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Optimal design and transient simulation next to environmental consideration of net-zero energy buildings with green hydrogen production and energy storage system

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Abstract

The integration of renewable energies to produce required commodities and mitigate environmental effects in developed countries has been investigated and tested recently. This study aims to model and develop a building without getting energy from the grid with four occupants for Kuwait's capital and largest metropolis, one of the most significant cities in the Middle East, for reducing greenhouse gas emissions (GHG). Hydrogen energy is employed as energy storage for this building outside the zero-energy network due to the benefits and applications of hydrogen energy. TRNSYS software was utilized for this simulation, and the transient performance of the previously described ZEB was examined annually using TRNSYS software. The building is powered by solar panels, and any extra electricity generated is considered for the hydrogen production and storage unit for use when there is a lack of solar radiation and the building has to be powered. Hot water is created using an evacuated tube solar collector, and it is then kept in a hot water tank. For cooling and heating load, a geothermal heat pump system with auxiliary heaters is employed. MATLAB software is used to analyze the thermal comfort of occupants using the Fanger model. The findings indicate that 72 PV panels with a 1.46 square foot surface area will be used to supply the building without any power shortages. In addition, the building will have zero energy and will receive its hot water from forty 1.5 m^2 solar collectors. The ultimate hydrogen pressure tank will be greater than that of the beginning level. The building's air conditioning system offers annual thermal comfort. Additionally, the provided DHW is always at the predetermined temperature of 55 °C. Finally, the usage of the building's roof space can turn into a ZEB and greatly lower Kuwait's greenhouse gas emissions. Environmentally, the proposed system reduce 33% CO2 emission rate compared with fossil fuel.