Chapter 17
Energetic Efficiency and Sustainability:
Artificial Intelligence in the Design of Public Policies

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ABSTRACT

The 21st century faces a growing energy crisis driven by rapid population growth, urbanization and industrialization, particularly in emerging economies. Fossil fuels account for 80% of global energy consumption, which has led to increased greenhouse gas (GHG) emissions and intensified climate change, increasing the need for a transition to energy-efficient systems. Artificial intelligence (AI) emerges as a platform to address these challenges by improving energy efficiency and sustainability. Smart public policies can help harness the potential of AI to promote energy efficiency and ensure socio-environmental equity. Collaboration between government and stakeholders is essential to develop regulatory frameworks that enable an efficient energy transition. This paper explores the applications of AI in energy sustainability, its socio-economic benefits and the challenges and opportunities involved in implementing AI-based solutions in public policies.

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INTRODUCTION

The world of the 21st century is facing an energy crisis that threatens the reliability of the supply of energy demand and at the same time a threat to climate change. The decline of conventional energy sources (fossil fuels) has led to the acceleration of global warming. World energy consumption has had an annual growth rate of 5% in the last 20 years, a high rate that is totally unsustainable. This strong growth is mainly due to several factors, such as the population explosion, increasing urbanization and industrialization in developing economies (Birol, 2021). Countries such as India and China have experienced rapid economic growth, in which the demand for energy, especially in the industrial and transport sectors, has skyrocketed.

This increase in energy consumption has generated considerable environmental challenges, among which the associated increase in greenhouse gas (GHG) emissions, the main cause of climate change, stands out. According to the Intergovernmental Panel on Climate Change (IPCC), drastic measures must be taken to reduce the impacts of climate change through aggressive energy policies that achieve energy security and reduce negative environmental effects. With atmospheric concentrations of CO_2 increasing, due to the world's dependence on fossil fuels: coal, oil and natural gas (IPCC, 2024). Previous research shows that global CO_2 emissions peaked at 36.4 gigatons in 2020 (according to data from the Global Carbon Project). This sets the stage for the imperative transition to more sustainable energy sources and more efficient use of existing resources (IRENA, 2024).

In recent years, a transition towards renewable energy has been sought, gaining a part -of the generation of the energy matrix, but fossil fuels continue to constitute a major proportion of global energy consumption. Although great efforts have been made worldwide to limit the carbon footprint, fossil fuels still constitute a large part of 80% of global energy consumption.

These include, in descending order, oil consumption, with about 45 million MWh per year, followed by natural gas, with about 35 million MWh, and finally coal, with 30 million MWh. In countries with developed economies, they have helped to reduce the use of coal, while in emerging economies it continues to be the energy with the greatest energy demand (*IEA*, 2024).

Sustainability analyses increasingly recognize energy efficiency as one of the most important strategies to reduce energy consumption and mitigate GHG emissions. Research indicates that a 20% improvement in overall energy efficiency could result in a 30% reduction in global energy demand by 2030 By significantly reducing CO_2 emissions, energy efficiency not only offers substantial economic cost savings, although it also serves as a critical solution to achieving sustainability amid the current climate crisis (*IEA*, 2024).

Global energy consumption remains a key determinant of both economic growth and environmental sustainability. Population growth, urbanization, industrialization, and advances in energy consumption technologies have all contributed to rising energy demand. Recent reports from IEA highlight that global primary energy consumption has reached approximately 600 exajoules (EJ), equivalent to approximately 166.7 million megawatt-hours (MWh) annually (IEA, 2024). Energy consumption patterns reflect a combination of factors including economic development, energy policies, and shifts towards cleaner energy sources such as renewables and nuclear power (Gahlot & Garg, 2024).

Energy efficiency is the platform for sustainable development, due to the consequences that the reduction of energy consumption and generation, especially from fossil fuels, has on the reduction of the impact of climate change. The United Nations Environment Programme (UNEP) estimates that greater energy efficiency could save more than 3 billion tons of CO2 emissions by 2030. This represents a

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