


# Chapter 8

## Smart and Sustainable Strategies for Urban Energy Efficiency: An Integrated Framework

**Sitesh Kumar Singh**

 <https://orcid.org/0000-0002-7108-0808>


*National University of Science and Technology, Oman*

**Jaishri Gothania**

 <https://orcid.org/0000-0002-2656-642X>

*Lingaya's Vidyapeeth, India*

**Michael Toryila Tiza**

 <https://orcid.org/0000-0003-3515-8951>

*Federal Polytechnic Wannune, Nigeria*

### ABSTRACT

*Due to the overall growing trend of urbanisation, cities are primary areas of energy consumption and carbon emission and therefore highly need smart, efficient policies to sustain their existence. The chapter gives a framework consisting of five pillars: smart infrastructure and data, policy ecosystems, innovation platforms, governance coordination, and citizens' engagement. It discusses the change in the urban energy system through examples of Sweden, Germany, the UAE, Saudi Arabia, and the UK. Their effects on technologies, such as AI, digital twins, edge computing, and vehicle-to-grid systems, are explored. The important values of just energy transitions are identified as equity, digital inclusion, and resilience. The chapter provides policy, budgetary and planning tips and gives future research recommendations, in*

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*behavioural science, multisector integration, and mutable governance, and they are meant to inform long-term sustainable city energy policies, particularly in rapidly expanding Global South cities.*

## **INTRODUCTION**

### **Background and Significance**

It is in the urban areas where global challenges about energy and the environment stand out. Today, over 55 percent of the world population resides in cities, and this has been forecasted to increase to about 70 percent by 2050 (UN DESA, 2019). Such densely inhabited spaces account for more than two-thirds of worldwide energy consumption and carbon dioxide (CO<sub>2</sub>) emissions, mostly because of increasing demands within the fields of transportation, construction, and buildings. Urbanization proceeds at an increasing rate and therefore the need to adopt innovative strategies which facilitate energy efficiency, but which also guarantee environmental and social sustainability.

Traditional urban energy systems were mainly focused on reliability, growth and not on sustainability or flexibility. They are usually not integrated and hence bring energy wastefulness, high cost of operation and environmental strain. Moreover, they are poorly placed to address the dynamism of the changing climatic conditions, energy deficiency and urban sprawl. To eliminate these constraints, cities will be required to shift towards adaptive, intelligent, and sustainable energy models (IEA, 2021).

The connection between smart technologies and strategy that is focused on sustainability presents an opportunity to transform (Das et al., 2020). Artificial intelligence (AI) and the Internet of Things (IoT) along with data analytics are digital innovations that can enhance efficiency in energy usage, responsiveness in real-time, and the overall performance of a system. These tools can dramatically decrease urban energy footprints, and when sustainable practices other than renewable energy integration, green infrastructure, and principles of a circular economy are built in, these tools can increase urban resilience and livability (Batty et al., 2012).

### **Defining Smart and Sustainable Urban Energy Efficiency**

In urban context, energy efficiency can be defined as efficient usage of energy to provide services like lighting, transport, heating and cooling, with little wastage. This definition, however, is expanded in smart and sustainable cities, as the emphasis is put on the environmental and systemic effects of energy usage. Smart energy systems dynamically manage energy using sensors, automation and prediction analytics. The

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