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Smart energy-efficient HVAC solutions for comfortable and healthy sleep environment

People spend one-third of lifetime sleeping. Developing innovative HVAC solutions for sleep environment would be crucial for both energy reduction and occupant health outcomes. Residential buildings account for 22% of the primary energy consumption in the United States, and 42% of the consumption is for space heating and cooling. In addition, approximately 50 to 70 million Americans chronically suffer from a sleep disorder that interferes with daily functioning and adversely affects health, well-being, productivity, and longevity. The sleep environment is usually associated with unsatisfactory temperature, where people could be disturbed by feeling hot or cold, resulting in poor sleep quality. The CEC Electric Program Investment Charge (EPIC) 2018-2020 Triennial Investment plan involves the efforts to create healthy, comfortable, and highly-efficient buildings (S1.2) and improve performances in HVAC systems (S1.3) under Theme 1. However, both the two sections focus little on sleep environment.
I proposed that CEC supports also innovations focusing on HVAC solutions for sleep environment to reduce energy consumption in residential buildings. Contact base heating (electric blanket) can be an order of magnitude more efficient that air heating. The CEC should also encourage initiatives under Theme 1 to enhance occupantsâ€™ thermal comfort and sleep quality. We suggest that the solicitations encourage smart HVAC solutions (e.g., incorporating occupantsâ€™ feedback in the loop using IoT) to control the micro-environment of a sleeping occupant rather than to heat/cool the entire space. Existing heating and cooling systems control the space based on room air temperature, which is weakly related to thermal comfort of the sleeping person, i.e., what a wall thermostat in the bedroom or in an adjacent space senses is significantly different from the conditions under the blankets and what is experienced by people in bed.