Panel 4 Introduction

Commercial Buildings: Technologies, Design, and Performance Analysis

What are some of the most important new designs and technologies available to commercial building owners and operators for reducing energy use? What are the most effective performance analysis methods in use today? These are some of the major issues we have tried to address in this panel. In previous ACEEE Summer Studies, several panels have been established to assess the performance and analysis of commercial buildings. This year Panel 4 has been created to focus on commercial building technologies, design, and performance analysis—what works, why it works, and how do we know it works. To accomplish this, 107 abstracts were reviewed by the panel leaders and trimmed down to a selection of 34 papers that represent the best practice from around the world.

These sessions are chock-full of interesting and diverse topics that cover almost all aspects of energy use in commercial buildings, from measured energy use of computers and photocopiers to the measured energy savings from the lighting retrofit at the U.S. DOE's Forrestal building, to the use of the Internet for monitoring and control.

Baseline Analysis

These three papers cover baseline analysis of commercial buildings and equipment, addressing the issues of building energy use, expected building energy use, and identification of opportunities for energy efficiency. Sharp explores the use of U.S. DOE's Commercial Building Energy Consumption Survey (CBECS) data as a source of baseline electric energy use intensity (EUI) data. Hewett et al. provide baseline data on the penetration rates of efficient commercial and industrial gas technologies in the Midwest. Hall et al. discuss five new energy screening tools for buildings, which include tools that range from simple annual fuel use comparisons in order to identify poorly performing buildings to detailed assessments of fan and chiller energy use in single buildings and detailed calculations of baseline energy use at the end-use level.

Computer Energy Use

With these papers, we chose to highlight an often overlooked aspect of energy savings—reducing the energy use of personal computers, photocopiers, and office equipment. Katipamula et al.'s discussion of the energy savings potential from implementing the U.S. EPA's ENERGY STAR compliant personal computers is quantified by carefully studying a commercial office building in Northern California. Nordman, Piette, and Kinney evaluate energy use measurements from computers located at six locations across the United States in order to derive the energy use modes, hours of use in each mode, energy use, and potential energy savings. Dandridge, Norford, and Nordman develop and test procedures to monitor the energy use of photocopying machines. The paper compares a method that uses light flashes from the photocopier against actual energy consumption to analyze the energy use of photocopiers.

Envelope Technologies and Performance

These papers focus on the building envelope and the climate data that govern envelope performance. Bourne and Carew describe the design, construction, and performance of a night roof-spray storage cooling system. Gartland, Konopacki, and Akbari examine the impact of reflective roof materials on radiative, convective, and conductive heat transfer in roofs with attics. Trowbridge discusses a procedure to adjust DOE 2.1 weather data to match ASHRAE design conditions for specific cities.

Federal Buildings Performance

Three papers focus on the performance of buildings in the federal sector. Specific issues include the interaction of energy and water savings at federal facilities, and the importance of monitoring and verification activities in performance contracting.

Bou-Saada et al. describe the analysis of a major lighting retrofit at the U.S. DOE's Forrestal complex in Washington, D.C. Mayo, Westby, and Ginsberg discusses the Federal Energy Management Program's federal water efficiency policy and the relationship between water and energy savings. Goldberg discusses monitoring and verification requirements for performance contracting. While not limited to federal buildings, performance contracting as a means of achieving energy efficiency is vital in the federal sector.

Daylighting and Lighting Technologies

These papers highlight energy savings through the use of daylighting and lighting technologies. Floyd, Parker, and Sherwin evaluate occupancy sensors using 15-minute before/after data from two office buildings. Their studies showed that average savings were 10 percent of the electricity use. Allen carefully evaluates daylighting systems to assess the effectiveness of the systems, showing at one facility the daylighting reduced energy use by 32 percent, varying from 14 percent in December to 45 percent in June. At another facility the savings were 11 percent on a clear summer day and 3 percent on a cloudy spring day. Lee et al. evaluates a deep-perimeter, light redirecting system in a southern California office building.

Methods for Assessing Building Performance

A diverse, yet interesting compliment of papers discuss how one determines whether or not a building is performing up-to-snuff. Benton et al. discusses a first-of-its-kind utility-sponsored lending library that makes available instrumentation and data acquisition systems for evaluating on-site building environmental conditions. Kammerud and Blanc evaluate a real-time pricing (RTP) system that was installed in a 40-story building in San Francisco. Dirks et al. discuss the building energy analysis and retrofit selection of Russian multifamily housing.

Retrofit Case Studies

Existing buildings and systems provide a very rich vein of energy savings potential. These papers cover a range of topics, from estimation of savings potential in an existing distributed steam heat system to monitoring of retrofit performance to the importance of O&M audits during capital improvements. Claridge et al. discuss the importance of performing a comprehensive continuous commissioning process as well as installing capitalized retrofit measures in the Texas LoanSTAR program. Mazzucchi, Gillespie, and Lippman discuss energy system performance monitoring at a large office building in San Francisco, California. Case et al. describe the development of a steam dispatch system for a distributed steam heating system.

Simulation for Building Performance Analysis

Many analysts use simulation to analyze building performance. Three papers present the state-of-the-art of the use of simulation for modeling retrofit performance analysis. Crawley et al. discuss the long-awaited marriage of the U.S. DOE's DOE-2 simulation program and the U.S. Army's BLAST simulation program in the context of the next generation of building simulation tools. Huang and Crawley discuss the issue of weather data as it applies to comparative DOE-2 simulations. Glicksman and Taub evaluate the energy savings from occupant-controlled HVAC systems using a specially developed simulation model capable of simulating the microclimate that surrounds a typical desk in an office.

Efficient HVAC Systems Design and Technologies

These papers focus on HVAC system design and the contribution of HVAC systems to whole-building energy usage. Outdoor air ventilation rate, an important factor in HVAC design, is examined in two papers that look at relationship between ventilation rate and energy usage. Jagemar and Andersson discuss the design analysis and commissioning of an energy efficient retrofit to a hospital wing in Sweden. Greenberg discusses measured savings from retrofits to electric motors, which ranged from -16 to 40 percent, while belt-drive replacements measured savings ranged from -2 to 12 percent. Olken et al. discuss remote building monitoring and control using the Internet. Wow! Now we'll have buildings and cars driving along the information highway!

Reddy, Liu, and Claridge examine the relationship between energy use and indoor air quality in terminal reheat variable air volume systems (TRVAV). Mudarri et al. quantify the energy impacts of increased ventilation rates. Franconi and Huang

analyze the contribution of the building shell, system, and plant to the space conditioning energy consumption of commercial buildings.

Display Papers

Our four refereed papers presented as displays put the icing on a well-made cake. Schrum, Parker, and Floyd discuss the effectiveness of daylight dimming systems using measured results from a test facility in Florida that show that savings vary from 24 to 51 percent depending upon the orientation, season, and type of blinds. Hernandez et al. present an analysis concerning the use of a hybrid cooling system in an office building, which consisted of a two-stage indirect evaporative air handler with a backup high-efficiency chilled water system. Lau and Ander demonstrate a side-by-side comparison of new and rebuilt CFC-free chillers, which shows that a new HCFC-123 chiller lowered electric demand by 24 percent and reduced energy use by 22 percent—not exactly what you would expect! Norford, Englander, and Wiseley discuss an expert system software program for real-time-pricing. This ASHRAE-funded software includes variations for facility design, seasonal adjustments, rate schedules, and load shapes, and helps the user analyze RTP savings opportunities, develop control strategies, and compare costs. Wonder if Bill Gates' new home could use this new RTP software?

We think that you'll agree with us when we say that the papers in this panel present an exciting cross section of the new technologies, design, and performance analysis methods that are available for commercial buildings. They show consistent progress toward improved information about the energy savings potential of important end-use loads such as lights, computers, and other office equipment. Several interesting topics are included as well, e.g., the results of efforts to begin to improve the energy use of Russian multifamily buildings, improved energy use in Swedish hospitals, and the use of real time pricing systems to reduce energy demand in large commercial buildings.

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