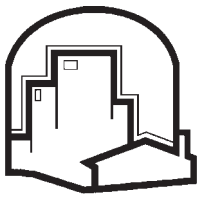
2000 ACEEE SUMMER STUDY ON ENERGY EFFICIENCY IN BUILDINGS



Efficiency & Sustainability

PROCEEDINGS

1 Residential Buildings: Technologies, Design, and Performance Analysis

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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 1: INTRODUCTION

Residential Buildings: Technologies, Design, and Performance Analysis

Panel One covers diverse topics associated with residential buildings: technological improvements to the thermal envelope, ventilation, equipment, thermal distribution systems, and appliances. The eclectic focus of the papers reflect the evolution of current thinking regarding residential energy efficiency at the turn of the century.

Energy Distribution Systems

Energy distribution systems are a natural focus for recent efficiency research given the wide acknowledgment of their shortcomings. Siegel, Walker, and Sherman show the large magnitude of duct losses on peak system performance, while Francisco and Palmiter provide a more refined description of how duct system efficiencies can be measured. Finally, Sherman, Walker, and Dickerhoff evaluate the long-term integrity of duct sealants.

Advanced Buildings and Integration with Photovoltaic Power

Integrated building design is one of the emerging trends of the last decade of global efficiency research. Points of interest include combining efficiency with solar electric power and addressing health issues. Gusdorf and Parekh show how Canada's flagship efficiency program, R-2000, has evolved to produce greater efficiency savings while addressing the need for improved indoor air quality. In the United States, Parker et al. present results from a side-by-side test of a very efficient Florida home, which produced a 93 percent reduction in daily energy demand and near zero demand during peak hour. In contrast, Tsurusaki, Tanaka, and Nakaami describe an extremely ambitious project in Japan, which has evaluated 132 residential installations with 3 kilowatt photovoltaic systems that produced 40 percent of electric power requirements.

Envelope Components

Building envelope improvements and associated evaluation remain fundamental to improving the energy efficiency of residence buildings. Meisegeier and Chinery provide an assessment of best practice efficiency upgrades for residences around the country from evaluation of a complex set of options. Additionally, Rudd, Lstiburek, and Ueno present important performance data on unvented attics, a controversial method to improve attic thermal performance in appropriate climates. Finally, Hill and Carruth describe a unique project attempting to design a very energy-and resource-efficient building in Canada with some interesting conclusions regarding the post-construction performance.

Ventilation Technologies

Ventilation of our homes in an energy-efficient fashion remains an extremely strenuous challenge for the 21st Century. Shapiro, Cawley, and King provide an enlightening evaluation of exhaust-only ventilation systems in New England. Complementing this work is a detailed study by Strunk, Kinney, and Carver in New York State. Springer, Loisos, and Rainer provide the other side to ventilation: how it can be used to meet cooling loads in the more arid portions of California.

Advanced Glazing Systems and Shading

Recent improvements to window technology for our homes make very substantial air conditioning energy savings possible. However, shading remains a time-tested method to accomplish the same end. Anello et al. show a measured 15 percent savings in cooling energy from a carefully executed side-by-side test of advanced spectrally selective windows in Central Florida. Farrar et al. describe a series of ingenious measurements of the oft-ignored impacts of shading on window performance and conclude that shading is more important than the glazing itself. Finally, Sonne and Vieira show how neighborhood-level landscape shading can reduce peak summer afternoon temperatures by 3˚F or more.

Analysis and Simulation

Our methods of assessment of residential energy efficiency continue to improve. MacDonald and Livengood demonstrate how residential energy consumption can be benchmarked to have a meaningful reference relative to other buildings. From a nuts and bolts perspective, Henderson, Parker, and Huang describe how our most detailed building energy simulations can be improved through enhanced modeling of equipment part-load performance. In contrast, Stoecklein et al. demonstrate an analytical evaluation based on detailed monitoring in many residential buildings in Australia.

HVAC System Performance

The performance of heating and cooling equipment is extremely important to achieving efficiency goals. Bouchelle et al. show how various factors—particularly thermostat setback—can adversely impact air-to-air heat pump performance and seriously degrade its potential efficiency advantages. Against this, Proctor and Parker show how heating, ventilation, and air conditioning system fan energy consumption can significantly impact cooling and heating efficiencies. Goldner describes how part-load impacts and sizing can impact system seasonal efficiency of heating systems in the Northeast.

Appliances and Equipment

Water heating and other appliances are a large total share of residential energy use and ancillary devices such as a thermostat can be important. Johnson, Bhagani, and Carlson show persuasively how the controls for baseboard electric heating systems can make a large difference in the heating efficiency of that system. Lekov et al. present a detailed evaluation of various design options to increase the efficiency of residential water heaters. And finally, Sidler et al. show results from a very interesting study of measured cooking energy end-use in large sample of French homes.

Testing and Measurement

Our ability to gauge efficiency depends largely on our success in accurate measurement. Palmiter and Francisco describe a very promising new device that measures air handler air flow—a chronically difficult, but important measurement. Additionally, Andrews presents a detailed evaluation of the relative accuracy of various duct leakage measurement techniques available to installers or auditors. Finally, Cautley, Schepp, and Desjarlais provide an evaluation of how moisture levels can be measured in residential buildings, along with the specific hazards involved.

Technology Transformation

An important challenge for residential energy efficiency is moving from a new technology to one that succeeds in the marketplace. Akbari, Konopacki, and Parker describe the development of provision within ASHRAE Standard 90.2 for reflective roofing systems, a powerful method to reduce cooling loads in hot climates. Also, getting there and staying there is important. Richardson and Skumatz discuss the success of measure retention in residences. And last, but not least, we have a one-off: a paper on transformer efficiency by Korn et al., which although a commercial building technology, was intriguing enough to the panels leaders to be afforded a place on our roster. Learn something!

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