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Designing Sustainable and Energy-Efficient Urban Network: A Passive Architectural Approach with Solar Integration and Urban Building Energy Modeling (UBEM) Tools

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Abstract : The development of an urban design and power network planning has been gaining momentum in recent years. The integration of renewable energy with urban design has been widely regarded as an increasingly important solution leading to climate change and energy security. Through the use of passive strategies and solar integration with Urban Building Energy Modeling (UBEM) tools, architects and designers can create high-quality designs that meet the needs of clients and stakeholders. To determine the most effective ways of combining renewable energy with urban development, we analyze the relationship between urban form and renewable energy production. The procedure involved in this practice include passive solar gain (in building design and urban design), solar integration, location strategy, and 3D models with a case study conducted in Tehran, Iran. The study emphasizes the importance of spatial and temporal considerations in the development of sector coupling strategies for solar power establishment in arid and semi-arid regions. The substation considered in the research consists of two parallel transformers, 13 lines, and 38 connection points. Each urban load connection point is equipped with 500 kW of solar PV capacity and 1 kWh of battery Energy Storage (BES) to store excess power generated from solar, injecting it into the urban network during peak periods. The simulations and analyses have occurred in EnergyPlus software. Passive solar gain involves maximizing the amount of sunlight that enters a building to reduce the need for artificial lighting and heating. Solar integration involves integrating solar photovoltaic (PV) power into smart grids to reduce emissions and increase energy efficiency. Location strategy is crucial to maximize the utilization of solar PV in an urban distribution feeder. Additionally, 3D models are made in Revit, and they are keys component of decision-making in areas including climate change mitigation, urban planning, and infrastructure. we applied these strategies in this research, and the results show that it is possible to create sustainable and energy-efficient urban environments. Furthermore, demand response programs can be used in conjunction with solar integration to optimize energy usage and reduce the strain on the power grid. This study highlights the influence of ancient Persian architecture on Iran's urban planning system, as well as the potential for reducing pollutants in building construction. Additionally, the paper explores the advances in eco-city planning and development and the emerging practices and strategies for integrating sustainability goals.

Keywords : energy-efficient urban planning, sustainable architecture, solar energy, sustainable urban design
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