DESIGN OPTIMIZATION AND OPERATION SIMULATION OF SUSTAINABLE ENERGY SYSTEMS FOR COVERING THE HEATING AND COOLING ENERGY DEMANDS OF AN EXISTING OFFICE BUILDING

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ABSTRACT

To achieve climate neutrality, energy production should be focused on sustainable and eco-friendly energy sources. According to global energy organizations' data (IEA, 2023[1]), the building sector accounts for 30% of the world's final energy consumption. The revised Energy Performance of Buildings Directive, that is expected to be formally adopted, sets goals for carbon footprint of buildings. The design and optimisation of low carbon energy systems towards covering buildings' energy demands, is expected to have a pivotal role in energy transition and CO_2 emissions reduction of the namely building sector.

The present study aims to optimize the operation of highly efficient energy systems to cover the heating and cooling demands of an existing office building, with a total area of 5,211.9 m^2, located in the Municipality of Kozani, Greece. nPRO software[2] was used for simulation purposes and the optimisation of the proposed configurations. The cooling and heating demand profiles were determined based on the existing energy studies. Based on the estimated annual energy demand profiles (including peak demand and heat losses), two different configurations were simulated and analyzed. The proposed scenarios include: 1) an integrated system including PV panels, a heat pump, and a battery and 2) an integrated system consisting of PV panels, a heat pump, and a backup biomass boiler. Therefore, a comprehensive technical analysis was carried out on the two alternative energy systems, specifically focusing on mass and energy balances, carbon footprint and a preliminary economic evaluation.

KEYWORDS: Office Building, Heating and Cooling, RES, Design Optimization, Operation Simulation

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