Chapter 6
AI and IoT-Enabled Automation for Energy Optimization and Efficiency

Vishnu Gandhi V.
Easwari Engineering College, India

M. Ezhilvendan
https://orcid.org/0009-0003-3213-1304
Panimalar Engineering College, India

ABSTRACT

This chapter explores the integration of Artificial Intelligence (AI) and Internet of Things (IoT) technologies for energy optimization and efficiency across various sectors. It highlights fundamental concepts, key enabling technologies, and applications including smart grids, buildings, industrial automation, and renewable energy management. The synergy between AI's advanced algorithms and IoT's pervasive sensing enables real-time monitoring, predictive analytics, and automated control, driving significant reductions in energy consumption and environmental impact. The chapter also discusses critical challenges such as scalability, data quality, security, and deployment barriers, while outlining promising future trends like explainable AI, federated learning, and 5G connectivity. Emphasizing sustainability and cross-domain integration, this chapter provides a comprehensive overview of how AI and IoT empower smarter, more efficient energy systems for a sustainable future.

DOI: 10.4018/979-8-3373-3176-8.ch006

1. INTRODUCTION

1.1 Background and Motivation

Economic growth, new technology and the development of people have always depended on energy. Currently, energy plays a bigger role than before, especially since we are tackling the needs for economic growth and looking after the environment. Energy consumption on a global scale has gone up significantly in recent years due to increasing cities, more manufacturing and service businesses and the spread of technology that requires a lot of energy(Kavitha et al., 2023). The combination of modern cities, innovative infrastructure and industrial sites makes it necessary to supply a lot of energy for their lighting, heating or cooling, movement, data work and various manufacturing activities. At the same time, much of this energy is lost since there are inefficiencies, old systems and no real-time monitoring. There are additional effects of energy inefficiency, not only financial ones. Overconsumption results in using more fossil fuels, using up valuable resources and emitting a lot of greenhouse gases which are main reasons for climate change. In addition, when energy systems are overloaded during high demand, there may be less reliability, grid issues and power failures. In this situation, minimizing energy use has become a serious issue for the world that affects the economy, the environment and energy security. Therefore, researchers, engineers and policymakers are focusing more on managing energy in an intelligent way. In the past, focusing on energy efficiency required people to watch and record energy use, perform scheduled maintenance and look at consumption after it happened. Even though these approaches give important results, they cannot react fast to current changes or predict the future accurately. For this reason, people are now using smart systems that can adapt energy use with little help from people. Automation is making a big difference in dealing with issues related to energy. With the help of automation, it is possible to keep an eye on energy systems, control them and optimize them which helps reduce wastage, improve performance and allow for better maintenance. Advanced automation systems can change lighting, temperature control, ventilation and air conditioning depending on who is in the building, the weather and the prices of energy. Automated control in industry helps machines to be used more efficiently, less time is spent idle and the workload is distributed properly. Because of these improvements, there is less money spent on operations, machines last for a longer time and the environment is less affected. Also, automation is in line with the increasing focus on environmental sustainability and fighting climate change. Automated systems make it possible to use energy more efficiently and support the goals set by different countries and organizations for better energy efficiency. They also play a role in using renewable energy by helping energy systems adjust faster and, in turn, respond well to changes