


Chapter 16

Harnessing AI–Powered Renewable Energy: Technological Breakthrough and Legal Frontiers

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ABSTRACT

It is very easy to condemn any advancement within the earliest indications as despite the efforts to bring the rise of AI into among the much sustainable energy and decent jobs being created, those trained in the use of AI to effectively develop sustainable energy and contribute to the elimination of local and global environmental degradation, very detailed plans for such implementation have not been quantified; almost every published paper has been vague. Preferred applications of AI on renewable energy sources are fragmented across different platforms with potential uses; apparently, only a few have highlighted systems for such steps to integrate overall energy planning. There will be a presentation of the future trends and possible developments in artificial intelligence for renewable energy breakthroughs, which will work excellently for scholars, practising engineers, and industry experts as far as improving the domain and removing the already existing obstacles.

INTRODUCTION

Renewable energy use has an immediate link to the progress of societies. Life's necessities have gone on a rise owing to the ever-ballooning world population alongside moves towards urbanisation and overall economic progress. That goes to fuel and power production in numerous industries relying upon conventional forms of energy like natural gas, coal, and petroleum to meet its burgeoning demand more and more day after day (S. Mahapatra, et al., 2021).

The reliance on fossil fuels has depleted not only resources but has also played a major role in changing the climate and warming the earth through the massive production of greenhouse gases (GHG). The climatic changes contributed through its destruction rising ocean levels. For instance, glacier retreat, deforestation, air and water pollution, ozone layer depletion, radioactive gases that induce the greenhouse

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effect, acid rain, and environmental damage all pose severe threats to both the economy and society. The agency further warns in its report that the GHGs emitted from energy consumed would increase the temperature by 6°C from where it was before, causing the most significant environmental damage yet. Indeed, the practical removal of harmful environmental changes and the potentially brighter energy future in line with clean and green energy for the welfare of mankind are set out as reasons for setting good transition plans. Precisely, the studies scrutinize a range of AI directions that have been employed in the field of renewable energy such as solar power, photovoltaics, microgrid embedding, management of battery-based power, wind turbine technology, as well as geothermal power generation. He also tried to delve into and provide a thorough knowledge of AI's contribution to revolutionizing renewable energy systems through examination of recent technical breakthroughs made, major research findings as well as illustrative case studies. Indeed, the present paper not only evaluates the constraints hindered under this branch but also tries to build plausible ways to address the same (Kumar et al. 2021).

More on alternative energy sources like renewable energy (RE), which is seen as the most important answer: Renewable energy will reach 10,800 GW globally by the year 2040, as the International Energy Agency (IEA) forecasts. Breaking away from the crowd of fossil fuels, these renewable systems—solar, wind, hydro, biomass, and ocean power—seal the preference because of their duration, a minimal ecological footprint, promotion of cost efficiency, and the long endurance these systems could offer to both a facility and the developer. Recent developments have harvested energy generation and distribution for earth-friendly living. Solar and wind energy sources—photovoltaic and wind turbines—provide the most forward-moving parts of a renewable energy system (Kothari et al., 2021).

An energy revolution powered by sustainable renewable energy technology will have a potential to revolutionize the electricity industry. It may promote effective cost management of electricity, improve the adaptability and resiliency of energy systems, upgrade old infrastructures, mitigate CO₂ emissions, provide dependable power delivery in remote areas, and decrease ecological impacts. Energy storage systems (ESS) have evolved significantly over the years in efforts to meet emission reduction and energy efficiency requirements. These advances highlight the old prescription to upgrade the accuracy in forecasting RE, essential for the functional optimisation of the power system (Kadhem, et al., 2017).

Advances in technology have made renewable energy systems more accurate. Through creation of intelligent devices and future software, artificial intelligence is an advanced idea. In the olden day, mechanical Engineers made simple algorithms of choosing among an array of choices, such as data collection and monitoring for renewable applications. It's very likely and can be true: AI has evolved greatly in the past years, bringing great change to people's daily lives and in sustainable growth; it can include different traditional applications in sectors such as energy, agriculture, learning, health care, security, and industry and in the arts (Perea-Moreno, 2021).

Artificial Intelligence (AI) has powerfully influenced the RE policy and business by simulating scenarios, policies to analyse this efficacy, and forecast economic results. It helps to monitor ecosystems, calculate the carbon footprint of energy generation, and optimize resource utilization so as to reduce environmental impact. AI can be used to help predictive modelling by promoting greater accessibility of clean energy for more marginalised communities as well as improving relatively less explored renewable innovation for the generation of energy (e.g. tidal and wave). For solar power, meta-heuristic methods based on AI improve system performance, and they also have integrated algorithms to enable forecast of the wave energy characteristics. Optimization of the advanced biofuels that minimize the emission from transportation and industrial sources is now currently available through methodologies. Such projects include the employment of an AI-based previous artificial brain, which predicts the solar still's perfor-

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