Chapter 6
Sustainable AI Technologies:
Challenges and Opportunities

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ABSTRACT

Sustainable AI merges artificial intelligence (AI) development with ecological, social, and economic resilience. It addresses energy consumption,

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resource management, ethical implications, and policy integration. This chapter explores current practices, identifies challenges, and uncovers opportunities for developing systems that align with sustainable goals. It reviews existing research on carbon footprints, data governance, ethical frameworks, public policy, and cross-sector collaboration. It also analyzes potential methods to measure and mitigate AI's environmental impact, with illustrative tables and diagrams spread throughout. Finally, the chapter offers an outlook on integrating these findings into a cohesive vision for sustainable AI, bridging academic and industry efforts, and enhancing practical governance frameworks.

INTRODUCTION

AI has expanded rapidly. It influences transportation, finance, healthcare, and other crucial domains. While AI research focuses on model accuracy, data availability, and computational capabilities, awareness of ecological and social implications is growing (van Wynsberghe, 2021). The rise of energy-hungry models, concerns about e-waste, and the need for fair and transparent AI set the stage for rethinking how these systems evolve.

Sustainability in AI refers to practices that limit resource exhaustion, align with social good, and maintain economic viability (Nishant et al., 2020). This approach ensures that while models progress, they remain sensitive to environmental footprints and social justice (Bossert & Hagendorff, 2023). This chapter provides an extensive analysis of sustainable AI, addressing carbon emissions, ethical design, data governance, technical innovations, and policy frameworks.

Discussion begins with the conceptual foundations of sustainable AI. It then explores environmental impacts, social responsibilities, and potential regulatory measures. The chapter also includes integrated tables and figures to illustrate key mechanisms, frameworks, and concepts in the sustainability domain. This holistic presentation aims to supply a robust reference for students, researchers, policy experts, and technology leaders considering or implementing AI solutions that balance efficiency with responsibility.

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