

The Role of Artificial Intelligence in Advancing Sustainable Energy: A Review of Benefits and Limitation

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Abstract

Artificial Intelligence (AI) is emerging as a transformative force in the global transition to sustainable energy. This study presents a comprehensive review of current research across three focal areas: technical implementation of AI, policy frameworks, and regional applications, particularly in low resource contexts. By integrating insights from a technical review, a conceptual policy framework, and a country-specific case study, this abstract outlines how AI can reshape energy systems to meet climate and development goals. Many researchers proposed a novel AI-enabled policy framework, addressing key stages of the energy policy lifecycle—agenda setting, formulation, implementation, and evaluation. This framework employs AI-driven decision-making, scenario modeling, and multi-criteria analysis to ensure equity, transparency, and adaptability in energy governance. Further, AI-based sustainable energy has potential in addressing energy poverty through decentralized, AI-powered microgrids and peer-to-peer energy trading, while considering challenges related to infrastructure, workforce skills, and data access. The researchers point out, common challenges persist across all domains: lack of high-quality and interoperable data, high computational costs, cybersecurity risks, and limited regulatory maturity. Future success depends on interdisciplinary collaboration, investment in data infrastructure, and the development of ethical, inclusive AI policies. This abstract provides the importance of integrating AI into sustainable energy transitions technically robust, socially inclusive, and policy informed paving the path toward global decarbonization and energy justice. Building on recent reviews, it is important to propose novel concept of an AI Readiness Index for Sustainable Energy Systems, aimed at helping policymakers assess technical, infrastructural, and ethical preparedness for deploying AI in national energy strategies. This framework fills a critical gap in current research, which focuses heavily on implementation but rarely evaluates readiness or capacity for adoption—especially in developing regions.

Keywords

Artificial Intelligence, Sustainable Energy, Machine Learning, Energy Policy, Renewable Energy, Smart Grid, Energy Forecasting, Energy Equity.