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Editorial

Energy Efficiency, Low Carbon Resources and Renewable Technology

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1. Introduction

Low carbon and renewable energy technologies help reduce the emissions of carbon dioxide and other greenhouse gases, which cause climate change [1,2]. With advancements in research and development into this area, the potential for energy saving in both hot and cold climates is ever increasing [3]. This editorial communicates and disseminates interesting and innovative research in the fields of energy efficiency, low carbon resources and renewable technology that were contributed to this Special Issue. The aim of this Special Issue was to provide a platform to share knowledge, innovative ideas and approaches, solutions and new technologies in tackling the energy supply and demand challenges to support the transition to a low carbon and sustainable future. Research involving high performance low-carbon resources, the current state-of-the-art solar PV and other renewable technologies and their applications, energy efficiency of renewable systems, intelligent approaches for supply-demand balance, experimental and simulation studies, modelling and optimisation and case study dissemination relating to the scope of the journal were highly encouraged.

As Guest Editors of this Special Issue, we were able to determine that research into the field of renewable energy technologies in encouraging low carbon environments is diverse and multidisciplinary in nature, and it is widespread among scientists and scholars. The articles which were submitted, as well as the ones finally selected to be published, cover a broad range of thematic areas ranging from the science and technology of renewable systems, social analysis and renewable technologies within a global climate.

2. A Short Review of the Contributions Published

In this section, we provide a summary of the contributions made by the scientific community towards the theme of this Special Issue.

Ref. [4] carried out an investigation on determining the heat transfer coefficient (HTC) of a heat pipe heat exchanger (HPHE) while being installed as a cooling mechanism on photovoltaic panels. The study was carried out at the University of Technology and Applied Sciences in Muscat, Oman. The experimental work monitored the effect of temperature variations on PV-HPHE-induced power generation. The heat pipes were arranged in a double-sided condenser in a spanwise manner with a spacing of 50 mm in the center with an inclination angle of 3°. J-type thermocouples (exposed wire and polytetrafluoroethylene (PTFE) insulated) with a tip diameter of 1.5 mm were used. The results indicated the mean value of HTC that was measured at 2.346 W/m^2 K. The findings showed that the HTC values possessed a minimal standard error from the effect of variations of the ambient temperature. The mean HTC value of 2.346 W/m^2 K can be used in the succeeding experiments using the same novel PV-HPHE setup. Additional results showed the recorded variations from the mean value of the HTC effect on the HPHE heat flow generation, which resulted in a 29% increase in power performance efficiency using PV-HPHE.

Ref. [5] carried out a performance analysis study of a solar cooling system with equal and unequal adsorption and desorption operating times. This investigation examined the impact of adopting unequal adsorption/desorption times on the entire cooling performance of solar adsorption systems. A cooling system with silica gel–water as an adsorbent–adsorbate pair has been built and tested under the climatic conditions of Iraq. A mathematical model was established to predict the system's performance, and the results were successfully validated via experimental findings. The results showed that the system can be operational at unequal adsorption/desorption times. The performance of the system with equal time is almost twice that of the unequal one. The roles of adsorption velocity, adsorption capacity, overall heat transfer coefficient and the performance of the cooling system were further evaluated.

Ref. [6] investigated the sensitivity of reservoir and operational parameters on the energy extraction performance of combined CO_2, enhanced gas recovery (EGR) and CO_2-plume geothermal (CPG) systems. The authors carried out simulations to evaluate the sensitivity of natural gas recovery, pressure build-up and geothermal power generation performances of the combined CO_2-EGR–CPG system relative to key reservoir (horizontal permeability, permeability anisotropy, reservoir temperature and pore-size-distribution index) and operational (wellbore diameter and ambient surface temperature) parameters. Using a natural gas reservoir model, the authors also investigated the effects of different strategies of transitioning from the CO_2-EGR stage to the CPG stage on the energy-recovery performance metrics and on the two-phase fluid-flow regime in the production well. The simulation results showed that there was an overlap of CO_2-EGR and CPG stages and there was a relatively brief period of CO_2 injection, but no production achieved the best overall energy (natural gas and geothermal) recovery performance. Permeability anisotropy and reservoir temperatures were the parameters that the natural gas recovery performance of the combined system was most sensitive to. The geothermal power generation performance was most sensitive to the reservoir's temperature and the production wellbore's diameter. The results of this study pave the way for future CPG-based geothermal power-generation optimization studies. For a CO_2-EGR–CPG project, the results can be a guide in terms of the required accuracy of the reservoir parameters during exploration and data acquisition.

Ref. [7] presented a detailed study on data-driven virtual inertia control methods for doubly fed induction generator (DFIG)-based wind turbines to provide inertia support in the presence of frequency events. The Markov parameters of the system were first obtained by monitoring the grid frequency and system's operation state. A data-driven state observer was developed to evaluate the state vector of the optimal controller. Furthermore, the optimal controller of the inertia emulation system was developed by using a closed solution of the differential Riccati equation. Moreover, a differential Riccati equation with self-correction capability was developed to enhance the anti-noise ability to reject noise interference in frequency measurement process. Simulation verifications were performed using Matlab/Simulink to validate the effectiveness of the proposed control strategy. Simulation results showed that the proposed virtual inertia controller can adaptively tune control parameters online to provide transient inertia supports for the power grid by releasing the kinetic energy and to improve the robustness and anti-interference ability of the control system of the wind power system.

Ref. [8] presented a review of degradation factors for both conventional monofacial and state-of-the-art bifacial photovoltaic modules in order to highlight how the current and voltage characteristics of these technologies are affected by degradation. Microcracking, encapsulant discoloration and light induced degradation seem to have similar effects on both modules. Contrarily, bifacial modules were prone to potential-induced degradation as electromagnetic shielding is affected by bifaciality. Bifacial devices were less affected by light and elevated temperature-induced degradation. The degradation (1.3%) is similar for both technologies up to 40 kWh/m^2 of solar radiation. Above this value, monofacial degradation increases faster, reaching values of 7%. For tilted systems, the front side soiling degradation of 0.30% per day was found to be similar for both technologies. The study concluded that, for vertical systems, the soiling loss for bifacial devices was considerably lower with values of 0.02% per day.

Ref. [9] researched into integrated power systems, building and transport sectors to determine its impact on net zero communities. A Net Zero Community (NZC) concept and its energy characteristics is an emerging topic with multiple variations in terms of scope and calculated methods, which complicates the quantification of its performance. This study covered three key barriers in achieving NZC targets: (1) the main focus of current definitions on buildings, disregarding community power systems and energy use in transportation; (2) different requirements (source, supply, metrics, etc.) in the existing definitions; and (3) lack of updated published reports to track the progress of committed NZC targets. This paper reviews the following: (1) variations in the existing definitions and criteria from peer-reviewed publications; (2) the latest climate projection models by policymakers for achieving net zero by 2050; (3) the literature on renewable-based power systems; and (4) three planned NZC cases in international locations in order to study their NZC targets, energy performance and challenges. The outcome highlights NZC design guidelines, including energy efficiency measures, electrification and renewables in PBT sectors that help stakeholders, including policymakers, developers, designers and engineers, speed up the achievement of NZC targets.

3. Conclusions

The challenges relative to achieving a carbon neutral future are vast and, therefore, presents a plethora of opportunities for scholars and scientists to improve the performance and efficiencies of renewable energy technologies. This is evident from the submissions of this Special Issue, which examined a variety of such systems including solar (thermal, photovoltaics and cooling), combined CO_2, natural gas recovery and CO_2-plume geothermal power generation of reservoirs; novel data-driven virtual inertia emulation methods for wind turbines; and net zero communities. As reflected by the content in this Special Issue, the ingenuity and commitment among members of the scientific community have proven to be driven and committed to meet the challenges by conducting high-quality research and disseminating knowledge into practice.

Conflicts of Interest: The authors declare no conflict of interest.

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