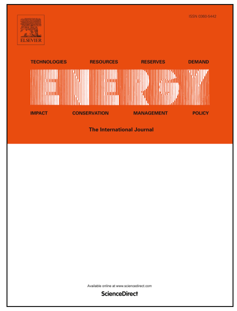

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Cooling Energy Simulation and Analysis of an Intermittent Ventilation Strategy under Different Climates

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ABSTRACT

Energy use on heating, ventilation and air conditioning (HVAC) accounts for about 50% of building energy use. To have a sustainable built environment, energy efficient ventilation systems that deliver good indoor environmental quality are needed. This study evaluates the cooling energy saving potential of a newly proposed ventilation system called Intermittent Air Jet Strategy (IAJS) and compares its performance against a mixing ventilation (MV) system in a classroom located in three cities with different climates, Singapore with 'hot and humid', Ahvaz with 'hot and dry' and Lisbon with "moderate" climate. The results show a significant reduction of cooling energy need and flexibility in control strategies with IAJS as a primary system in hot and humid climates like Singapore. Hot and dry climate with short cool periods like Ahvaz show possible application and considerable energy savings with IAJS as a primary system under optimized variable setpoints, but moderate climates have an increased risk of occupant discomfort likely due to increased draft especially during the cool season. Thus, IAJS as a secondary system that operates only during cooling season may be conducive for moderate climates like Lisbon. Additionally, the results show that supply fan energy savings can also be realized if well implemented.

Keywords: Intermittent air jets; IDA-ICE simulation; Energy savings, Convective cooling, Hot and humid climate, Hot and dry climate, Moderate climate

1 INTRODUCTION

Energy concerns are a daily ubiquitous topic due to challenges of our current energy economy and its impact on climate change. The rising energy demand necessitates aggressive reforms on energy use, conservation and efficiency, especially so because of validated assertions of a causal relationship between energy demand and greenhouse gas (GHG) emissions [1,2]. One sector with a rising energy demand is the built environment, which currently uses more than 40% of primary energy and accounts for 30 – 40% of GHG emissions [3], of which heating, ventilation and air conditioning (HVAC) takes about 50% of the total building energy use. Global trends [4] show that much of cooling and air conditioning is achieved by electricity driven systems which increases the burden and cost on electrical power systems. Because of the correlation between building energy use and surrounding climate conditions, cooling energy consumption/demand in buildings is expected to increase due to climate change [5]. For example, in Europe climate change is considered as one of the major drivers for increased cooling requirements and HVAC energy use [6,7].

Energy efficient HVAC systems that do not compromise the indoor environmental quality (IEQ) are necessary and needed. Research has demonstrated ways that different HVAC technologies, configuration and approaches can be effective for energy conservation without compromise on thermal comfort [8]. Common consensus in literature shows that changes on HVAC *modus operandi* can yield substantial energy savings more so on cooling requirements [9]. Research [10–12] shows that strategies that offer possibilities to extend air temperature setpoints have a high energy saving potential on building energy use.

Indoor operative temperature setpoints or the HVAC deadband (thermostat setpoint range) is critical for indoor climate control and has consequences on occupant thermal comfort and the HVAC energy