Chapter 15
The Role of Renewable Energy in Powering Electric Vehicles

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ABSTRACT

This chapter explores the symbiotic relationship between electric vehicles (EVs) and renewable energy sources, highlighting the benefits of combining clean electricity generation with transportation technology. It begins by discussing the environmental and energy security needs driving the shift to renewables, emphasizing the importance of reducing greenhouse gas emissions gas emissions and dependence on fossil fuels to combat climate change and enhance energy resilience. The versatility of renewable energy sources like solar, wind, hydro, and geothermal is showcased for their abundance, sustainability, and scalability in the transport sector. The chapter examines the role of renewable energy in lowering carbon emissions in transportation, particularly through vehicle electrification. It details the environmental advantages of EVs over combustion engines, including reduced greenhouse gases, air and noise pollution, and discusses the potential of EVs to integrate variable renewable energy sources and stabilize the grid.

THE ROLE OF RENEWABLE ENERGY IN POWERING ELECTRIC VEHICLES

The global push towards sustainability and the reduction of greenhouse gas emissions has led to significant advancements in both renewable energy sources and electric vehicles (EVs) (Liu et al., 2015). These two technologies, while in-

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dependently beneficial, share a symbiotic relationship that amplifies their positive impact on the environment and energy systems. Renewable energy sources, such as solar, wind, and hydroelectric power, offer clean, and inexhaustible alternatives to fossil fuels, while electric vehicles provide a means to significantly reduce emissions in the transportation sector. Together, they create a virtuous cycle: renewable energy can power EVs, reducing the carbon footprint of transportation, while EVs can serve as mobile energy storage units, enhancing the stability and efficiency of renewable energy grids (Chellaswamy & Ramesh, 2017).

Renewable energy generation is inherently variable, with solar and wind power fluctuating based on weather conditions and time of day. This intermittency poses challenges for grid stability and requires innovative solutions for energy storage and demand management. Electric vehicles, with their onboard batteries, present a unique solution to this problem. When connected to the grid, EVs can act as distributed energy storage systems, absorbing excess renewable energy during periods of high generation and supplying energy back to the grid during peak demand times. This bidirectional flow of energy, known as vehicle-to-grid (V2G) technology, not only stabilizes the grid but also maximizes the utilization of renewable energy (Yilmaz & Krein, 2012). Moreover, the integration of EVs with renewable energy sources can accelerate the adoption of both technologies. As more consumers switch to electric vehicles, the demand for clean electricity increases, incentivizing further investments in renewable energy infrastructure. Conversely, the expansion of renewable energy capacity can make EV charging more cost-effective and environmentally friendly, encouraging more people to transition away from fossil-fuel-powered vehicles.

The relationship between renewable energy sources and electric vehicles exemplifies how interconnected technologies can drive progress towards a sustainable future. By leveraging the synergies between these two domains, one can achieve a more resilient and low-carbon energy system, ultimately contributing to the mitigation of climate change and the preservation for future generations.

Electric vehicles (EVs) and renewable energy sources can work synergistically to create a more sustainable energy and transportation system. This integration offers several key benefits and opportunities:

Reducing Carbon Emissions

Decarbonizing Transportation

EVs produce no tailpipe emissions, significantly reducing greenhouse gases (GHGs) and pollutants compared to conventional internal combustion engine vehicles. When powered by renewable energy sources like solar, wind, or hydropower, the entire lifecycle emissions of EVs are drastically reduced.