Chapter 1
Innovation in Smart Grids and E-Mobility Ecosystem

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ABSTRACT

The prevalent grid infrastructure enabled with progressive digital technologies, interfaced with artificial intelligence and smart sensors, paving the way towards bidirectional electricity flow is a smart grid. The existing complexity of power network coupled with the integration of stochastically driven renewables and a drive towards e-mobility eventually makes the evolution towards smart grid extremely pivotal. It is inimitable that advancement in smart grids is essential to operate the power system with enhanced efficiency and cater to system security, reliability, and resiliency. E-mobility is another future-driven technology which is being emphasized across the globe for reducing carbon footprints and propelling towards a sustainable eco-system. The chapter will highlight the coordination between smart grid and e-mobility, overview of integrating renewables and development of energy storage systems, key aspects of e-mobility by applying different solutions.

1. INTRODUCTION

A vivid elucidation of smart grid technology and its relevance to enhance the e-mobility eco- system is provided in this chapter. The current power system grid network is undergoing a progressive revamp due to various factors like renewable integration, increase in energy demand, transition towards e-mobility and inclusion of energy storage in the network. All these factors have attributed to considering smart grid technology and e-mobility as a pertinent research area in the field of engineering. Smart grids primarily aim at digitalization of power grid by implementing advanced sensors, IOT, artificial intelligence and machine learning techniques to handle enormous data (S G, 2088). The energy industry growth is due to the technological development which is manifested through the evolution in smart grid infrastructure. This necessitates a multi-disciplinary approach in power system analysis and management. India is the third largest country in the world in energy consumption and production and thus the prime motive is to meet the great energy challenge which comprises of the following:

1. To end energy poverty and establish universal access of energy.
2. To meet the swelling energy demand and strengthen economic goals.
3. Achieving sustainability by integrating renewables and drifting towards e-mobility to reduce carbon footprints.

All these challenges are the driving force for energy sector to traverse new avenues of development to enhance grid's efficiency, sustainability, security, and reliability. An equitable and increased access to electricity would eventually facilitate innovation, enhanced productivity, and improved living standards (Badi, 2022). A smart energy sector would facilitate an escalated support to all sectors like agriculture, education, business, communications, infrastructure, and education which would culminate in development of country's economic growth. However, today's energy sector is driven by a sustainable approach to meet human energy needs and not harming the future generations and so it revolves around three pivotal factors of economic interest, social interest, and most importantly environmental interest.

Since the early 19th century, a global need was recognized to gradually transit towards renewables or clean energy, but it was not realized to a large extent due to unavailability of required infrastructure and cheaper fossil fuels like coal, gas, and oil. However, after Paris Agreement as an international treaty between many countries and as per United Nations Sustainable Development (UNDP) goals-SDG 7 the focus shifted towards clean technology for achieving a carbon neutral world by 2030 (Shyu, 2021). This led to a huge transition towards clean energy and between 2010-2018 the cost for solar and wind energy saw a drastic reduction. The vital factors driving this change are as follows:

- Ensuring comprehensive availability of clean energy for all with smart infrastructure.
- A significant enhancement of renewables in the global energy sector by 2030.
- To double the global energy efficiency by 2030.
- To intensify research in clean energy, energy storage, energy efficiency thereby promoting a growth of smart grids, electromobility and penetration of renewables in energy infrastructure.

This chapter is to provide a thrust on successful disposition of smart grid systems, evolution of modern energy infrastructure, internet of energy for automated and upgraded energy networks and transition towards electro mobility in India. The first section primarily addresses the renewable penetration into

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