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Editorial

Energy Context: Analysis of Selected Studies and Future Research Developments

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Citation: Morea, D.; El Mehtedi, M.; Buonadonna, P. Energy Context: Analysis of Selected Studies and Future Research Developments. *Energies* **2023**, *16*, 1423. https://doi.org/10.3390/en16031423

Received: 7 January 2023
Accepted: 29 January 2023
Published: 1 February 2023

1. Introduction

Energy context has been the subject of a great deal of research from different perspectives, including, but not limited to: energy transition, renewable energy, nuclear power, energy saving, energy use, energy level, energy trade, energy security, traction energy, energy communities, energy poverty, Energy Performance Contracting (EPC), climate change, climate policy, and climate sustainability [1–30].

New research opportunities in the energy sector, based on an examination of previous studies, can be defined.

To this end, the aim of this Editorial is to analyze selected studies on energy context and then to outline future research directions.

The remaining sections are organized as follows: Section 2 examines some studies in the energy field and Section 3 defines possible future research developments.

2. Research Analysis in the Context of Energy

In the energy field, many studies have been carried out: a select number are analyzed below.

Connolly et al. [1] evaluated future global warming from CO_2, CH_4, and N_2O until 2100, derived from human activities and for Business As Usual (BAU) conditions. A semi-empirical approach was used, comparing the Global-Climate-Model-based evaluation with empirical evaluation. The results of the research highlighted the following:

- The 2015 Paris Agreement's target of keeping global warming (derived by human activities and for BAU situations) below 2.0 °C will be broken by the middle of the century with a climate sensitivity to greenhouse gases related to a Transient Climate Response (TCR) equal to 2.5 °C or an Equilibrium Climate Sensitivity (ECS) equal to 5.0 °C.
- The aforementioned target would not be broken (for BAU conditions) until the 22nd century or later if TCR < 1.5 °C or ECS < 2.0 °C.
- The current Intergovernmental Panel on Climate Change range evaluations for TCR of 1.0 to 2.5 °C and ECS of 1.5 to 4.5 °C have not yet determined if global warming derived by human activities is a 21st century problem.

Streimikiene et al. [2] reviewed the literature analyzing energy poverty and climate change mitigation in European Union (EU) households. They developed an integrated framework that addresses energy poverty, just carbon-free energy transition and climate change mitigation.

Martiniello et al. [3] studied the Public–Private Partnerships (PPP)–EPC deals, finding a solution to equally share benefits between public and private actors and to count them as off-balance by Public Administration (PA). Using the model of Carbonara and Pellegrino [4] to assess and benchmark the net benefit of different EPC structures, they found a contract structure that minimizes the difference of Net Present Value (NPV) gained by the contractual parties. Moreover, they tested the above contract structure on an Italian case study in the healthcare sector. The findings highlighted that a long-term PPP–EPC deal can have a mixed contractual structure where profit-sharing percentage changes during the contract's life, ensuring the same NPV to both public and private partners.

ÓhAiseadha et al. [5], in a review paper, considered the potential challenges and the environmental and socioeconomic impacts of major energy sources, both traditional and innovative. They found many concerns from the literature regarding the engineering feasibility and environmental impacts of wind and solar energy. Moreover, the technology advantages and disadvantages of technology should be considered by policy-makers in their decisions on energy policy.

Máté et al. [6] addressed, in Central European countries, food security and its relationship with energy use and climate change. Using multiple-factor analysis, they found that:

- Food affordability and accessibility are positively correlated with climate change, while food quality has a negative association with increasing temperature.
- Food affordability, accessibility, and quality can be achieved simultaneously with renewable energy resources.
- Inequalities pose grand challenges.
- Innovative local solutions (such as advances in agriculture systems, educational programs, and development of environmental technologies) are needed, with impacts on social and economic aspects.

Tcvetkov [7] reviewed the existing climate policy portfolios, focusing in particular on CO_2 utilization and disposal technologies as well as the evaluation of the role of hydrocarbon industries as the basis for the development of CO_2-based production chains. The findings of the analysis highlighted that:

(a) Climate investments on a limited portfolio of energy technologies could prevent global emission goals being achieved.
(b) The potential social effects of greenhouse gas (GHG) emission utilization should be considered when the same emissions are accounted to diversify climate strategies.
(c) Creative measures are needed for the hydrocarbon industries to implement environmental projects.
(d) The present cost of reducing CO_2 emissions surpasses the estimates of the social cost of carbon.

Mucha-Kus' et al. [8] analyzed the creation of Energy Communities from a regulatory and practical point of view. The results showed that their profitability is dependent on the nature and supply–demand profile of its members, and that there is the possibility of obtaining benefits within the cooperative both on the global and individual level.

Kopfmüller et al. [9] introduced an integrative approach to evaluating energy scenarios that combines socio-technical scenarios and a sustainability assessment tool to support energy system transitions.

Tutak et al. [10] ranked the sustainable energy development of the EU countries. They used 14 selected indicators representative of the main areas of EU energy policy and in line with the Agenda 2030 objectives. The entropy complex proportional assessment (COPRAS) hybrid method was used. The results of their research showed that EU energy and climate policy should consider the specificity of countries and groups and be devoted to those with comparable problems.

Pietrzak et al. [11] evaluated renewable energy (RE) in Poland, involving experts in the field. The researchers found the necessity of simplifying relevant legislation in Poland, the possibility of developing the wind and biomass sectors, and, finally, the need to educate about the use and obtainment of energy.

Morea et al. [12] analyzed the current state support mechanism incentive adopted by the Italian government in the wind sector. They performed a scenario analysis (Monte Carlo simulation) by varying the key variables of the investment. The results of the research showed that, with the current mechanism, the percentage of NPV with positive leverage is approximately equal to 70%.

Peña-Ramos et al. [13] assessed how the energy transition has influenced Spain's energy relations with other countries. The study showed minor differences in traditional relations with fossil fuel exporters, while the contractions in Spanish energy economic policy were major.

Akaev and Davydova [14] carried out a mathematical description of the upcoming energy transition. Using the performed mathematically oriented scenario, the consequent results highlighted a great energy transition with the Paris Agreement goals only being achieved by 2060.

Gierszewski et al. [15] presented an analysis of the future role of nuclear energy in Poland in the context of a low-carbon energy transition. A critical analysis of scientific sources and comparison of statistical data, as well as document analysis and comparative analysis, were used. The findings indicated the probable directions of the energy sector transformation in Poland in the next decade.

Morea and Poggi evaluated the technical, energy and economic feasibility of investment projects in the wind sector [16] and photovoltaic systems [17] using the Sukuk, an Islamic Finance instrument that prohibits interest rates as in conventional financial markets. The results of the study highlighted the importance of incentives and the applicability of the Sukuk instruments for sustainable investments in the sectors considered. The same findings have been confirmed by subsequent research [18].

Kuc-Czarnecka et al. [19] proposed a new approach to correct the sensitivity analysis of the Energy Transition Index (ETI) structure. The findings showed that the ETI is unbalanced and includes many variables of marginal importance for the final ranking.

Wang et al. [20], using the optimal control theory, found a cost-effective model to evaluate a long-term (to 2050) climate-resilient power generation mix for Taiwan. Moreover, by applying the Stochastic Impacts by Regression on Population, Affluence, and Technology (STIRPAT) approach, they forecasted the demand of electricity by 2050. The study showed the sources of different power generation were mixed, recommending the route of electricity saving by 2050.

Ryszawska et al. [21] recognized the factors of the co-creation process in renewable energy project activation in housing co-operatives. Applying the Dialogue, Access, Risk, Transparency (DART) model, the study showed that co-creation was most observable in the area of dialogue and communication between cooperative authorities and its members, while it was least noticeable in the area of transparency.

Morea et al. [22] evaluated the attainable amounts of savable energy in railway driving when using extensive coasting. Specifically, an algorithm was developed to evaluate the energy absorption of railway locomotives during normal service and validated on an Italian railway line (case study). The findings showed that the fast-run strategy, adopted by railway companies to recover from unexpected delays, can lead to a negligible time recovery with respect to the coasting strategy, while determining a significantly larger energy consumption.

Berdysheva and Ikonnikova [23] examined the evolution of the international network of energy flows for the period 2000–2018. The results provided insights into the energy transition and its effect on the international network of energy flows and energy security.

Some studies evaluated the dependence on government incentives of investment sustainability in the photovoltaic system [24] and wind sector [25], showing the importance of incentives to achieve so-called "grid-parity".

Other studies [26,27] evaluated the adoption of Light-Emitting Diodes (LEDs) to replace conventional lamps in the public-lighting systems of Rome, Italy. They calculated the possible savings of energy and costs and used both an economic–financial analysis and real-option analysis. The results of the research highlighted that the use of LED technology is economically recommended, and the economic value obtained from real-option analysis was higher than economic and financial analysis because the latter did not consider the flexibility and price volatility of the project.

Campisi et al. [28] evaluated, implementing the integrated renewable energy sources and using a multi-criteria analysis, the energy efficiency and reduction in the consumption of fossil fuels for the planning and renovation of single-family residential buildings in Italy. The findings underlined that the best solution concerned the installation of solar thermal panels combined with a heat pump.

Kochanek [29] presented two possible scenarios for the development of the Polish energy sector from the current national policy and international commitments of Poland. The findings highlighted that both scenarios would undertake overly slow development of renewable energy resources, and the unsure attitude of the Polish government towards zero-emission energy sources significantly delays the development of some of its forms.

Mrozowska et al. [30] analyzed the activities in the field of energy transition in Poland and evaluated the possibility of achieving, by 2050, the goals set in the European Green Deal. The system method and decision-making method were used. The results indicated the difficulty in reaching the effective implementation of the energy transition before 2050 due to political, economic, social, and technological conditions.

3. Possible Future Research Developments

Analysis of the selected studies has made it possible to define the following future research directions in the context of energy.

There is no evidence regarding the behaviors and attitudes of energy-poor households [2]. It is necessary to investigate them to address the main behavioral barriers of energy-vulnerable households and to develop suitable policies and measures.

The interpretation of the research results of Martiniello et al. [3] focus on a single case study. Further research could test the findings under different settings of energy savings and discount rate. Moreover, future research should also focus on more standardized contractual solutions for an optimal allocation of risks between partners, or aim to set up monitoring and control indicators which are useful to apply contractual penalties.

The model used by Carbonara and Pellegrino [4] does not consider the price elasticity effect on the amount of energy savings. If the energy price rises, measures to control the amount of energy usage might be adopted, and the energy cost savings might be less than the estimation carried out. Moreover, the variations of the three main EPC contracts scheme used could be considered. Finally, the risk borne by the parties in the different EPC structures could be better evaluated so as to make decisions on the basis of a fair allocation of rewards and risks.

Investing in climate adaptation can improve the ability of societies to deal with climate change and weather extremes [5]. Therefore, critical assessments of current policies to suggest efficient actions regarding global climate change expenditure could be addressed.

With reference to the study of Máté et al. [6], further studies could be carried out in crossway-dissimilar disciplines and theories: economic growth, circular economy, sustainability, resource management, and climate theories. The aim is to review and develop indicators that reflect the status of the planet as well as potential routes.

Some significant factors constraining the development of CO_2 utilization technologies are the following [7]:

- There are no clear estimations of how much CO_2 the technology could capture and what the price of this technology will be in the near future.
- The imperfection of the methodology for Social Cost of Carbon (SCC) evaluation and difficulty to define the social effects of CO_2 utilization.

Therefore, the development of new methods and approaches in this context will make it possible to shift the focus from unidirectional measures of solar and wind energy support to capture and utilization technologies.

The approach of Kopfmüller et al. [9] could be improved according to the indications highlighted in the conclusions section of the study.

Future research could also be developed on the barriers and difficulties of the co-creation process in energy projects, as well as the necessary conditions for co-creation at each stage of the project implementation.

The management strategy of Morea et al. [22] could be conducted as an experimental activity and could be implemented on board, collecting data from real-time tests in different traffic conditions.

Finally, the evolution of energy communities for individual fossil fuels could be analyzed to gain further understanding of coal-related developments, as well as the linkage between importer and exporter energy security.

Author Contributions: The authors contributed equally to this Editorial. Conceptualization, methodology, resources, validation, visualization, writing—original draft preparation, writing—review and editing, supervision, and project administration: D.M., M.E.M. and P.B. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

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

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