Chapter 5
Harnessing Wind Energy for Smart-Sustainable Cities and Villages: Pioneering Climate Action Through Intelligent Energy Management in Industry 5.0

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ABSTRACT

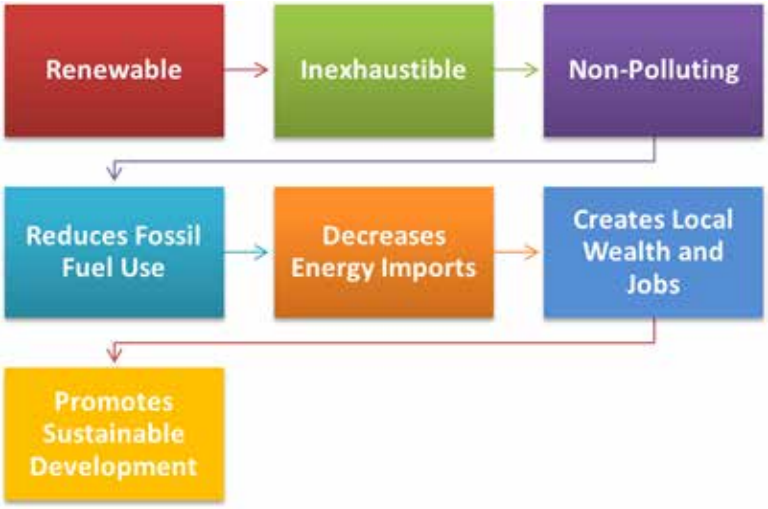
Wind energy is obtained by wind harvesting. It was among the first energy sources that people used, and it's still the most dependable and efficient type of renewable energy available today. The energy source with the greatest rate of growth in the world is wind energy which has several advantages. In order to promote a future with decarbonized power, it confronting technological and socio-economic obstacles to maximize wind energy's potential and benefits to the community. Wind turbines capture energy from the wind by using mechanical power to turn a generator and produce electricity. Wind is not only an abundant and endless resource but also generates electricity without consuming fuel or polluting the air. This chapter comprehensively explores the usage of cutting-edge wind energy technology with intelligent energy management system and creative solutions optimize energy production and distribution with a focus on the contribution of wind energy to carbon footprint reduction.

DOI: 10.4018/979-8-3693-7112-1.ch005

1. INTRODUCTION

Wind energy is a renewable energy source that does not pollute, is inexhaustible, and reduces reliance on fossil fuels, which are the primary contributors to greenhouse gas emissions and global warming. Thus is considered a "native" energy source because it is available almost everywhere on the planet. This availability helps reduce energy imports and stimulates local economic growth and employment. For these reasons, generating electricity through wind energy and using it efficiently supports sustainable development (Hassan et al., 2024). There are multifarious features of wind energy as- Renewable; Inexhaustible; Non-Polluting; Reduces Fossil Fuel Use; Decreases Energy Imports; Creates Local Wealth and Jobs; Promotes Sustainable Development. Wind energy does not emit harmful substances or contaminants into the air, which can significantly damage the environment and human health. Toxic substances can acidify land and water ecosystems and corrode buildings, while air pollutants can cause heart disease, cancer, and respiratory issues like asthma (Alharasees et al., 2024).

Figure 1. Multifarious features of wind energy



(Source- Original)

Wind energy does not produce waste or contaminate water, an essential consideration given the current water scarcity. Unlike fossil fuels and nuclear power plants, wind energy has one of the lowest water-consumption footprints, making it crucial for preserving hydrological resources. Cities and villages provide fundamental, dynamic, and revolutionary frameworks for human activity. The main places where people live are cities, and the main sources of energy are the electric networks used by utilities. Most people on the planet live in electrified metropolitan centers, and even in places where these trends are not as prevalent, these elements are growing at a rapid pace. Since cities consume 70% of the world's energy, they are where utilities are most likely to expand. City and village platform assets and regions may overlap or be adjacent. For instance, streetlight ownership can alternate between cities and utilities; municipal utilities are governed by governments, whereas investor-owned utilities might not. As cities evolve into megalopolises and megacities and as electrification spreads to new industries like trans-