Chapter 9
Smart Forecasting With AI: Revolutionizing Energy Consumption and Storage

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ABSTRACT

The use of smart forecasting in artificial intelligence (AI) to transform energy storage and consumption is examined in this chapter. Artificial intelligence (AI) is revolutionizing the energy systems industry particularly in the areas of smart grids energy storage management and renewable energy by analysing large volumes of data and finding patterns. In order to predict energy generation and consumption maintain grid stability and maximize storage the chapter explores the crucial roles that AI and machine learning play. Additionally, it emphasizes how big data, and AI can be combined to increase forecasting accuracy which has important ramifications for renewable energy sources like solar and wind. The effective use of AI in energy forecasting commodity market forecasting and smart grid operations is demonstrated by real-world case studies. Chapter also addresses ethical and social issues in AI deployment focusing on the cooperation of AI systems with human expertise.

INTRODUCTION

Integrating Artificial Intelligence (AI) into organizations has become the new normal across many industries and its effects have been most conspicuous in the energy sector. This paper proves that the integration of Artificial Intelligence in energy production, distribution and consumption has revolutionized the conventional systems to better systems. AI-based forecasting is at the center of this change as it helps to determine demand for energy and, therefore, manage its consumption. With the help of Big Data processing that AI can perform in real time, it is possible to gain a much better understanding of energy flows and come up with better solutions that are more efficient and sustainable. Due to the rising

DOI: 10.4018/979-8-3693-7112-1.ch009

complexities in energy systems and the need to expand the use of renewable energy sources, the application of AI in energy management and storage has significant potential in meeting global energy needs.

Another of the most important fields in which AI has shown the possibility of a positive impact is energy efficiency. Conventionally, energy forecasting was done via historical data and basic statistical models, which many a times failed to capture the future trends of energy consumption. The shortcoming of these methods was most apparent in the field of renewable energy, where the variability of the energy production from solar or wind sources can be significant. AI, however, uses more complex machine learning algorithms that can analyze large volumes of data, recognize trends, and therefore provide very accurate estimates as to energy consumption and production. This capability is crucial in managing the injection of renewable energy into the grid and ensure that the size of available supply correlates well with the demand (Kiasari et al., 2024). The same applies to the role of AI in energy storage where it is also vital. This paper seeks to address the challenge of energy storage as renewable energy sources like solar and wind are intermittent in nature. By anticipating when and how much energy should be stored or released based on consumption trends and weather forecasts, artificial intelligence (AI) may maximize the performance of energy storage systems. To guarantee that extra energy is saved for usage during times of low production, AI models, for instance, may predict periods of high solar energy production and tell energy storage systems to charge during these times (Ahmad et al., 2022). Reducing reliance on fossil fuels and increasing the reliability of renewable energy need this degree of optimization. Energy sustainability in the future depends on the idea of intelligent forecasting in energy management. In the end, a more stable and effective energy grid results from energy suppliers being able to make well-informed decisions about whether to generate, store, or distribute energy thanks to accurate energy predictions. The accuracy with which AI can forecast energy demand guarantees that the proper quantity of energy is generated and stored, minimizing waste and raising total system efficiency. For example, AI-driven forecasting in smart grids allows energy flows to be dynamically adjusted depending on consumption data that is collected in real time. This is especially helpful in lessening the load on the system caused by peak demand pressures and energy outages (Ohalete et al., 2023).

AI is essential for reducing energy expenses in addition to enhancing energy storage and consumption. Energy businesses may better manage their resources and prevent expensive emergency power imports or wasteful overproduction by improving their demand predictions. AI may also be used to spot trends in energy usage that can point to inefficiencies or cost-saving possibilities. For example, AI can evaluate smart meter data to identify when and where energy is being wasted, giving companies and consumers useful information to cut back on energy use (Bin Abu Sofian et al., 2024). These savings lower the total demand for energy production, which benefits not just specific customers but also larger environmental sustainability initiatives. The capacity of AI to manage distributed energy resources (DERs) is another indication of the technology's rising significance in energy forecasting and storage. The energy grid is becoming more decentralized as more individuals and companies use renewable energy technology like battery storage devices and rooftop solar panels. An essential component of incorporating these dispersed resources into the larger energy system is AI-driven forecasting. AI assists in balancing supply and demand at the local and national levels by forecasting the energy that distributed energy resources (DERs) will generate and use. Thus, it is possible to create energy systems that are more intelligent, robust, and able to adjust to shifting energy sources and patterns of use (Kumar et al., 2020).

Furthermore, AI has applications in energy storage that go beyond renewable energy. Batteries and pumped hydro storage are two examples of conventional energy storage devices whose efficiency is being increased through the application of AI. AI, for instance, can maximize battery cycles for both charging