Chapter 13
The Future of Green Energy:
Power Electronics in Electric Vehicles (EVs) and Renewable Energy Systems

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ABSTRACT

This chapter, per the authors, explores the ongoing transition from conventional energy systems to renewable energy technologies in response to climate change, fossil fuel depletion, and global sustainability goals. It highlights key innovations in solar photovoltaics, wind turbines, energy storage, and smart grids, while analyzing the economic, regulatory, and infrastructural challenges that hinder widespread adoption. The chapter applies theoretical frameworks including the Triple Bottom Line, Technological Innovation Systems, and Socio-Technical Systems to examine green energy's technological, environmental, social, and economic dimensions. It also evaluates the role of digital tools such as machine learning, and investigates the environmental costs of materials like rare earth elements. By integrating global research and case studies, this chapter provides a comprehensive overview of green energy's future, outlining both opportunities and barriers to a sustainable energy transition.

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INTRODUCTION

The twenty-first century established a defining principle through the need for fundamental change in human progress methods. The transition from conventional energy systems to sustainable renewable options emerged due to changing climate conditions together with diminishing fuel reserves and deteriorating environments and increasing energy requirements. Green energy refers to power generated from renewable natural sources such as sunlight and wind and water and biomass which leads this transition. Green energy advances technology while driving economic expansion as well as energy security and it serves to address environmental problems.

The last 20 years brought forth substantial variations to how we produce and use energy. Transformer technologies along with offshore wind turbines and modern solar panel solutions and complex energy reserve systems are transforming the global energy network. This technological advancement creates both a more resilient and environmentally cleaner energy system and reduced greenhouse gas emissions and decreased fossil fuel dependency.

The path toward complete green power requires overcoming several challenges. Adoption of green energy still faces several obstacles, despite remarkable technological advancements. Several barriers prevent the widespread adoption of green energy including initial investment costs along with unpredictable energy availability, insufficient networks and regulatory hurdles and storage constraints besides resistance from the fossil fuel industry sectors. Lack of funding, technical know-how, and supportive regulations impede the adoption of renewable energy systems in many developing nations. Modernized power grids need extensive system revisions because integrating green technology demands costly complex changes even in well-developed countries.

Green energy technology advancement leads to new environmental concerns which include long-term material usage sustainability and solar panel and battery recycling methods as well as the employment sector effects from the fossil fuel transition. Past and current technology advancement will need to be complemented with progressive policies and international partnerships and financial funding and public engagement to advance into the future.

The chapter delivers simultaneous stories depicting the progress and obstacles encountered during research of green energy technologies. This study investigates important technological innovations in sustainable energy systems while examining the main obstacles which prevent building a truly environmentally sustainable global energy infrastructure. Real-world examples as well as market-oriented data are coupled with legislative information to provide comprehensive knowledge about our present environmental state in the chapter.