

Role of Artificial Intelligence in the Renewable Energy Sector

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ABSTRACT

Artificial Intelligence (AI) technology powers the new digitalization paradigm. AI is a game-changing technology that has the potential to completely change the global renewable energy market. In light of climate change and resource depletion, renewable energy is an important resource for future world development. The utilization of AI techniques has become a viable way to enhance the dependability, effectiveness, and cost-effectiveness of renewable energy systems. In order to improve forecasting competences and enthusiastically adapt renewable systems, the role of neural networks, machine learning algorithms, and optimization methods in complicated data sets is investigated. This research demonstrates extensive analysis of the state of investigation of AI and renewable energy, escalating difficulties, approaches, and accomplishments. The conceivable effects of forthcoming AI developments on enlightening renewable energy systems are examined, including reinforcement learning, AI, and edge computing.

INTRODUCTION

Between 2000 and 2030, there will likely be an average annual rise in global energy demand of 8%. The majority of the energy required, which has the strongest effects, comes from fossil fuels. To diminish their interdependency on fossil fuels, a number of industrialized and emergent nations have furnished laws encouraging the handling of renewable energy sources including wind and solar power (Moradi et al. 2020; Houran et al. 2023). One of the extreme common replacements to fossil fuels is using sources of renewable energy since it can help reduce the use of fossil fuels and address issues like global warming, population expansion, price changes, and environmental concerns (Østergaard et al. 2021; Gutierrez et al. 2021). Furthermore, increased diversity and flexibility in power generation can result from hybrid designs that incorporate energy sources like hydrogen, solar, wind, and others. Hybrid systems that utilize renewable energy sources have been thoroughly explored through various research initiatives, focusing on aspects like power supply management and figuring out the optimal system size (Moosavian et al.,

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2024). Moreover, the augmentation of energy storage systems is accelerating due to variable nature of renewable energies like wind energy (Faritha Banu et al. 2022).

Artificial intelligence (AI) techniques have augmented the dependability, efficiency, and sustainability of renewable energy systems. The promising of AI based optimization techniques to change completely the different facets of renewable energy systems, from resource estimation to system management, has been the focus of a rising compilation of investigation in recent years. Nevertheless, there is still a significant vacuum in synthesizing the body of existing literature, critically evaluating study findings, and outlining future research goals, even with the increased interest and accomplishments in this field. This study aims to highlight the research originality in synthesizing different data, identifying encompassing trends, and revealing the fundamental mechanisms driving the persuasiveness of AI techniques in renewable energy systems optimization by combining insights from various studies. The urgent necessity to fully utilize AI technologies to tackle the complex issues confronting the renewable energy industry serves as the justification for this study. The requirement to enforce ingenious solutions that can enhance the utilization of renewable resources while diminishing ecological effects and ensuring economic credibility is significant specified the hastening of climate change and the rise in energy demand.

This study aims to educate policymakers, researchers, and industry stakeholders about the advantages and disadvantages of current methods and direct future research efforts toward more efficient and sustainable solutions by critically examining the state of the art in AI-enabled renewable energy systems optimization. The consolidation of AI and technology of renewable energy suggestions a renewed technique with tremendous commitment for reconstructing system competence, dependability, and sustainability. Although earlier research has examined the utilization of AI in a diversity of fields, little is known about how AI interacts specifically with renewable energy systems (Liao et al., 2024). By offering a systematic investigation of the state of applying AI to optimize sustainable energy systems and describing future directions in this field, this investigation follows to close this gap. It is feasible to create intelligent systems that can estimate energy output, optimize resource allocation, and adjust to changing environmental conditions by utilizing AI's capabilities, such as machine learning algorithms and extrapolative analytics (Aziz et al., 2015).

This research is unique because it focuses on the nexus of two cutting-edge domains: artificial intelligence and renewable energy. This research attempts to provide a unique viewpoint on how artificial intelligence (AI) might transform the renewable energy industry by combining insights from a variety of sources, such as studies on cognitive processes linked to future-oriented thinking, brain-computer interfaces, and memory functions. In addition to improving our theoretical knowledge of AI techniques in renewable energy systems, the synthesis of these multidisciplinary viewpoints will offer useful suggestions for stakeholders, industry, and policymakers. This study intends to open the door for creative solutions that help hasten the transition to a supplementary maintainable and efficient energy landscape by critically evaluating the state of the field, emphasizing the uniqueness of the proposed methodology, and defining future research possibilities.

Data is now a potent tool for exhibiting and optimization in many scientific domains in the twenty-first century. The detrimental environmental consequences of energy systems, such as greenhouse effects, carbon footprints, and ozone depletion, which were detailed in the 2015 Paris Agreement (Conte et al., 2022), can be lessened by an efficient data-driven modeling and optimization process (Alassery et al., 2022). Relatively new ideas in the energy field, machine learning and artificial intelligence have the probable to be suitable tools for operating systems by implementing historical and predicted futures to maximize system usefulness (Entezari et al., 2023). The term “artificial intelli-

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