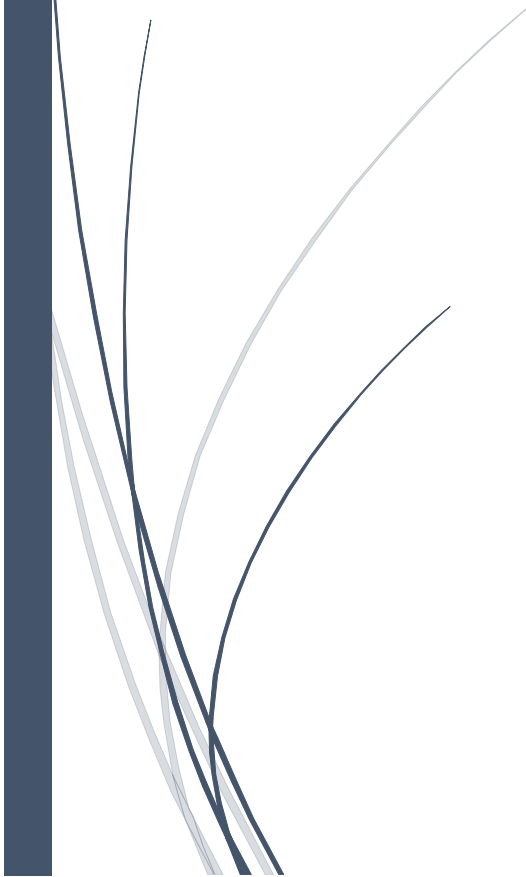


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RADemics

Integration of Renewable Energy Sources in Healthcare Facilities for Carbon-Neutral Medical Operations

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Integration of Renewable Energy Sources in Healthcare Facilities for Carbon-Neutral Medical Operations

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Abstract

The global healthcare sector faces an urgent imperative to decarbonize operations in alignment with international climate targets, as it remains a substantial contributor to greenhouse gas emissions due to its dependence on fossil fuels for uninterrupted energy supply. This chapter explores the strategic integration of renewable energy sources into healthcare facilities as a pathway toward carbon-neutral medical operations. A comprehensive analysis is presented on the energy demands specific to clinical environments, highlighting the high dependency on electricity for critical care, diagnostics, HVAC systems, sterilization, and data infrastructure. The chapter evaluates the technical feasibility, economic viability, and infrastructural adaptability of implementing solar, wind, biomass, and hybrid renewable systems in various healthcare settings. Special attention is given to the role of smart grids, energy storage, and intelligent energy management systems in enhancing resilience and ensuring continuous care delivery. Emissions are categorized across Scope 1, 2, and 3, with a particular focus on hidden contributors such as anesthetic gases, patient and staff travel, food services, and laundry operations. Comparative carbon footprints of public and private hospitals are assessed, as are the implications of building age and architectural design on emission intensity. Policy frameworks, financial models, and institutional barriers are examined to offer scalable solutions for global health systems. This chapter contributes a systems-level perspective on decarbonizing healthcare infrastructure, reinforcing the essential role of renewable energy in achieving both operational efficiency and environmental sustainability in the medical domain.

Keywords: Carbon-neutral healthcare, Renewable energy integration, Scope 3 emissions, Energy management systems, Green Hospital infrastructure, Decarbonization strategies

Introduction

Healthcare systems around the world require large and continuous amounts of energy to provide essential medical services [1]. Hospitals and clinics rely on electricity for lighting, ventilation, operating rooms, laboratory equipment, and digital health systems [2]. This constant demand leads to high energy consumption and significant carbon emissions, especially when fossil fuels are the main energy source [3]. As healthcare services expand to meet the needs of growing populations,

their environmental impact also increases [4]. Climate change is already affecting human health, and the health sector, ironically, contributes to the problem through its own carbon footprint. Reducing emissions in healthcare is now seen as a necessary step not only for the environment but also for protecting public health [5].

One of the most promising solutions to this challenge is the integration of renewable energy into healthcare facilities [6]. Solar panels, wind turbines, and biomass systems can supply clean power for hospitals and clinics, reducing their reliance on fossil fuels [7]. These technologies also improve energy security, which is especially important during natural disasters, grid failures, or pandemics, integrating renewable energy into healthcare systems is not simple [8]. Hospitals have strict energy reliability needs, and any power failure can endanger lives. Therefore, solutions must be carefully designed to ensure stable and safe energy supply at all times [9]. This includes using backup batteries, smart energy systems, and hybrid models that combine renewable energy with conventional power [10].