

KEYNOTE 1: ENERGY, COMFORT, OCCUPANT BEHAVIOR: VARIOUS BUT INTERDEPENDENT PERSPECTIVES OF BUILDING PERFORMANCE ASSESSMENT

Abstract

The most popular approach to assess building performance is probably through energy performance indicators. As energy consumption (of non-renewable resources) is also the most prominent indicator of the environmental impact of existing buildings, respective targets or minimum requirements can be found in national building codes and standards, including procedures for calculation or simulation. Targeting at a sustainable building development, further performance indicators have to be considered as well. Besides investments at the beginning, economic performance includes all operational costs during the whole lifecycle of a building. Interestingly enough, it is not energy or another technical category that holds the largest share of the running costs of a building—it is costs for human resources that are dominating. Consequently, well-being, comfort, and productivity are further indicators, which have to be considered in a holistic building performance assessment. This is underlined by the fact that (comfort-related) occupant behavior can significantly influence the energy performance of a building, particularly if occupants are not allowed to interfere with the indoor climate control. This is mainly the scope of our research through the last 20 years. With a focus on monitoring and building performance analysis, we investigated several office buildings in depth and compared the results to a large sample of the German research initiative 'Energy Optimized Building (EnOB),' which comprised a large variety of new as well as refurbished examples of different building types. We showed that well-designed buildings with passive cooling and an integrated energy concept could outperform the reference value in the German building code at that time by almost 50%. Investment costs of energy-efficient office buildings appeared to be in the same range as the costs of conventional buildings. A survey amongst the occupants of 43 of these buildings revealed that high energy efficiency not necessarily coincided with high satisfaction. A strong correlation was found between the ratings given for the indoor temperature and air quality, and the degree of occupant control over these parameters.

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This highlighted the occupants' need for interactive options. Initially based on field experiments and then followed by an ongoing series of laboratory studies in a newly designed test facility until today, we then further investigated aspects of thermal comfort. One objective is to contribute to a better understanding of the mechanisms of adaptive comfort in order to develop a more elaborated model compared to the existing simple correlation between comfort and mean outdoor temperature. Our test facility LOBSTER is designed exactly for this purpose, providing test rooms in which the indoor thermal environment can be controlled by individually heating/cooling wall surface temperatures and different ventilation strategies, but at the same time offering different adaptive opportunities to the subjects depending on the respective experimental design. This is also in line with various recent experiments to find triggers or significant boundary conditions (physical, psychological, social) for behavioral actions related to maintain or improve thermal comfort.

Andreas Wagner studied mechanical engineering at the University of Karlsruhe before he worked as a researcher at the Fraunhofer ISE in Freiburg for eight years. Since 1995 he has been a full Professor for Building Physics and Technical Building Services at the Faculty of Architecture of the Karlsruhe Institute of Technology (KIT) and head of the Building Science Group with approximately 30 researchers and students. His research focuses on monitoring and performance analysis of energy-efficient buildings as well as comfort and occupant satisfaction at workplaces. He was Dean of the KIT-Faculty of Architecture twice, and he is spokesperson for 'Efficient Energy Usage' at the KIT Energy Centre. He is also a member of different editorial boards as well as numerous committees.