World Academy of Science, Engineering and Technology
International Journal of Environmental and Ecological Engineering
Vol:16, No:11, 2022

Calibration of Residential Buildings Energy Simulations Using Real Data from an Extensive in situ Sensor Network – A Study of Energy Performance Gap

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Abstract : As residential buildings account for a third of the overall energy consumption and greenhouse gas emissions in Europe, building energy modeling is an essential tool to reach energy efficiency goals. In the energy modeling process, calibration is a mandatory step to obtain accurate and reliable energy simulations. Nevertheless, the comparison between simulation results and the actual building energy behavior often highlights a significant performance gap. The literature discusses different origins of energy performance gaps, from building design to building operation. Then, building operation description in energy models, especially energy usages and users' behavior, plays an important role in the reliability of simulations but is also the most accessible target for post-occupancy energy management and optimization. Therefore, the present study aims to discuss results on the calibration ofresidential building energy models using real operation data. Data are collected through a sensor network of more than 180 sensors and advanced energy meters deployed in three collective residential buildings undergoing major retrofit actions. The sensor network is implemented at building scale and in an eight-apartment sample. Data are collected for over one year and half and coverbuilding energy behavior – thermal and electricity, indoor environment, inhabitants' comfort, occupancy, occupants behavior and energy uses, and local weather. Building energy simulations are performed using a physics-based building energy modeling software (Pleaides software), where the buildings'features are implemented according to the buildingsthermal regulation code compliance study and the retrofit project technical files. Sensitivity analyses are performed to highlight the most energy-driving building features regarding each end-use. These features are then compared with the collected post-occupancy data. Energy-driving features are progressively replaced with field data for a step-by-step calibration of the energy model. Results of this study provide an analysis of energy performance gap on an existing residential case study under deep retrofit actions. It highlights the impact of the different building features on the energy behavior and the performance gap in this context, such as temperature setpoints, indoor occupancy, the building envelopeproperties but also domestic hot water usage or heat gains from electric appliances. The benefits of inputting field data from an extensive instrumentation campaign instead of standardized scenarios are also described. Finally, the exhaustive instrumentation solution provides useful insights on the needs, advantages, and shortcomings of the implemented sensor network for its replicability on a larger scale and for different use cases.

Keywords : calibration, building energy modeling, performance gap, sensor network
Conference Title : ICHB 2022 : International Conference on Healthy Buildings
Conference Location : London, United Kingdom
Conference Dates : November 18-19, 2022