processes and thermal energy supply systems. In a study by Leon et al. [1], thermodynamic analysis of two processes of vegetable oil conversion to biodiesel was conducted. The authors proposed the use of solar energy in the biodiesel production process to supplement the energy demand. Using exergy analysis, the system's components where the exergy destruction occurred were identified. The study showed that exergy-based methods are very useful for analysing different biodiesel production processes. The exergy-based approach allows different production methods to be compared and provides additional information to system designers, who can then make decisions on how to improve the production process.

In a study conducted by Ozcan et al. [2], advanced exergy analysis was used to investigate district heating (DH) systems connected to different waste heat sources. The authors demonstrated that by using advanced exergy analysis, additional information on avoidable, unavoidable, endogenous, and exogenous parts of exergy destruction in the components of the DH system could be obtained. Splitting exergy destruction into different elements allows system designers to better understand the nature of exergy destruction. For example, the results of the study showed that in DH systems, connected to different waste heat sources, the share of avoidable and unavoidable exergy destruction parts in heat exchangers differed, while it was almost constant in pumps. This information, and the results of advanced exergy analysis in general, could be used to design and optimise DH networks connected to different waste heat sources under different climatic conditions.

A completely different method of analysis of energy conversion system components, based on endoreversible thermodynamics, was applied by Paul and Hoffmann [3]. In this study, a new model of regenerator, as an integral part of a Stirling engine or any other energy conversion system with a regenerator that could be used as a renewable energy conversion device, was presented. Three variants of the endoreversible regenerator model were introduced. The proposed model simplifies the analysis of non-equilibrium thermodynamic systems and can be used to solve optimisation problems associated with renewable energy conversion systems with regenerators using endoreversible thermodynamics methods.

Two research studies published in this Special Issue focused on the control and energy management of micro-grids connected to renewable energy sources. In a study by Azuara-Grande et al. [4], two energy management strategies for a hybrid micro-grid, consisting of a diesel generator, PV, and battery storage, were proposed and investigated. The authors

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concluded that the choice of energy management strategy depended on the micro-grid specification. For greater reliability, an energy management strategy that minimises diesel power generation, maximises solar power generation, and charges battery storage only with excess power should be used. However, an optimal energy management strategy, which focused on the improved utilisation of the battery energy storage system, is more appropriate if energy consumption is the priority.

In a study conducted by Nassar et al. [5], offshore floating energy units composed of wind, tidal, and solar energy conversion systems combined with battery storage were investigated. A new control method was proposed and analysed to accurately regulate the voltage and minimise the circulating current between floating energy units, connected to a low-voltage direct-current (LVDC) micro-grid. Simulation results showed good dynamic performance of the proposed control method, which can also be used for most offshore and onshore LVDC micro-grids.

Two papers were devoted to analysing renewable energy conversion devices. A study on the optimisation of mono-crystalline silicone solar cells was carried out by Thirunavukkarasu et al. [6]. In this study, the influence of some parameters, such as wafer thickness, doping concentration, and doping levels, on the efficiency of the solar cell was investigated using the PC1D simulations tool.

In another paper, the design of a hybrid excited flux-switching Vernier machine was presented by Diab et al. [7]. An important feature of Vernier machines is their suitability for low-speed and high-torque applications. The research team designed, manufactured, and tested a permanent magnet generator for marine renewable energy conversion. This research is ongoing and, in the future, the authors plan to present more results that provide information on the performance of the machine under load conditions.

Seven research papers were published on various issues of the analysis and control of renewable energy conversion systems. We thank all the authors and reviewers who contributed to this Special Issue and hope that readers will be interested in learning about the latest developments in the field of renewable energy conversion systems.

Conflicts of Interest: The author declares no conflict of interest.

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