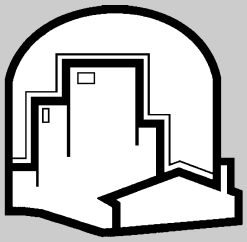

2002 ACEEE Summer Study on Energy Efficiency in Buildings

Teaming for Efficiency
PROCEEDINGS

Residential Buildings: Technologies, Design, Performance Analysis, and Building Industry Trends

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PUBLICATIONS: (202) 429-0063

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Foreword

The 2002 Summer Study on Energy Efficiency in Buildings, a biennial conference organized by the American Council for an Energy Efficient-Economy (ACEEE) brings together professionals from around the world to discuss the technological basis for, and practical implementation of, improving energy use in buildings. Participants, including authors of the papers published in these proceedings, represent government agencies, industry, utilities, national laboratories, universities, consultants, public interest groups, and others.

We selected the Summer Study's theme, "Teaming for Efficiency," to highlight the importance of public/private partnerships, regional collaborations, and inter-regional efforts. However, it is clear from the papers presented at this conference and published in these proceedings that the word "team" meant much more to our conference participants than the traditional definition with which we had started—a group of people joining together to bring a specific effort to fruition. The complexity and global nature of today's energy concerns calls for national and international collaborations and the linking together of fields of study and strategies which often evolve separately.

In addition to focusing on teams and partnerships collaborating on specific projects, papers in these proceedings highlight the importance of metaphorical teaming between many individual subjects. Lessons learned from the papers include:

- teaming between individuals involved in field measurements and analytical evaluations is key to developing new efficient products
- the integration of component technologies into building systems results in totals greater than the sums of the individual parts
- research and deployment efforts need to complement each other
- teaming of systems with operators through commissioning, load management, and the use of information technologies is key to realizing expected energy savings and curtailing demand
- teaming is key to getting the tools that support energy-efficient building design and construction into the hands of people who design, build, and operate buildings
- as witnessed in the subject of utility issues, the lack of teamwork and the absence of the ethic of collaboration for the good of society as a whole derailed one of the world's largest energy infrastructures
- the issue of teaming runs through the whole field of market transformation: defining market transformation is, in itself, a team effort, and market transformation programs inherently rely on team efforts to be successful. Advocates of energy efficiency must team with those working to improve the quality of the built environment because energy efficiency is inherently linked with increased comfort and productivity in buildings

- teamwork between program developers and evaluators ensures that we learn from our mistakes and promote our successes
- cross-cultural efforts lead to more effective programs

Finally, as global events this past year have reminded us, energy efficiency professionals are part of the team working to solve global environmental and security problems.

The subjects of the ten volumes in these proceedings are:

1. Residential Buildings: Technologies, Design, Performance Analysis, and Building Industry Trends
2. Residential Buildings: Program Design and Implementation
3. Commercial Buildings: Technologies, Design, Performance Analysis, and Building Industry Trends
4. Commercial Buildings: Program Design and Implementation
5. Utility Issues
6. Market Transformation
7. Information and Electronic Technologies: Promises and Pitfalls
8. Human and Social Dimensions of Energy Use: Understanding Markets and Demand
9. Energy and Environmental Policy
10. Program Measurement and Evaluation

At this 15th Summer Study, we offered participants a new presentation format—"Round Table" sessions. These sessions involved a full hour and a-half session within the topic area of each panel, and were designed so that industry and non-industry participants could collaborate on topic areas where issues are best addressed by a diverse panel of authors. Within each volume of these proceedings, you may find one or two such "Round Table" papers.

We, the Co-Chairs, would like to thank the 25 Panel Leaders who evaluated more than 600 abstracts, and selected and led 273 papers through a rigorous review process. We would like to thank the many peer reviewers who worked with the Panel Leaders through this process. Most importantly, we would like to thank ACEEE staff, in particular Glee Murray, Rebecca Lunetta, Renee Nida, Deborah Ziff, and Julie Harvell for their tireless efforts to make this an extremely successful conference and to produce these valuable proceedings.

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Linda Sandahl, Pacific Northwest National Laboratory

Acknowledgments

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PANEL 1: INTRODUCTION

Residential Buildings: Technologies, Design, Performance Analysis, and Building Industry Trends

The papers in this panel present information on the energy efficiency of residential buildings. The major topic areas are HVAC equipment and systems, duct performance, domestic hot water, thermal performance of the envelope, advanced components, and diagnostics and ratings. The papers feature field-measured results, engineering analysis, new technologies, design approaches, measurements, and the latest data on what works and what is happening. Also, new technologies are presented along with their measured performance.

Air Conditioning

Residential air conditioning is one of the most important components of peak electrical demand and energy use, but how do residential air conditioners perform and why? A database on the characteristics and efficiency of over 13,000 residential air conditioners is presented with interpretation of the data. The impact of evaporator coil fouling is explored with laboratory tests, analysis, and modeling. Solar gains on the air conditioner outdoor unit are shown not to be a major factor in Florida homes.

HVAC Technology

Compressors, fans, and ducts all have an impact on the efficiency of the residential HVAC system. The design and analysis of an innovative frostless heat pump system that can deliver significantly higher seasonal performance is presented. Pressure loss measurements of modern duct system components in one paper offer the context for another paper's analysis of the importance of air handler fan energy use and efficiency.

Duct Efficiency Measurement and Analysis, and Improvement

HVAC ducts have traditionally consumed one-third or more of the energy used for residential heating and cooling, but before measurements and analysis developed to demonstrate this fact, little was done to improve efficiency. Ongoing and sometimes hotly debated efforts to improve duct measurements and analysis, as well as comparisons of efficiency

improvement techniques are presented in several papers. Flow hoods for measuring residential duct systems are compared and evaluated. At least four methods of measuring duct leakage are evaluated in the laboratory and compared in the field. Duct sealing technologies are compared in large-scale tests of cost effectiveness and practicality.

Ventilation and Ducts

Whole house ventilation and indoor air quality (IAQ) are examined to determine whether new homes meet standards or code requirements. Twenty-four new Wisconsin homes were monitored to measure the effectiveness of mechanical ventilation equipment as well as ventilation rates during two weeks of the heating season to see whether they met the requirements of ASHRAE Std. 62.2P (American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc. new standard of ventilation). Thirty-one homes in Washington were tested for envelope/duct leakage, fan flow-rates, and operation to determine compliance with the Residential Ventilation and Indoor Air Quality Code.

Roofs

Experimental results are presented on the thermal performance of roofing materials and duct and attic configurations. An investigation is presented on the energy performance and peak demand of seven roof systems that focused on color, light or "white" to dark, and attic ventilation strategies using side-by-side Habitat for Humanity homes in central Florida. Also, complex inorganic color pigments are shown to make dark-color roofs behave similar to white-color roofs in the infrared portion of the solar energy spectrum. A different strategy for addressing the attic duct heat gain has been applied in three different homes.

Walls

Two papers address the thermal performance of Insulated Concrete Form (ICF) walls. Measured and simulated cooling results are presented for two ICF homes compared to two wood frame homes located in Dallas, Texas. Similar studies were completed on an ICF and a wood frame home located in Knoxville, Tennessee.

Advanced Components

The next three papers look at independent subjects, which address advanced components. Results of the first application of structural insulated panels (SIPS) to manufactured housing are presented. Nineteen photovoltaic systems were monitored in California to characterize system performance related to annual energy production, power output, and system size. Also, new compact fluorescent lights, which are targeted for faster development and market acceptance, are evaluated for energy savings, air tightness, and durability.

Diagnostics and Ratings

The actual performance of residences is reviewed in several papers. The U.S. Environmental Protection Agency has developed software that can be used to compare the annual energy use of a home to other homes nationally; it also assigns a performance ranking.

A statistical comparison of total energy use is presented for ENERGY STAR® homes compared to the rest of the local data in Alachua County, Florida. Thirty new homes in California were evaluated to determine how well energy-efficiency measures such as duct leakage, HVAC system airflow, envelope leakage, and insulation were installed.

Domestic Hot Water

Domestic hot water heating is another large consumer of residential energy. Several papers feature an analysis of the factors which affect energy use and demand in 171 Florida homes with electric water heating. A "Round Table" presentation discusses distribution losses, which will describe the current practices, summarize the results of past and ongoing studies, discuss ways to think about hot water system efficiency, and point to areas of future study.

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