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Editorial

Special Issue: New Developments and Prospects in Clean and Renewable Energies

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1. Introduction

The world is facing ongoing and emerging energy challenges such as energy poverty for ~25% of the world's population, limited fossil fuel resources, and the global environmental crisis [1,2]. To overcome or at least address these challenges, it is essential to explore and implement effective, cost-competitive, and practical solutions or alternatives. The worldwide energy demand is dramatically increasing for a variety of reasons, the two most important being population growth and increasing living standards requiring greater energy inputs [1,3]. Clean, renewable, and eco-friendly energy sources (e.g., solar, wind, geothermal, biofuel, hydro) can not only help us to meet global energy needs, but also reduce the negative consequences of climate change (CC), mitigate the threat of global warming, and achieve sustainable development.

The current Special Issue aims to fill knowledge gaps and help develop technologies related to clean, sustainable, and renewable energy (RE) systems (both stand-alone and hybrid). Of the eight articles submitted, five were accepted for publication after the peer-review process, an acceptance rate of ~62.5%. In the subsequent section, concise descriptions of the published articles can be found, which collectively address a variety of pivotal topics and applications within the field of clean and REs.

2. Summary of Published Articles

Offshore RE is vital for sustainable energy systems, but like onshore RE, it faces fluctuation and intermittency. Energy storage is a potential solution, but existing onshore technologies are not suitable for the harsh marine environment. Novel offshore energy storage concepts, including underwater compressed gas energy storage (UWCGES), have emerged. The first study in this SI comprehensively reviews UWCGES, encompassing its status, challenges, and future prospects. Wang et al.'s [4] review paper summarizes recent academic and industrial advancements. Challenges are explored from technical, economic, environmental, and policy perspectives, while potential UWCGES applications are briefly assessed.

UWCGES is a promising energy storage solution for offshore platforms, RE farms, islands, and coastal cities. However, a notable challenge is the accumulation of liquid in underwater gas pipelines, leading to blockages, energy transmission interruptions, and operational issues. Chengyu et al. [5] conducted an experiment focusing on liquid accumulation pressure distribution in hilly terrain under zero net liquid flow (ZNLF) conditions. They established and validated a slug flow pressure model with various inclination angles and determined a mapping relation between slug flow and pressure through motion imaging and pressure detection. These findings contribute to the advancement of UWCGES technology.

Kalús et al. [6] investigated building components with energy-active elements. The aim of this research is to evaluate the application of energy (solar) roofs, ground heat

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storage and active thermal protection in their cooperation. Different modes of operation of the energy systems were experimentally verified with emphasis on the use of RE sources and waste heat. The research methodology is focused on the analysis and synthesis of the current state of knowledge in the field, inductive and analogical forms of the development of innovative modes of operation of combined building-energy systems, the development of innovative variants of building envelope panels with integrated energy-active elements, and synthesis of the knowledge obtained from the scientific analysis. The obtained data were transformed into the design and implementation of the prototype of the prefabricated house IDA I (Bratislava, Slovakia), the experimental family house EB2020 (Tomášov, Slovakia) and the mobile laboratory—simulator and optimizer of intelligent compact devices (Modra, Slovakia). The authors are currently building a test cell for research on thermal insulation panels with integrated active thermal protection. The results of the theoretical analysis of building structures with active thermal protection show their energy potential and functionality, e.g., thermal barrier, heating/cooling, heat storage, etc. Based on the implementation of experimental buildings, new technical solutions for envelopes with controlled heat transfer were proposed. The novelty of their research lies in the design of different variants of the mode of operation of energy systems using RE sources and in the retrofitting of building envelopes with integrated energy-active elements.

Moriarty and Honnery [7] showed the importance of considering all sustainability challenges Earth faces, not just CC, when evaluating how energy should be used in the future. The rise of multiple global environmental challenges makes the search for solutions more difficult, because all technological solutions give rise to some unwanted environmental effects. Further, not only must these various problems be solved in the same short time frame, but they will need to be tackled in a time of rising international tensions, with steady global population increase. This review looked particularly at how all these environmental problems impact the future prospects for RE, given that RE growth must not exacerbate the other equally urgent problems, but must make a major difference in a decade or so.

Their key finding is that, while the world must shift to RE in the longer run, in the short term, what is more important is to improve Earth's ecological sustainability by the most effective means possible. The authors showed, using the transport and agricultural sectors as examples, that non-CC challenges were often more serious. Hence, emphasis needs to shift from improving technical measures such as the energy efficiency of transport (as measured using pass km or tonne km per primary MJ), or agricultural output (as measured by tonnes per primary GJ). Reducing both the global transport tasks and agricultural production (while still providing an adequate diet for all) can be far more effective than converting the energy used in these sectors to RE.

Garcia-Gutierrez et al. [8] introduced an innovative method to cluster solar radiation stations using static and dynamic parameters by employing multi-criteria analysis for easier solar resource forecasting. The innovation stems from characterizing solar irradiation both quantitatively and qualitatively, including the variability of intermittent sources. The 76 Spanish stations are characterized initially by static parameters like mean, standard deviation, skewness, and kurtosis. Four clustering methods (hierarchical, k-means, k-medoids, and spectral cluster) group areas with similar solar irradiation traits at thirty-minute intervals. The results show that hierarchical clustering closely aligns with Köppen classification for both scenarios (five and three classes). Performance evaluation indicated little benefit in simultaneous implementation of k-means and spectral clustering, as the results are over 90% similar for three and five classes. The recommendations favor using k-means or hierarchical clustering based on mean, Hurst exponent, and forecastability parameters for effective solar radiation clustering.

3. Future Research Need

While submissions for this Special Issue are no longer being accepted, the demand for continued in-depth research and development in the realm of clean and REs and systems, whether as stand-alone solutions or in hybrid configurations, remains pertinent. Given the

unique attributes of renewable energies—characterized by their local availability, potential consistency, resilience, minimal greenhouse gas (GHG) emissions, and long-term viability—there is a strong anticipation that renewable and sustainable energy sources will assume a more significant role in shaping the future of the global energy landscape.

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

Abbreviations

CC	Climate change
GHG	Greenhouse gas
ZNLF	Zero net liquid flow
RE	Renewable energy
UWCGES	Underwater compressed gas energy storage

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