

Chapter 17

AI and Machine Learning for Energy Optimization

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ABSTRACT

ML and AI can transform energy optimisation in numerous industries. This chapter discusses how AI and ML have revolutionized price, energy efficiency, and environmental sustainability. AI-powered systems can optimise the grid's renewable energy integration, manage energy resources in real time, and forecast consumption trends using optimization, and predictive analytics. Smart grids, renewable energy forecasting, industrial energy management, smart buildings, and EV charging infrastructure are major applications. This chapter also discusses these fields ML methodologies. Supervised learning estimates energy consumption, RL regulates energy adaptively, and deep learning analyzes complicated data. This chapter pres-

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ents effective AI-driven energy solution case studies. Edge AI, decentralized energy management, and intelligent storage technologies are also covered. It address data security, ethical concerns, and regulatory compliance caused by AI's growing use in energy optimisation to achieve a sustainable and egalitarian future.

1. INTRODUCTION

For manufacturing operations to be both efficient and environmentally friendly, energy management is essential. Conventional approaches to managing energy usage have long been used by the manufacturing industry, despite their high energy consumption, and they frequently fail to provide the precision and flexibility needed for maximum performance (Putha, 2020). The goal of energy management is to maximise efficiency and cut down on expenses by systematically controlling energy resources to satisfy operational needs. Monitoring energy consumption on a regular basis, installing energy-efficient technology, and following all applicable regulations are all examples of traditional energy management procedures. Manufacturing facilities rely on energy management systems (EMS) to run efficiently (Figure 1). EMS include various technologies and approaches that aim to optimise energy use. Integrating multiple components to monitor, control, and improve energy use, EMS are fundamentally structured frameworks. Energy efficiency, operational cost reduction, and sustainability goal support are the core EMS objectives.

Powerful tools for improving predictive capacities, optimising resource allocation, and automating decision-making processes are offered by AI and ML technologies in the context of energy management. Energy consumption can be predicted using historical data and real-time inputs through predictive analytics, which are driven by machine learning algorithms. Better predictions and proactive energy resource management are made possible by these algorithms' ability to spot trends and patterns that aren't always obvious. In addition, energy management systems can benefit from AI-enabled integration of complicated data sources like IoT sensors and external environmental variables. Systems powered by artificial intelligence can optimise energy use and decrease operational expenses by utilising advanced data analytics and machine learning models to deliver actionable insights and recommendations.

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