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A Simulation Study of Passively Heated Residential Buildings

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Abstract

This research aims to gain understanding of the key design aspects in using renewable sources (e.g., geothermal and solar) for residential heating. To achieve this aim, a simulation study has been undertaken by using the EnergyPlus™ software Version 8.1. First a brief review of the literature was carried out, which covers solar ground-source heat pump, solar-heated water, low-temperature wall and floor surface radiators, types of solar collector, fixed tilt versus solar tracker, and cost versus savings. Then the conceptual design idea and energy simulation process are described. Following this a simulation study of a 30 m2 one-bedroom simple house, as a case example was carried out. The results show that, with two surface radiators, a 30 m2 house would remain within the acceptable thermal comfort temperature range in winter. The simulation results also show that the floor radiator, fed with water from U-tube in deep ground warms the concrete-in-ground floor, which would otherwise be cold for more than half a year. The simulation results also show that the wall radiators, fed with water (stored in a 2 m3 indoor tank) heated by evacuated tubes make the indoors comfortable throughout the year. Furthermore, the results of additional 3-dimensional simulation show that, the creation of a thermal mass under the floor, using vertical insulation into the ground along its perimeter, may obviate the need of the floor radiator and borehole. In conclusion, the results of the simulation study show that it is feasible to utilise a combination of the renewable geothermal and solar energy to achieve indoor thermal comfort in houses. Future research is needed which includes validation of these simulations results with actual data collected from the case example and simulation study of more complex and larger scales residential houses.

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Keywords: residentail house; enegery cosumption; thermal comfort; Solar-geothermal heating; Surface (panel) radiators; Passive heating; Ground-insulation

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