Chapter 11
Integration of Renewable Energies in Warehouses

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ABSTRACT

The adoption of renewable energy technologies to meet warehouse energy demand is a crucial step in achieving sustainable development, as there are global energy shortages and environmental challenges. This chapter provides an overview of the application of renewable energy technologies, including solar, wind, and geothermal, for adoption in warehouses. Moreover, it also describes the potential of these technologies in the reduction of fossil fuel utilization, operational cost reduction, and minimizing carbon footprints. Initially, solar energy, through photovoltaic (PV) and photovoltaic/thermal (PV/T) systems, is discussed in detail as an attractive alternative for electricity and thermal energy requirements. Therefore, this chapter highlights

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the potential role of renewable energy technologies by carefully examining their benefits, associated challenges, and their practical applications as a way forward toward a sustainable future in the warehouse industry.

1. INTRODUCTION

Governments and businesses worldwide agreed to support sustainable growth, considering the world's increasing energy shortages and environmental challenges. Sustainable development aims to establish more efficient and environmentally friendly production methods by maximizing resource use and minimizing the environmental impact of products across their entire life cycle. The increase in carbon emissions and energy consumption over the past two decades has become a significant barrier to long-term sustainable development and growth (Lei, 2024). Conventional storage techniques frequently fail to monitor and optimize energy use, leading to environmental contamination. Hence, it becomes particularly crucial to develop new strategies that improve energy efficiency and achieve sustainable, environmentally friendly development (Boysen & de Koster, 2024).

Warehousing operations are key components of the global supply chain process because they enable businesses to effectively store, organize, and distribute products across industries (Cannava et al., 2024). However, these facilities often consume substantial amounts of energy, resulting in high operational costs and a substantial carbon footprint. The warehouse sector is rapidly growing as the technology continues to advance and the trend of online sales, therefore, more energy and space are required to meet the demand (Oloruntobi et al., 2023). The transportation and warehousing industry uses between 10% and 15% of the world's industrial energy, and is expected to increase emissions by more than 40% by 2030. More than 100 kWh/m^2 could be consumed annually by warehouses, especially those with refrigeration, indicating a significant possibility for efficiency improvements and the incorporation of renewable energy sources. The standard classification of warehouses is shown in Figure 1.

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