2000 ACEEE SUMMER STUDY ON ENERGY EFFICIENCY IN BUILDINGS

Efficiency Sustainability

3 Commercial Buildings: Technologies, Design, and Performance Analysis

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American Council for an Energy-Efficient Economy

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Foreword

Responding to the theme of this Millennium Summer Study—"Efficiency and Sustainability" professionals from around the world discussed the technological basis for and practical methods of implementing efficient and (hopefully) sustainable energy use in buildings. Issues, trends, challenges, and accomplishments were discussed. Each volume in this proceedings focuses on specific issues that encompass global visions for the future and discussion of future trends.

The 2000 Summer Study continued to emphasize new trends in buildings, equipment, markets, and social issues. Topics ranged broadly from the ENERGY STAR® program for new construction to building envelope and system engineering issues. The papers presented reviewed the latest information on utility restructuring and impacts on utility-sponsored programs, as well as global market issues, information technologies, and non-energy benefits. Sustainable development strategies; community-scale initiatives; factors influencing energy consumption and purchase of energy-efficient technologies; and how to design, implement, and evaluate energy programs were just a few of the cutting edge discussions that warm the mind and stir our quest for enlightment.

The subjects of the ten volumes in this proceedings are:

- 1. Residential Buildings: Technologies, Design, and Performance Analysis
- 2. Residential Buildings: Program Design, Implementation, and Evaluation
- 3. Commercial Buildings: Technologies, Design, and Performance Analysis
- 4. Commercial Buildings: Program Design, Implementation, and Evaluation
- 5. Deregulation of the Utility Industry and Role of Energy Service Companies (ESCOs)
- 6. Market Transformation
- 7. Information and Electronic Technologies
- 8. Consumer Behavior and Non-Energy Effects
- 9. Energy and Environmental Policy
- 10. Building Industry Trends

We, the co-chairs, would like to thank the 23 panel leaders who sorted more than 658 abstracts, selecting and nurturing 309 papers through the rigid review and publishing process, and selecting more than 60 talks for the poster sessions. We would also like to thank the many peer reviewers who worked with the panel leaders. Finally, a well-deserved thank you to the staff of ACEEE, in particular Glee Murray and Rebecca Lunetta (who received key assistance from Renee Nida and Julia Harvell) for their support and guidance throughout this process and for making the week a very successful "energy camp."

James McMahon, Lawrence Berkeley National Laboratory Pat Love, Oak Ridge National Laboratory

Acknowledgments

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PANEL 3: INTRODUCTION

Commercial Buildings: Technologies, Design, and Performance Analysis

This panel focuses on the energy performance of new and existing commercial buildings. Beginning with a session on designing energy-efficient new buildings, the panel proceeds through a wide range of topics including monitoring, building envelopes, modeling, commissioning, technologies, and examples. Specialty sessions focus on daylighting; heating, ventilation, and air conditioning (HVAC) systems; miscellaneous equipment; and energy-efficient commercial buildings in Europe and the Pacific Rim.

Design: Baselines, Fresh Air, and Parametrics

Session 1 features papers evaluating the unique opportunities for maximizing cost-effective energy efficiency in new buildings. The first paper summarizes the major findings of a study that surveyed architects and engineers to assess the strength of market barriers to energy efficiency. The second paper describes lessons learned in applying a building energy simulation program that facilitates rapid comparison of energy efficiency alternatives in the early building design stage. The final paper explores the energy implications of designing ventilation systems based on a range of occupancy projections.

Models & Diagnostics: Cooling, Chillers, and Forced Air

Fault Detection and Diagnostics (FDD) is receiving a lot of attention these days for the promise it holds for automating the process of figuring out what is wrong with a building, or better yet, telling you when it isn't operating as efficiently as it could be operated. Good models are a crucial part of any FDD system and this session has two papers that tackle models for cooling systems from an FDD perspective. The other paper reports that in five duct systems studied in the field, conduction gains/losses were generally greater than the losses due to duct leakage.

The Shell Game: Walls, Windows, and Roofs

The three papers in this session highlight energy opportunities with commercial building envelope systems including lightweight concrete walls, electrochromic windows, and light-colored roofs. The first paper evaluates the net heat transfer characteristics of lightweight concrete wall materials, and simulates their impact on full-year HVAC energy use. The second paper describes laboratory tests of commercial windows with electrochromic (switchable) optical properties, and summarizes their potential impact. The third paper evaluates how weathering affects both solar reflectance and building thermal loads in a range of climates.

Lighting: Mail, Malls, and Architects

This lighting session includes one paper on efficient task lighting and two on daylighting topics. The first paper summarizes a project to develop and demonstrate an integrated lighting system that saves energy and improves lighting quality in U.S. Post Offices. The second paper discusses daylighting systems implemented as part of a "whole building" energy efficiency design in a Colorado retail mall. The last paper evaluates the level of daylighting expertise among commercial building architects based on in-depth interviews.

HVAC: Rooftops, Cool Slabs, and Fan Pressure

In commercial buildings, the systems and equipment chosen to provide the cooling (and heating) can make or break the energy efficiency of a building. Packaged rooftop units provide about 70 percent of the commercial cooling in California, but are notoriously inefficient. Measurements on over 200 units found typical consumption above 1.5 kilowatt (kW) per ton to reinforce this image! In contrast, night-time precooling of slab floors was shown to reduce cooling requirements by at least 50 percent in each of three buildings with "cool slabs"—and the need for compression refrigeration was completely eliminated in one! Many newer buildings have been designed to operate with higher fan static pressures than really needed, creating yet another opportunity for savings with no capital expenditure.

Controls: Schools, Hotels, and Card Keys

Even the best system can be turned into an energy hog if it isn't controlled right, and many systems, especially in schools and other smaller commercial buildings, are disabled by the operators while many others are operating disasters. The Oregon Office of Energy has developed three services to help their schools get what they pay for in controls. We then look at some of the ways modern controls could improve the efficiency of German hotels and conclude with a field look at the reduction in lighting and HVAC expense from a card-key controller in a motel room.

Equipment: Fuel Cells, Fridges, and Freezers

This session includes three papers on miscellaneous equipment in non-residential buildings. The first paper summarizes an energy-efficient 800 kW fuel cell array installed at a credit card processing facility to maximize energy system availability. The second paper assesses the impact of supermarket indoor humidity on the energy use of refrigerated display cases. The final paper evaluates the opportunities for, and barriers to, cost-effective energy savings in commercial packaged refrigeration equipment.

Commissioning and M&V: Campus, Utility, and PIER

Commissioning was virtually unknown in buildings when the first ACEEE summer study was held, but this session provides measured results that show that expenditure of \$2.5 million on a campus commissioning project has saved over \$10 million since 1996. The impetus for the only M&V protocol available today (International Performance Measurement and Verification Protocol or IPMVP) emerged from an informal session at the 1994 Summer Study. Experiences using the IPMVP in a utility program are given, followed by a description of three California projects intended to further the success of commissioning and M&V.

Examples: Flats and Modulars

Session 9 includes papers on three diverse energy efficiency projects. The first paper is the most recent chapter summarizing work in a major project to improve the energy efficiency of Russian apartment buildings. The second paper presents "before and after" energy use data for two Florida portable classroom buildings improved with five energy efficiency measures.

Examples: European and Pacific Rim Offices and Hotels

This session includes two international papers on example energy-efficient offices in Europe and China, and a third describing a retrofit hotel project in Singapore. The first paper presents descriptions and evaluations of German "lean buildings" that implement "whole building" integrated energy efficiency designs. The second paper summarizes progress on a joint U.S. and China project to implement a demonstration energy-efficient office building in Beijing that will house China's Agenda 21 climate change mitigation program. The third paper discusses an innovative project to create an energy efficiency showcase in a major Singapore hotel, using audit data taken from pre-retrofit building operation.

Euro Facades, Glass Block, and Comfort

Twenty years ago, many architects touted double envelope construction as a passive solar scheme that failed to catch on. A European improvement on this approach is described here. Hollow glass blocks offer a variety of architectural effects—they can be used more effectively with some of the optical measurements given in this session. This session concludes with early results on environmental conditions and occupant comfort perceptions from a 5-nation, 26-building European field data collection effort.

Finally, we'd like to thank Dan Turner for stepping in so one of us (DC) could disappear for a mini-sabbatical in New Zealand!

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