


Chapter 14

An In-Depth Study of Trends, Challenges, and Innovations in Energy Consumption

Khalil Saadaoui

 <https://orcid.org/0000-0001-6117-319X>

ENSEM, Morocco

Aziz Oukennou

Université Sultan Moulay Slimane, Morocco

ABSTRACT

Detailed assessments of trends and challenges, their potential solutions, and future opportunities for innovation are presented within the context of the global and regional energy issues that are driving the 21st-century energy system. In a work as broad as this, with fossil fuels maintaining a constant share of 80%, global energy consumption was expected to amount to 620 exajoules in 2023. In this study, we analyze energy consumption by residential (20%), industrial (30%), transportation (25%), and agriculture (5%) sectors. The report reveals stark disparities in energy access, with 600 million people in sub-Saharan Africa still without power, while renewables have climbed to 15% of global output. Advanced technologies such as smart energy systems, AI-based management and energy storage technologies can contribute to 5-12% efficiency improvement and 30% outage reduction.

DOI: 10.4018/979-8-3373-6766-8.ch014

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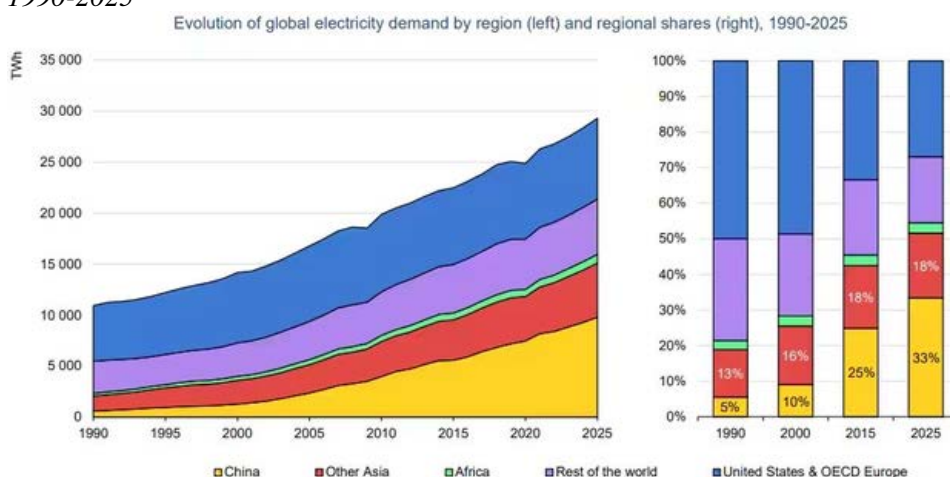
INTRODUCTION

Energy is at the core of all economics; it functions as the propelling force of economic growth, industrial evolution, social progress and technological innovation. With the global demand for energy rising due to growing population, urbanisation, and industrialisation, concerns over resource exhaustion, environmental pollution, and energy imbalance have intensified (Helm, 2023). The importance of energy in sustainable development is recognized in Goal 7, which seeks to ensure access to affordable, reliable, sustainable, and modern energy for all under the UN's SDGs, as energy is a key enabler of inclusive and sustainable development.

A review of energy use in buildings, Industry, transport and agriculture illustrates the complex challenge of developing innovative solutions, including intelligent energy systems, renewable energy integration, and new technologies such as AI and IoT. Case studies and policy frameworks discussed in this chapter are intended to help researchers, policy makers and Industry to gain actionable learning in the pursuit of optimizing the efficiency of global energy at the minimum of environmental and societal cost (National Renewable Energy Laboratory [NREL], 2023).

Among the most significant energy challenges and opportunities of the 21st century is the rising energy consumption. Global energy demands are ever-increasing, and not slowing down (growing at 2.1% per year between 2010 and 2022). Yet, we are facing a unique confluence of hardships – diminishing resources, environmental degradation, and profound energy inequity, which continues to impact nearly a billion people worldwide (Sovacool, 2023).

Figure 1. evolution of global demand by region (left) and regional shared (right), 1990-2025



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