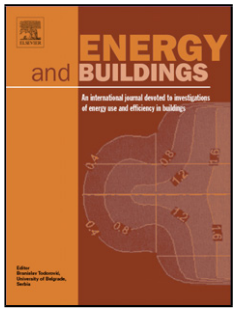

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Energy Performance Analysis of Variable Thermal Resistance Envelopes in Residential Buildings

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ABSTRACT

This paper evaluates potential energy savings associated with dynamic insulation materials (DIMs) – material assemblies that can change their thermal resistance through a controlled exchange of liquid or gaseous media – in the exterior walls of buildings. In the analysis, a two-step control strategy is considered to modify the R-value of DIMs based on the temperature difference between internal and external wall surfaces. Using a simulation environment capable of modeling DIMs, a comparative analysis is carried out to evaluate the impact of DIMs on the heating and cooling energy end-uses for single-zone residential buildings in three US climates. Several design and operating conditions are considered to assess the performance of DIMs and their potential energy use savings. The results indicated that variable thermal resistance envelope materials (RSI-0.5/RSI-2.5) have the potential to reduce annual cooling energy use in residential buildings on average by 15% and up to 39% for all three US climates and annual heating energy use by 10% on average for mild US climates depending on the window sizes and internal heat gains.