Panel 3 Overview: Commercial & Industrial Building Technologies

Panel 3 addresses energy efficiency in the commercial building sector, focusing on: the commercial building design process; commercial sector data; commercial sector technology; and commercial building retrofits. Significant findings from the Summer Study are presented below for each topic. For more detail, please refer to the selected papers in this volume, to the volume of abstracts, or to the reprints of other Summer Study papers in the Proceedings.

COMMERCIAL BUILDING SECTOR: AN OVERVIEW OF ISSUES AND RESEARCH

Energy consumption within the commercial building sector is the fastest growing among all sectors in the nation. However, this sector has shown the least improvement in energy efficiency since 1973 (Brambley, 1988). These requirements - and the apparent difficulty in making increasing energy significant energy conservation impacts - highlight the need for enhanced energy efficiency in the commercial building sector. The challenge, and potential impact, of effective energy conservation and load management this sector is significant, strategies in and the subject of increased attention.

energy-efficient More design of commercial buildings. effective buildings, retrofitting of existing commercial new energy-efficient technologies, better operational practices of and are key interest to building owners, building operators, utilities, regulatory bodies, and other energy and/or building design professionals. These parties have varying interests in commercial sector energy efficiency. Building owners and operators are interested in energy efficiency as a sound financial practice, Utilities, operating in an and in terms of maintaining building comfort. increasingly competitive market, seek to satisfy commercial customers, and often promote new, viable technologies. In addition, commercial sector energy consumption and conservation is a key concern of utilities seeking to better manage peak demand, and to forecast future energy requirements more Similarly, regulatory accurately. bodies are taking great strides in promoting commercial sector demand-side management programs as a "leastcost" option to increasing supply. Many regulators focus particularly on the "lost opportunity," the idea that inefficient buildings constructed area of today will consume more energy over the long term than necessary, and are to retrofit later than to construct in an energy-efficient more expensive today. manner Capturing lost opportunity is also of interest to For example, a jurisdiction is developing energy master municipalities.

planning technical guidelines and tools to achieve more energy-efficient building construction (Norton, 1988).

Considerable research is being conducted by energy professionals on the commercial building sector. Due to the diverse nature of the commercial building stock, research focuses necessarily on myriad building types, uses, and efficiency strategies. In addition, commercial building technology is evolving rapidly, increasing the need for measured data on technology performance. The confluence of energy demand growth, interest in demand-side management strategies, and evolving technology makes commercial building research timely and exciting. The Summer Study papers on commercial sector energy efficiency represent a significant sampling of this research, and key findings are summarized below by session.

<u>Commercial Building Design Process</u>

Research and programs on effectively incorporating energy efficiency in the commercial building design process directly address the issue of "lost Several barriers to more energy efficient design exist, such opportunity." economic concerns; maintenance problems; aesthetic concerns; making as: energy-efficient design strategies and technology fit properly; concerns about the potential negative effects of design strategies and equipment on activity; the overriding concern of designers and business developers to increasing first costs; the diffuse decision-making structure in the avoid design of commercial buildings; the lack of credible data on the performance of new technologies; and opting for conservative, traditional designs due to concern about liability. (Kilpatrick, 1988; Gardner, 1988; Holt, 1988)

To help overcome these barriers, current commercial building design research examines solutions at two levels. The first level focuses on developing broad, "macro" scale programs to improve the commercial building design process itself. A Commercial Building Systems Integration Program has been initiated by the U.S. Department of Energy and, as Gardner reports, includes building subsystem interactions, whole building energy targets, and Advanced Design and Operation Technologies.

The second level involves research and program developed at the state and local level, which stress solutions at the "micro", or individual building level. the emphasis is on technology transfer Often targeted towards improving the design process. For example, a design team approach, involving owner, developer, architect, engineer and other appropriate the building parties, is recommended by two authors (Wajcs, 1988; Lavine, 1988). As Wajcs notes, the team must establish energy performance goals early on in the design process. Moreover, it is essential, according to Brambley, that design participants communicate more effectively. For example, the building designer's intended operational practices must be relayed to the building operators during the commissioning of the building so that they can be used as operational guidelines. The concern about inadequate communication is supported by findings presented by Gardner, who contends that information on efficiency measures and strategies exist, but are all too often energy overlooked during the building design process.

3.10

building design specialists, with expertise in a11 Energy-efficient phases of design, can provide invaluable assistance, but are unfortunately Brambley notes that an emerging technology, a Computer-Aided few in number. Building Design (CABD) system, shows promise in filling this gap bv supporting energy-efficient design functions. In addition, an innovative energy-efficient application of new, lighting approach to encouraging technology for new construction and retrofitting is presented by Holt. One the barriers to designers adopting innovative, energy-efficient lighting of systems is their inability to visualize the amount and quality of lighting provided at nominally low installed lighting capacities. Holt proposes to operate a lighting laboratory where designers can readily assemble, test and visually evaluate these energy-efficient lighting systems.

Commercial Sector Data

Evolving computer and communications technology clearly has an impact on the way businesses operate, and on commercial building energy consumption. The growing interest in this particular end-use is represented by two papers focusing on the role of computer and miscellaneous equipment (CME) energy consumption and conservation.

Nguyen, in an on-site study of CME equipment in 1700 California buildings, notes that uncertainties regarding CME equipment intensities, their future penetration rates and internal heat gain impacts on HVAC equipment are key issues in commercial sector end-use forecasting. However, he considers the CME end-use generally insignificant with respect to total building equipment intensities, but notes that CME installed capacities are significantly higher in post-1979 buildings than in older buildings.

Given the need for more reliable forecasts of commercial sector energy use, CME end-use merits additional research and monitoring. For instance, Harris points out that projections for aggregate electrical demand for electronic office equipment are based on nameplate ratings, rather than measured consumption and demand. Moreover, he concludes that nameplate ratings overstate actual measured power by factors of 2-4 for personal computers and 4-5 for printers. Clearly, a need exists for measured data on CME demand and performance. Such data will facilitate forecasting commercial sector electricity demand more accurately, developing modeling guidelines for this end-use, and assessing system performance.

Further along these lines, Alereza reports on establishing a technology containing 24-hour load profiles options data base containing 30,000 market shares and efficiencies, capital costs, estimates of relative energy This type of data base is useful for forecasting dates of availability. commercial sector end-use electricity and natural gas consumption, taking of various end-use account seasonal and "dav type" performance into bases of this scale technologies within different building types. Data indicate the growing complexity of utility planning and decision-making.

Commercial Building Technology

Commercial building technology is evolving rapidly. but actual application lags in comparison. Measured data on system performance and developing a technology "track record" will help to spur market penetration. In addition, future market trends will influence whether or not new technologies are cost-effective from the consumer's point of view.

New findings are presented on a number of evolving commercial building technologies. For example, a paper presents information on vacuum insulating window research and development, which addresses the problem of thermal energy loss experienced with traditional commercial building windows (Benson, 1988). Given that there are approximately 19 billion square feet of windows in U.S. buildings, significant improvements in window thermal performance can have a large impact.

The effect of using battery storage for building electrical management is presented in terms of matching commercial building electrical supply and demand (Hurwitch, 1988). Battery storage is one of the emerging technologies that may replace standard pumped hydroelectric energy storage to achieve load leveling. Under current utility rate structures and customer load shape conditions, there is limited market potential for this technology; however, as demand charges increase, and utilities seek to retain large customers in a competitive marketplace, we can anticipate wider application of battery storage equipment.

The subject of cool storage is also discussed, and again, electric rate schedules will largely influence application of this technology (Piette. 1988). Utilities have been giving cool storage serious attention in the past few years, launching demonstration and rebate programs designed to introduce this technology. Cool storage techniques, once mastered by building operators, hold promise for load shifting. In addition, recent research indicates that first costs appear to be decreasing, and design engineers and building operators are gaining experience in implementing cool storage projects. Nonetheless, more submetered data on cool storage technology performance is needed.

The market acceptance and lighting power budget aspects of highly energy-efficient lighting systems are discussed by Goldstein. Energy usage for lighting is a significant aspect of building energy efficiency, perhaps accounting for half of total electricity consumption in certain commercial building types. The lighting industry has addressed the need for energy efficient lighting systems to a large extent, but these systems are not widely employed in the United States. Goldstein contends that the greatest barriers to market acceptance of efficient lighting equipment and controls are the lack of information on product availability, the lack of sufficiently ambitious standards which encourage innovative and energy-efficient lighting designs. and the absence of facilities to visually test super-efficient lighting designs.

Commercial Building Retrofits

In addition to promoting energy-efficient design of new commercial buildings. retrofitting existing buildings is an important aspect of upgrading the commercial building stock. Recently, many utilities have launched equipment rebate programs to promote energy-efficient retrofitting These and other demand-side management programs in the commercial sector. are designed to "purchase" efficiency, or capacity, as an option to building additional power generation and transmission facilities in the future. The growing importance of the "least-cost utility planning" approach will no doubt have a lasting impact on the utility environment.

The issue of how to compare demand- and supply-side options properly in long-term utility planning must be addressed. For instance, in order to properly calculate rebate amounts, and the demand reductions likely to result conduct from retrofitting, utilities should rigorous, well-planned As Jones points out, utilities should not rely wholly submetering projects. on vendor performance calculations, and submetering actual retrofit measures particularly important for large equipment rebates. Along similar lines. is measured retrofit performance data reported by Nortz and Englander show that retrofits discrepancies persist commercial building are effective, but between estimated and actual savings. Moreover, additional research is needed on determining how long energy savings from retrofit measures will persist (Gordon. 1988). Without measuring retrofit performance and persistence, rebate programs and other demand-side management strategies cannot be integrated with supply-side options successfully.

Building operation and maintenance strategies are discussed by Haberl and MacDonald, emphasizing continuing analysis of building consumption data to provide performance feedback to building operators. As computer and energy management and control system (EMCS) technology advances, timely diagnostic measurements - and perhaps operating advice from expert systemswill support building operators on a day-to-day basis.

CONTINUING THEMES IN COMMERCIAL BUILDING RESEARCH

The ACEEE Commercial Building Technology Panel continues to address the important issues facing commercial building energy researchers in their quest to understand and improve commercial sector energy performance. These issues, developed at the 1986 ACEEE Summer Study, include:

- Planning for an uncertain future in the commercial sector. New relationships between end-users and energy providers. energy adoption of least-cost utility provider competition and the significantly different concepts are leading to а planning The need for more detailed planning on the part of environment. all commercial sector parties, requiring new and more detailed data, will be one characteristic of future research.
- <u>Technology performance</u>. Commercial building energy conservation technologies are proven to work, but not as well as expected, in

both new and existing buildings. The gap between potential and actual performance must be narrowed. Technology management design implementation building and procedures and whole responsibility are needed to tap the conservation potential. In particular, technology management skills must be improved, and research and technology transfer programs at the national and state levels can aid local implementation.

The mechanisms and processes to Technology delivery systems. deliver cost-effective commercial building energy conservation end-user critical to achieving the to the are technology delivery systems need to be These conservation potential. flexible and market-oriented to achieve the desired penetration Innovative programs with experimentation and and performance. feedback are necessary to determine what works for individual market segments at the local level.

At this 1988 Summer Study, Commercial Building Technology Panel authors continued to define and address these issues, and to propose solutions based on research and program experience.

Harry Misuriello W.S. Fleming & Associates, Inc.