Chapter 10
Solar and Wind Energy in Urban Transformation:
Opportunities, Challenges, and Cybersecurity

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ABSTRACT

Green initiatives regarding energy generation is not just a social topic for debate; it is a necessity for ensuring our planet's future well-being. Both solar and wind energies are renewable sources that are gaining in popularity as replacements for fossil fuels. Along with the opportunities they bring to smart cities lie some issues that will need mitigation, and planning carefully will be crucial. It is useful to understand some history and the basics of current solar and wind technologies, as well as the cybersecurity concerns that can occur with smart grids. Citizen engagement, ethical and legal concerns, and industry standards, plus other options are explored, and a list of recommendations is offered for those who seek to plan a safe, green future for their cities.

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INTRODUCTION

The limitations and environmental hazards caused by fossil fuels is well known, as is the fact there are alternatives in the form of renewable systems. Exploration of these technologies is prudent as cities realize the dangers of climate change and slowly convert into "smart cities." The need to invest in cybersecurity measures comes with goals for cost savings and other positives. The two most often espoused renewable sources are solar and wind energy; how and where these are constructed, the challenges of implementation, data privacy and other cybersecurity issues, and concerns are presented, as well as brief comparisons to marine and hydropower, geothermal energy, and bioenergy alternatives. Policy writing and other recommendations provide city administrators with a framework to begin the journey towards safe changes.

LITERATURE REVIEW: THE NEED FOR RENEWABLE ENERGY

The environmental benefits of energies that do not pollute air, water, or land are obvious. Fossil fuels and nuclear energy are limited and harm the planet's health (Majumder et al., 2025). Communities that Make use of renewable energy contribute positively to mitigating the effects of climate change (Nidhi et al., 2024). Mahesha et al. (2022) add that countries and communities often rely on imported energies and high, variable expenses, yet still have unstable grids, providing additional reasons for renewable and local energy sources. Smart city goals include the desire for management of natural resources, leading to clean air and a reduced carbon footprint (Mahesha et al, 2022).

There are also social issues to consider. Over a decade ago, Zahnd and Jennings (2012) noted inadequate sanitation in large parts of the world, resulting in billions afflicted by water-related illnesses; providing renewable energy sources can significantly improve health and hygiene and lead to positive community outcomes. Nidhi et al. (2024) use the phrase "energy poverty" to describe urgent needs in developing countries, with implications in completing simple tasks such as cooking, but also in education, healthcare, and even gender equality. Efficient, clean energies are also supportive of lower-income populations and promote economic growth (Mahesha et al., 2022). Renewable energy sources can provide positive changes for whole communities.

The burning of fossil fuels accounts for 66% of the world's electricity and 80% of the total energy production (IEEE Standards, 2024). Mishra et al. (2025) specify 75% of the world's energy resources are used in cities, while those areas are also being most responsible for greenhouse gases and the depletion of already-limited