Abstract

To reduce the energy consumed by the operation of buildings, and the related economic and environmental costs associated with that consumption, the demand for analysis tools and processes to assist in the design and construction of high-performance buildings has grown considerably. High-performance buildings today are composed of numerous interacting systems that contribute to energy consumption, and simulating this complex interaction requires sophisticated analysis software and equally sophisticated understanding of how the models represent the physical systems in the building.

Cooper Union's academic building at 41 Cooper Square was designed to address the energy-intensive processes inherent in a laboratory, classroom and office-dominated building with a focus on energy efficiency. However, to date the energy analysis of the building during design and post-occupancy have been accomplished with tools not able to fully capture many critical energy systems, and which do not easily lend themselves to modification, extension or scrutiny.

The purpose of this thesis research is to evaluate the important energy-related building systems using a whole-building energy model created with the open, extensible, and rigorous building simulation engine, EnergyPlus. The goal of the study is to translate the complex systems operating in 41 Cooper Square into as comprehensive a model as possible, and to evaluate the model's performance compared to the building's actual energy consumption. The research investigated two approaches to calibrating the whole-building energy model: one using hourly metered power consumption data and another using monthly utility consumption. The approaches explored different time variation profiles of internal energy consumption as the primary calibration variable, and showed that model agreement with measured data depends on similarity of time scales between inputs and comparison data. A fully realized whole-building energy model tuned to match measured energy consumption can improve understanding of building physics and contribute to future research on efficient building operation.