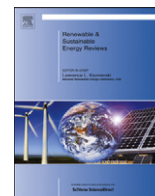




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Sustainable energy performances of green buildings: A review of current theories, implementations and challenges

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ABSTRACT

This study targets to elucidate the essence of sustainability in green building design implementations. In this regard, the study draws attention to the sustainable energy performances of green buildings to identify the influential parameters based upon the contemporary successful accomplishments. The study elaborates on the contemporary trends and applications of green building design and the respective impacts on sustainable developments. As a result, the analytical review confirms that the sustainable energy performance of green buildings has been transformed to a sensible and practical resolution to alleviate the CO₂ emissions and diminish the building sector energy consumption. In addition, with view to the current challenges and barriers, the study concludes that; it is still crucial to identify and develop efficient energy solutions associated with green buildings for addressing the future energy demands. Likewise, the findings highlight that the sustainable energy performances associated with integrated technologies and renewable energy systems are still intertwined with significant challenges related to the fundamental parameters of cost, maintenance, and operation. In conclusion, the contemplations of the research findings are recommended to be taken into consideration by architects, engineers and developers for the development of future eco-cities with an explicit viewpoint towards developing greener and smarter built environments.

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1. Introduction

Sustainable architecture and green design have become one of the most widespread areas of focus in the scholarly studies related

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to build environments. Accordingly, with view to the environmental assessment and energy performance of buildings, it is vital to develop an overview of current theoretical perspectives, trends, applications and constraints towards the development of green environmentally sustainable buildings. To confirm that, previous studies put forward a theory representing that the performance of green buildings is substantially related to the level of their environmental assessment, thus, versatile studies highlight the necessity of the identification and consideration of sustainable energy performance indicators in the environmental evaluation and any green implementations. In this regard, the building energy efficiency, the thermal performance of buildings and the material efficiency are considered as significant parameters of sustainable energy performance indicators to be fully taken into consideration during the performance evaluations [1]. According to the study by Joelsson [2], with view to the effectiveness of green buildings towards decreasing the use of energy and its negative impacts on the environment, there are fundamental strategies including 'reducing the energy demands', 'enhanced energy efficiency' and 'application of passive design techniques'. Likewise, the utilization of appropriate building envelopes is influential in more than half of the embodied energy distribution in a building, particularly in residential buildings [3].

1.1. Renewable energy applications in green buildings

It has been internationally recognized to promote innovative approaches for mitigation of carbon dioxide (CO₂) emissions due to energy consumption associated with building construction and operation. In view of that, the energy performance of green buildings has an immense effect on the sustainable development of the built environment. According to Kothari [82], sustainable development is highly intertwined with the deliberation of energy. Thus, on one hand, renewable energy sources including solar, winds, and waves, etc. play a substantial role for sustainable developments; on the other hand, sustainable energy sources including the waste-to-energy sources are highly influential in the enhancement of sustainability [82].

Reviewing versatile studies with focus on the concept of green buildings [1,2,3,83,84,85,86,87,88,89], the study demonstrates that

the green buildings (including low energy, ultra low energy and zero energy buildings) are significantly intertwined with energy efficient designs and advanced integrated technologies in order to cut the energy demand and consumption in view of heating, cooling, electricity, etc; through the application of on-site renewable energy sources.

With view to the sustainable energy performance of green buildings, the appropriate application of renewable energy supplies in buildings is a fundamental criterion. In this regard, solar sustainability systems have always been a key factor towards development of green buildings. Respectively, the study by Esen [90] performs a theoretical-experimental study on the cylindrical phase change storage tank connected to a solar powered heat pump system as represented in Fig. 1.

The study reveals a significant technique towards development of sustainability, hence improving the accuracy of respective measurements through development of a corresponding model. Furthermore, the study by Esen [91] develops and analyzes the performance of a solar cooking system utilizing vacuum-tube collectors with heat pipes containing a refrigerant as working fluid as shown in Fig. 2. Cooking ability was obtained while highlighting that the respective cooking time is dependent on the collective selection of refrigerant, meteorological conditions and constructive parameters. Eventually, the significant efficiency of the fabricated cooking system compared to the conventional concentrators and box cookers was proven specially in case of preheating the system.

Solar connectors have been utilized as a main component of green progressions. The respective research by Ensen [92] experiments the effect of utilizing dissimilar refrigerants on the thermal performance change of a two-phase thermosyphon solar collector. Refrigerant-charged domestic hot water systems can be simply manufactured through encompassing general flat-plate solar collectors while providing superior energy deeds. Therefore, it is recommended to exploit the respective results in further design and development of solar domestic hot water systems.

Cooling and heating systems are considered as a major focus point of recent researches related to green buildings. The study by Ensen [93] accordingly examines the energetic and exergetic effectiveness of ground-coupled heat pump system for heating applications. This research proves that significant improvements

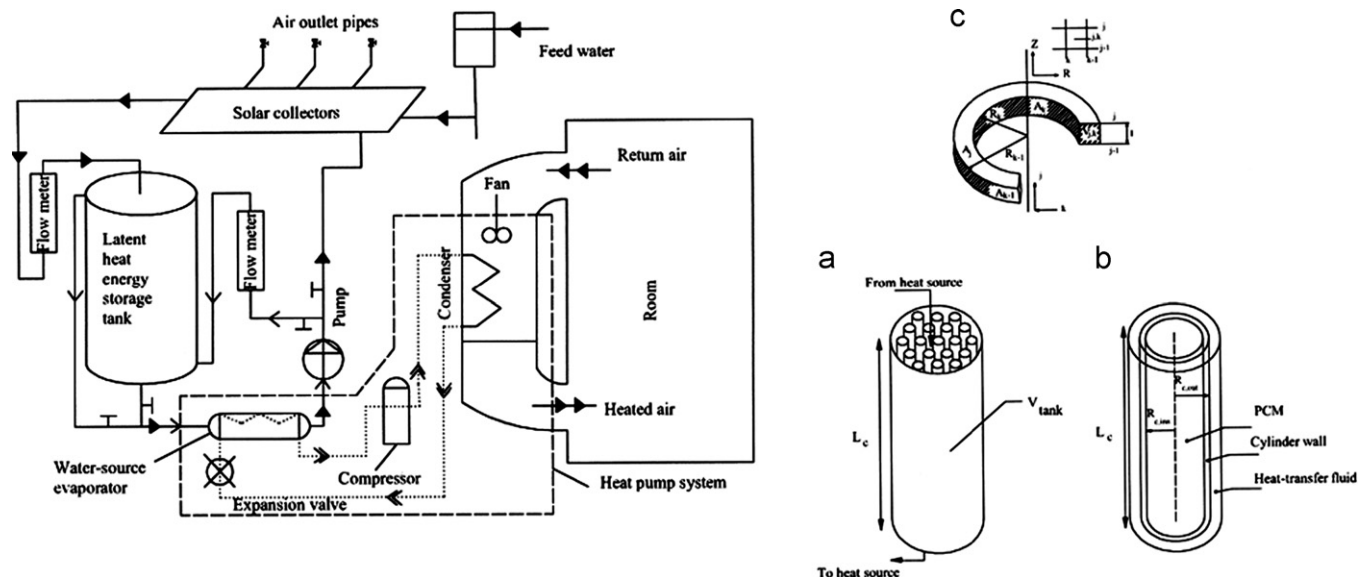


Fig. 1. The proposed system details [90].

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