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Energy-Efficiency Strategies for Insurance Companies

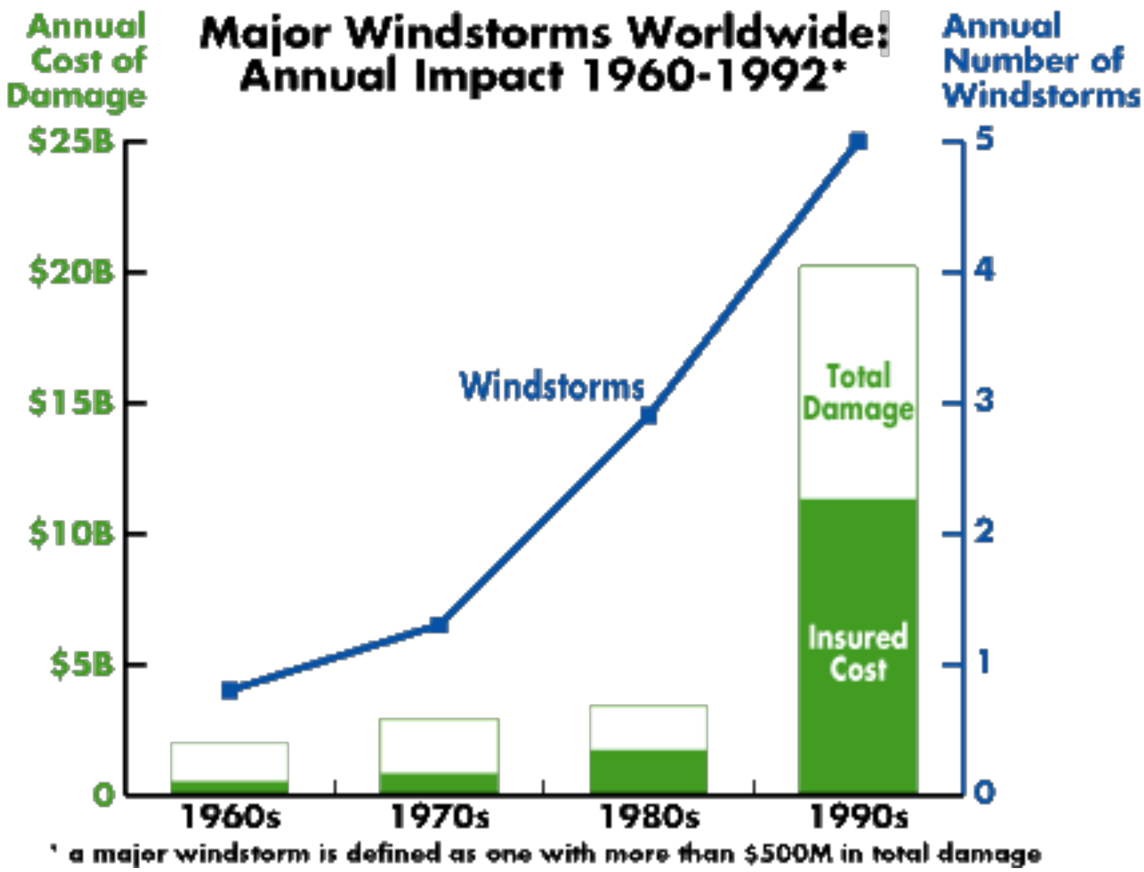

Figure 1: Note that the cost of windstorm damage loss has increased in part due to a rising concentration of property and populations in high-risk (e.g., coastal) areas. Inflation-corrected cost reported in 1990 prices; data from Munich Re & Swiss Re.

Global climate change is in the news again, partly because the insurance industry has taken notice of the threat climate change poses to its business. Recent research at the Center for Building Science suggests that selected efficiency strategies can help protect against insurance losses while reducing greenhouse-gas emissions, a winning proposition for the insurance industry.

The Climate Connection

The world's 1.4-trillion-dollar insurance industry is becoming increasingly concerned about financial risks from natural disasters precipitated by global climate change: windstorms, hailstorms, mudslides, wildfires, flooding, urban heat waves, public health problems, and agricultural damage. According to the Reinsurance Association of America, nearly 50% of the insured losses from natural catastrophes during the past 40 years have been incurred since 1990; the most notable was Hurricane Andrew, with an insured loss of nearly $16 billion.

To the insurance industry, the absence of certainty about global climate change is not synonymous with the absence of risk. The industry is familiar with acting to reduce risks even before full information about them is available. The most prominent expressions of concern about climate change are the Statement of Environmental Commitment by the Insurance Industry signed at the United Nations by 58 insurance companies from 22 countries, formal statements made by the same group at the Berlin Climate Summit of April 1995, and a chapter on climate change and the financial sector prepared for the Intergovernmental Panel on Climate Change (IPCC, Working Group II).

Energy-Efficiency Strategies that Prevent Insured Losses

Energy consumption is the largest contributor to global climate change, so promoting energy efficiency is a particularly promising strategy for the insurance industry. Many energy-efficient technologies can also reduce ordinary insured losses involving property, health, or liability. For the buildings sector, efficiency measures can reduce losses from fire, ice, wind, and water damage; temperature extremes; business interruption; occupational injuries; poor indoor air quality; and equipment performance problems. Over the years, the Center has generated a considerable body of research on energy-efficiency measures with the potential to reduce global climate change, as well as insured losses. Here are eight examples:

- Energy-efficient windows. During a fire, heat-stressed windows can shatter as a result of differential expansion near the frames; the increased supply of air flowing through a broken window accelerates the spread of fire. Efficient windows [Spring 1994, p. 2] may reduce the likelihood that fire will cause breakage. Efficient dual-pane windows or windows with retrofit films are also more resistant to breakage by thieves or windstorms.

- Building commissioning. A major cause of litigation and contractor call-backs in buildings is improper performance of heating and cooling systems. A reemerging practice called commissioning aims to increase quality control during design and construction, conduct formal functional testing and inspections of energy-using equipment to ensure that intended performance and energy savings are achieved, and provide for operator training. Insurers and legal experts have cited commissioning as a way to decrease the likelihood of professional liability claims.
- Urban heat-island mitigation. Lowering urban air temperatures by increasing the albedos of roofs and roads also has the side benefit of reducing smog, which in turn reduces health-insurance claims [Spring 1994, p. 6].
- Weatherization of multifamily buildings. Analysis of top-floor apartments typical of Chicago show that lightening roofs, insulating attics, and utilizing natural ventilation would have greatly reduced the likelihood of heat deaths during the heat wave of 1995 (see article this issue).
- Torchiere lighting efficiency measures. Compact fluorescent retrofits for halogen torchiere fixtures eliminate an important fire hazard in the home (see article this issue).
- Aerosol duct sealing. Eliminating residential duct leaks can help avoid dangerous pressure imbalances, which can lead to fire risks from flame roll-out or health and life risks from carbon $moNO_x ide$ backdrafting from gas appliances [Winter 1995, p. 8].
- Development of low-cost indoor air-quality monitors. A new passive carbon $moNO_x ide$ monitor allows for large-scale surveys to pinpoint this invisible life-threatening gas [Spring 1995, p. 6].
- Evaluation of residential building code compliance. This work has shown that performance targets set by codes are often not met in the field, an issue also of concern to the insurance industry with respect to safety-related noncompliance.

Indoor Environmental Quality Strategies

Human health and productivity are linked to the indoor environment in at least six ways: infections, disease, allergies/asthma, acute sick-building health symptoms, poor worker performance, and electronic equipment failures. Insured health care, lost-productivity, and professional liability costs resulting from indoor air-quality problems are substantial. The Center's Indoor Environment Program has conducted research in a number of areas with implications for decreasing insurance costs: causes of sick building syndrome [Fall 1995, p. 6], reducing indoor pollutant sources, identifying "high-radon" areas [Summer 1994, p. 4; also this issue] and designing radon-resistant homes, and minimizing the use of air recirculation. Other projects have focused on energy-efficient ways of improving occupational safety, such as developing an air vest to protect spray-booth workers from unhealthful working conditions [Winter 1993, p. 7].

What the Insurance Industry Can Do

By supporting the kinds of strategic energy-efficiency and indoor environmental quality options described earlier, the insurance industry could reduce near-term business risks while contributing to long-term reductions in greenhouse-gas emissions, which also threaten their bottom line. This represents an attractive no-regrets opportunity for the insurance industry, as the risk-reducing benefits would have distinct value irrespective of the timing or extent of avoided damages related to global climate change.

The industry could move forward by developing innovative insurance products (e.g., premium rebates) to encourage the use of loss-preventing efficiency measures, making their own buildings into efficiency showcases, participating in R&D and commercialization of new technologies and services, and collaborating with existing building and appliance standards development and compliance organizations.

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News From the D.C. Office

Integrated Chiller Retrofits: Sharing Experience Makes "Cool Sense"

A recent issue of the *Center for Building Science News* [Spring 1996, p.2] described the opportunities for significant energy savings from replacing older, inefficient chillers. These savings can be increased greatly if building owners and managers approach the chiller replacement not just as a requirement, but also as an opportunity-that of investing in other energy-saving measures that reduce cooling loads and lead to the downsizing of the chiller and related equipment.

The Air-Conditioning and Refrigeration Institute estimates that 80,000 existing chillers using CFC refrigerants need to be replaced or converted to use HCFC or HFC refrigerants. Of these, about 20,000 will be replaced or converted by the year 2000, representing an estimated $1.8 billion in new, energy-related capital investments in the next few years. If these existing chillers are simply replaced with more efficient models, the annual energy cost savings could be more than $300 million, or about $5 billion over the new chillers' expected 30-year life.

However, if these chiller replacements are integrated with other building and system retrofits, savings and short-payback capital investments could be increased by a factor of five. An "integrated chiller retrofit" takes advantage of efficiency improvements in, for example, lighting, the building envelope, cooling towers, and air distribution and controls, to reduce peak cooling loads. Staged chillers or a variable-speed drive could then better match cooling capacity to the range of actual cooling requirements.

While the current wave of chiller replacements offers these unique opportunities, they also come at a time when shortages of capital, limited awareness, or management inattention may lead instead to a "least-common-denominator" approach to phasing out CFC refrigerants and replacing older equipment.

To ensure that the buildings sector does not lose an important savings opportunity, we are developing a network of public and private partners to quickly amass and share information on integrated chiller retrofit strategies. "Cool Sense," a national information network, is a project of the Center for Building Science and staffed by personnel at Berkeley and the Washington, D.C., office. It has three main elements:

- A national forum on integrated cooling solutions designed to bring together key players in both the chiller and energy-efficiency retrofit markets to share lessons and explore innovative approaches to integrated chiller projects.
- A series of regional training workshops to provide practical training for building managers, contractors, energy service companies, lenders, and others in designing and implementing integrated retrofit projects.
- A World Wide Web page that will synthesize the latest information on integrated chiller retrofits, provide access to analytical tools and software, and help link users to other high-quality sources of product and project information.

Several government agencies and other organizations have expressed interest in joining the Cool Sense partnership as program cosponsors, contributors of project information, workshop hosts, or participants in other capacities. Earlier this fall, this exciting new collaboration was discussed in informal sessions at two conferences in California: the 1996 ACEEE Summer Study on Energy Efficiency in Buildings, and the intergovernmental TEEM-96 meeting (the Energy and Environmental Management Conference).

We welcome inquiries from readers of this newsletter.

—Jeffrey Harris, Dale Sartor, and Mary Ann Piette

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See our Web pages.

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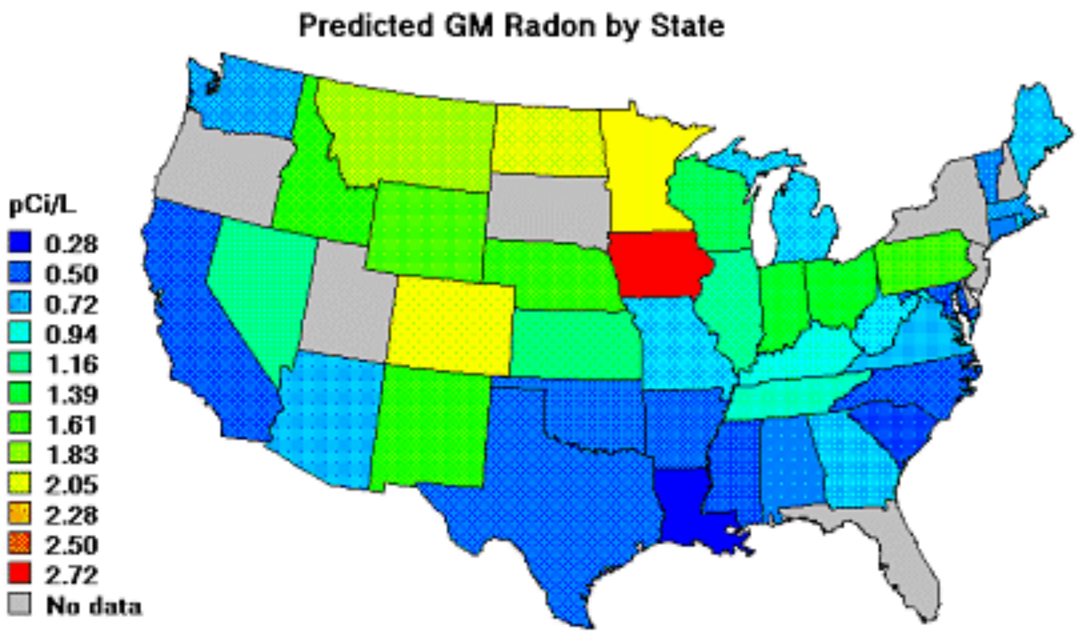
The High-Radon Project



Predicted geometric mean (GM) indoor radon concentration by county. These GMs are for annual average living area (AALA) indoor radon concentrations and were estimated based on a correlation of two national databases, one having AALA concentrations from about 5,000 homes selected nationally and the other having about 40,000 short-term (several- day) screening measurements, usually taken in the basement if there was one. Note that there is considerable variation in indoor concentrations within counties; also note that some county estimates are much more certain than others.

For several years, researchers in the High-Radon Project at the Center's Indoor Environment Program have been developing a statistical methodology for estimating regional indoor radon concentrations across the United States. The purpose of this work is to help state and other agencies identify high-radon counties and areas more precisely so that these authorities can focus their indoor monitoring and control efforts more effectively. The Project is a collaboration of the Indoor Environment Program, the U.S. Geological Survey, and the Statistics Department of UC Berkeley with funding from DOE and EPA.

Approach and Types of Results

The Project's basic approach is to examine the statistical correlation between available indoor radon monitoring data and information on physical factors affecting indoor concentrations for a state or region. These factors may include house structure types, radium concentrations in surface soils, other soil and geological characteristics, meteorological variables, and other predictive variables. The resulting correlation model is then used to predict local concentrations for counties (or smaller geographic units) that are more precise than would be possible using the monitoring data alone, because representative data are invariably relatively sparse [Summer 1994, p.4].

One result is a map of indoor radon for the state or region for which the analysis is performed, or for the U.S. as a whole if applied across the country. This indoor radon map can help identify with more reliability where indoor concentrations are expected to be substantially higher than average. The appropriate state or local agencies could then target surveys in these areas to find the houses with very high levels of indoor radon and give their occupants information and assistance to reduce indoor radon concentrations.

Many of the project's analytical results are presented as estimates and uncertainties in geometric mean (GM) indoor radon concentrations by state or county. When interpreting GMs, it is important to realize that within any region, some smaller areas will have higher GMs than others and that some individual homes will have indoor concentrations considerably higher than the region's GM.

We have conducted analyses for several states that were selected because of their particular distribution of radon concentrations or because of the relative availability of suitable predictive information. We have also performed analyses using a national dataset and a series of regional analyses that include most of the 48 contiguous states. In both the state and regional analyses, we have often found that our statistical models account for about 80% of the variability in mean county concentrations or, more precisely, in the logarithm of the county geometric mean indoor concentrations.

These analytical results are available from published journal articles and, for the regional analyses, from the Project's home page. Our results do not include predictions for smaller geographic scales such as census tracts or townships. Soon, users will be able to perform analyses themselves using monitoring data at these smaller scales. We will make the model subroutines and their documentation available through the Project's Web site. Encouraging the widespread use of these methods is a principal objective of the Project.

—Anthony Nero and Phil Price

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Visit the project's Web site.

This work is supported by DOE's Office of Health and Environmental Research and the Environmental Protection Agency's Office of Air and Radiation.

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Urban Heat Catastrophes: The Summer 1995 Chicago Heat Wave

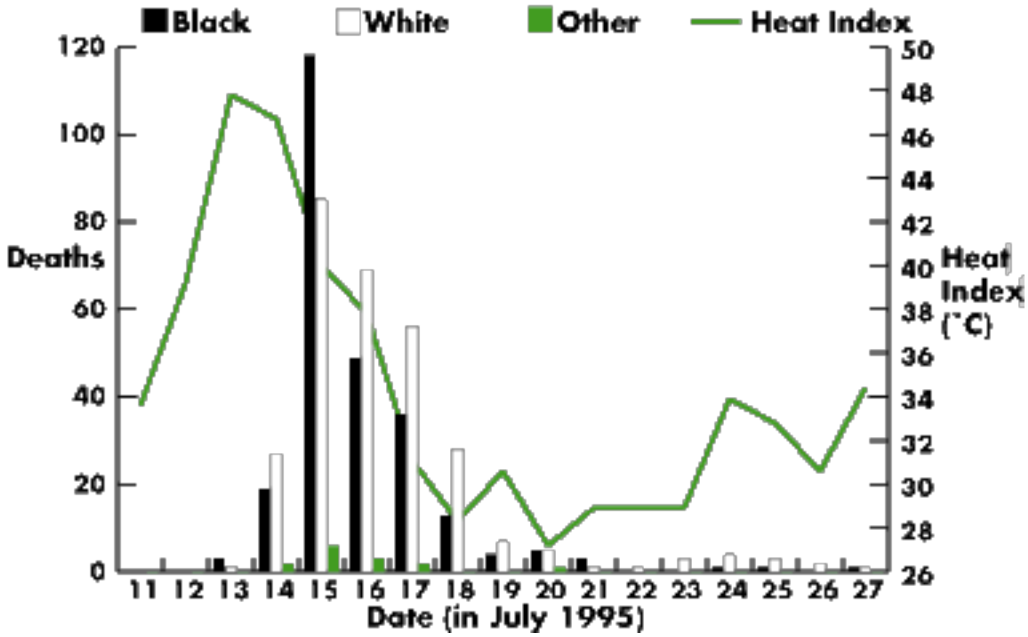

Figure 1: The bars indicate the numbers of deaths by race each day of the July 1995 heat wave in Chicago. The curve shows the heat index, which reflects the combined effect of temperature and humidity.

Last year's Chicago heat wave created a great deal of human discomfort and, according to the latest estimate, increased deaths in Cook County by more than 700 over five days. Epidemiological studies of heat-wave deaths have uncovered a number of socioeconomic, cultural, institutional, and physiological factors, but the role of the building and its interior conditions has been left largely unexamined.

A number of studies have compared ambient climate conditions to mortality during a heat storm. They found that there exists a heat-index threshold above which deaths increase rapidly. The duration, high humidity, high minimum temperatures, and low wind speeds all contribute to increased mortality, and a time lag exists between the peaks in the heat index and deaths. Surveys have also found that more deaths occurred in inner-city areas and disproportionately among older, infirm residents on the top floors of apartments without air conditioning. The mortality pattern appears to correlate with the thermal response of different building types to a heat storm, as well as to current conditions in the U.S. housing stock. Thus, it is surprising that studies have not been done on indoor conditions during a heat storm or on what role the thermal characteristics and operations of buildings play in this increased mortality.

The heat storm that affected Chicago from July 12 to 16, 1995, was a particularly acute episode containing all the danger signals-high temperatures and humidity and low wind speeds over a five-day period. The heat index reached 118°F (48°C) on the hottest day.

The Physiology of Human Discomfort and Heat Stress

Human discomfort and heat stress depend on temperature, humidity, radiant heat gain, and wind. A commonly used index for determining heat illness risk is the WBGT, a heat index that combines wet bulb, black globe, and dry globe temperatures into a single measure of environmental heat (Figure 1). Below a heat index of 64°F (18°C), the risk of heat injury is small. Above 82°F (28°C), strenuous activity should be avoided. From 90 to 104°F (32 to 40°C), heat cramps and exhaustion are possible; from 105 to 130°F (41 to 54°C), cramps and exhaustion are likely and heat stroke is possible; and above 130°F, heat stroke is highly likely. During the five days of the July heat storm in Chicago, 60 percent of the hours were above a heat index of 90°F, and 20 percent above 104°F.

The impact of excessive temperature on mortality is difficult to quantify and varies with the physical condition of the person. Preliminary statistics from the Chicago heat storm indicate that most of the victims were elderly people who were already in a weakened state.

Computer Simulations of Interior Conditions

The DOE-2 building simulation program was used to simulate indoor conditions in four prototypical multifamily buildings of different vintages during the July 1995 heat storm in the absence of air conditioning. The buildings were simulated first with windows closed, and then with windows opened for ventilation whenever the temperatures outdoor were lower than inside. To study the benefits of potential conservation strategies, the simulations were repeated with additional ceiling insulation, light-colored roofs, and lowered window-shading coefficients. These cases are called the "weatherized buildings."

If the buildings were unventilated, as was often reported to be the case, indoor temperatures could reach 108°F (42°C) on the top floors of buildings built in the 1940s (Figure 2). They were hotter than human body temperature for 80 percent of the hours during the peak three days. Conditions in the 1970s apartment building were even worse, with temperatures averaging 108°F over the three-day period. Because of their greater mass and moderate insulation, these buildings would remain hot for days after the peak air temperatures had passed. The heat index reached 129°F (54°C) in the 1940s apartments and 134°F (57°C) in the 1970s apartments over the period.

Strategies to Prevent Excessive Overheating during a Heat Storm

The simulations show that the single most important strategy to prevent excessive building overheating during a heat storm is ventilation. Under such conditions, ventilation will not keep the buildings comfortable, but will prevent them from acting like solar ovens and keep temperatures indoors close to or below those outdoors. In older, uninsulated buildings, adding ceiling insulation and lightening the roof color will have an appreciable impact on conditions in top-floor apartments. However, such weatherization in newer buildings will have a minimal impact on their indoor conditions during a heat storm.

Issues

The prevention or reduction of mortality during a heat storm should be viewed as a form of disaster relief. Because of the public outcry over the 1995 heat storm, the city of Chicago has been working on a relief plan. So far, their efforts have focused on public outreach, providing warnings, checking on tenants, and moving people to cool rooms to escape the heat. This preliminary study suggests the dangers can also be lessened by improving the thermal conditions and operations of the buildings. Since heat storms are sporadic, any such weatherization effort must consist of simple and inexpensive strategies.

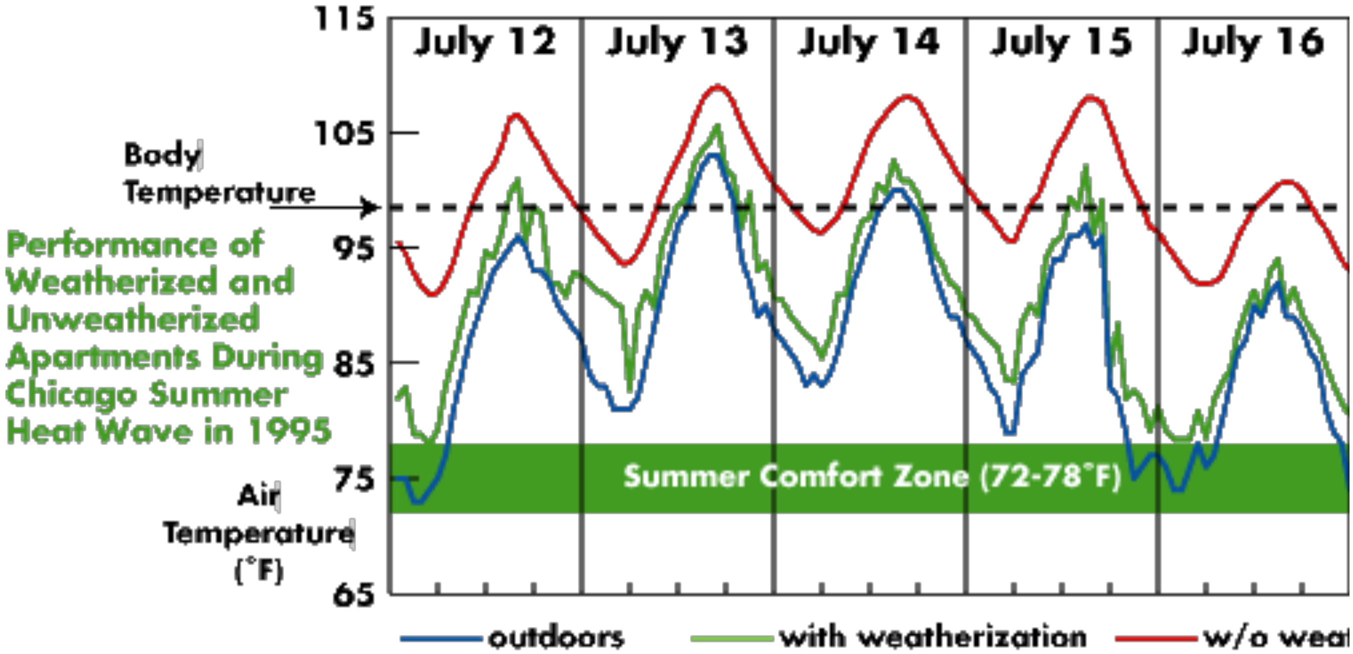

Figure 2: Computer-simulated indoor temperatures in the top floor of a prototypical 1940s two-story apartment building in Chicago during the July 1995 heat wave. In the existing building, top-floor temperatures reached 108°F and remained high even after the outdoor temperatures had started to drop. The addition of attic insulation, white paint on the roof, and open windows brought top-floor temperatures in line with outdoor temperatures.

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Energy-Efficient Torchieres for Residential Applications

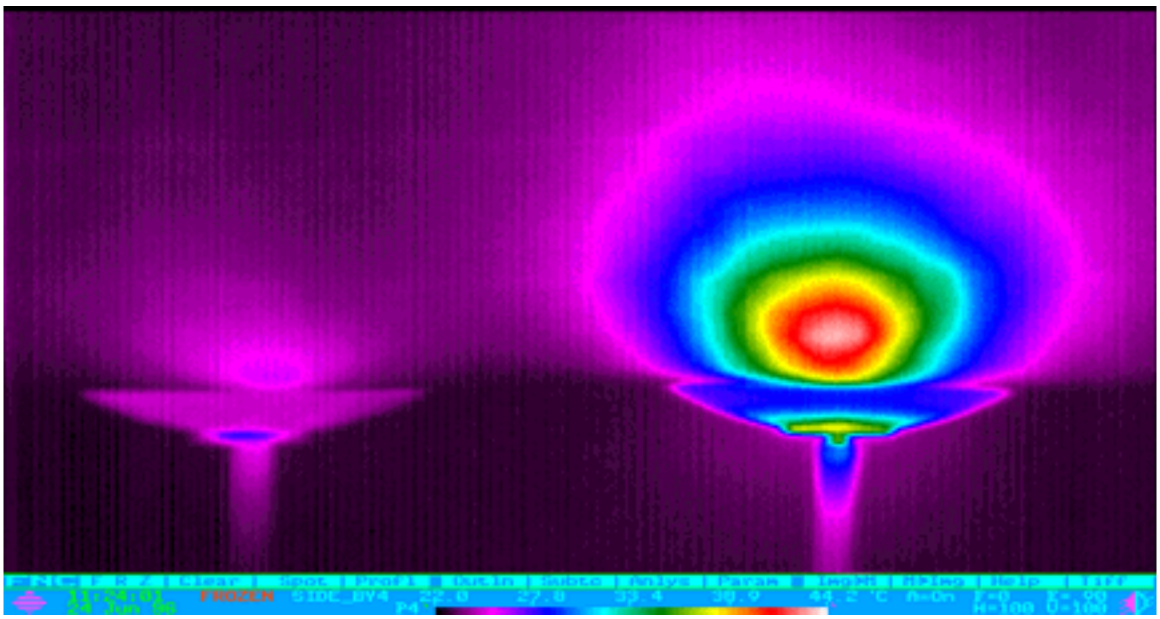

Figure 1. Infrared thermograph of a CFL fixture left) and a halogen fixture.

Over the past 5 years, the Center's Lighting Lab has been pioneering the effort to replace standard residential lighting fixtures with hardwired compact fluorescent lamp (CFL) fixtures. One type of fixture under development is a novel torchiere indirect uplight using a CFL. Preliminary studies measured these CFL torchieres photometrically and compared their performance to that of standard tungsten halogen sources. Measurements made of these systems include goniophotometry, infrared thermography and power quality analysis. Goniometric data and power assessments indicate that using compact fluorescent lamps instead of standard tungsten halogen sources can result in significant lighting energy savings. The Lighting Lab is in the process of setting up a consortium between large lamp, ballast and fixture companies to produce a dedicated CFL torchiere which uses only 55 Watts of power, but produces more light than its 300 Watt halogen counterpart.

Major Savings Opportunities

There has been a significant increase in sales of imported torchiere systems in the American market. These indirect lighting systems use tungsten halogen sources in the 300- to 500- Watt range. Imports of torchiere systems have resulted in one of the largest increases in residential lighting energy use and represent a significant challenge to energy-efficiency programs throughout the country.

The 300-Watt halogen torchiere fixture is currently one of fastest selling portable fixture types in the United States. Recent studies have estimated that halogen torchieres are now consuming more energy than CFLs are saving in the U.S. To counter this erosion of the progress obtained by years of demand-side management programs and related governmental and utility conservation activities, we need to rapidly develop energy-efficient alternatives to this fixture using compact fluorescent systems. We have produced a set of torchiere systems using efficient CFL sources and are optimizing them photometrically. Manufacturers hope to have production of prototype fixtures on the market early next year. While the initial price of the CFL torchiere will be around $35 more than halogen fixtures, the total payback over the life of the fixture from energy savings will nearly $200 (for a 300W halogen vs. a 55W CFL assuming a fixture life of 10,000 hrs and an energy cost of $0.08/kWh).

New Designs and Results

In the first phase of this study, we measured the performance of a standard dimmable torchiere system using a 300-Watt tungsten halogen source. The system was characterized using a goniophotometer, which generates total lumen output and candlepower distribution data [Summer 1995, p.4]. Efficacy, fixture efficiency, power factor and total harmonic distortion were obtained over the entire dimming range. In the second phase, we will modify a standard torchiere to accept a range of CFL sources and reflector systems.

Photometric data shows that the standard halogen torchiere has an efficacy ranging from 2 to 12 lumens per watt (LPW) depending on the dimming level. Preliminary results indicate that the efficacy for compact fluorescent systems is 5 times that of the halogen torchiere at full power and increases to nearly 30 times the halogen efficacy as dimming occurs. This is because halogen efficacy drops off dramatically over its dimming range while the CFL efficacy is fairly constant. Effective lumen matches have been achieved using a variety of CFL sources. The power quality, as compared to the dimmed tungsten halogen, improved significantly with a CFL. The dimmed tungsten halogen yielded power factors less than 0.2 and a THD approaching 200%. An infrared thermograph camera was used to compare the CFL prototypes to the standard halogen torchiere (see Figure 1). The IR photo not only illustrates how much energy is wasted on heat in the halogen fixtures, but also indicates the potential fire danger of these fixtures when placed next to combustibles such as drapes.

—Michael Siminovitch and Erik Page

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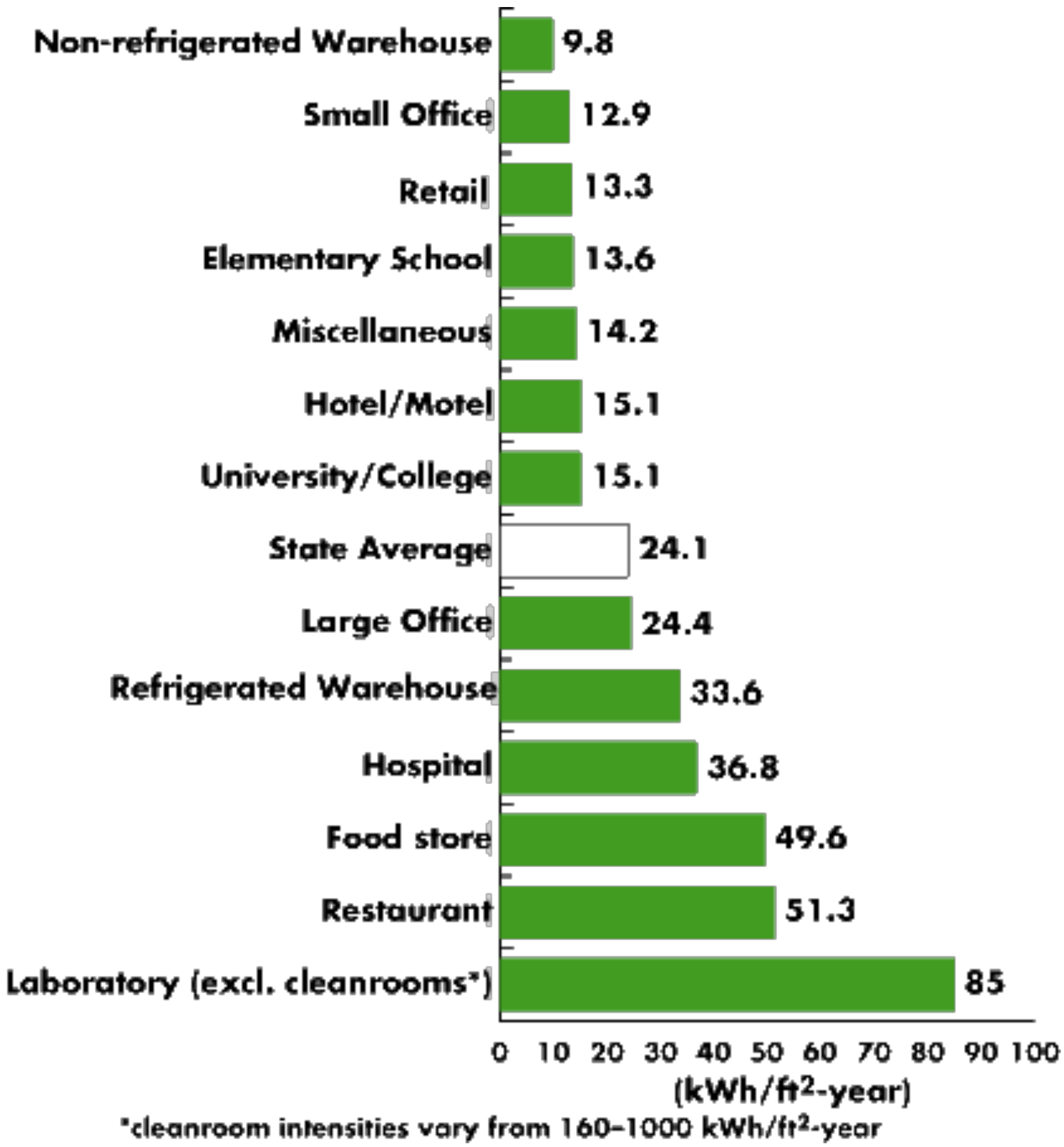
A-Team Report

Energy Efficiency in Laboratory-Type Facilities



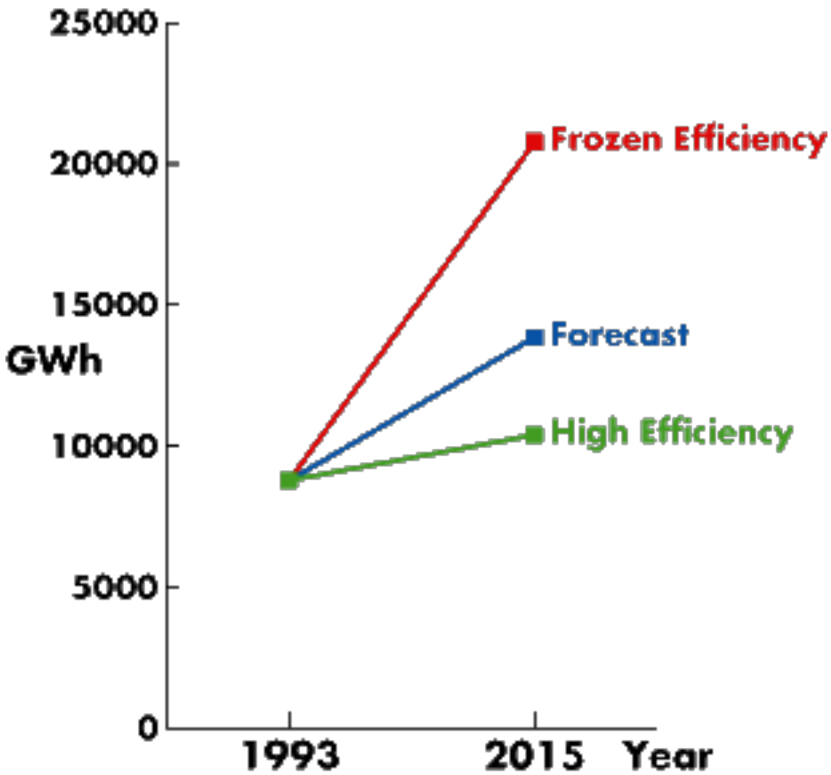
Comparative Electricity Use in California Buildings

Laboratory-type facilities use a considerable amount of energy resources and thus are the focus of a new study by the Applications Team. Improving energy efficiency in laboratory-type facilities is no easy task, and there are many formidable barriers to doing so in these highly specialized environments.

Given their demanding control requirements and specialized processes, laboratory-type facilities epitomize the important intersection of energy demand in the buildings sector and in the industrial sector. Laboratory-type facilities offer powerful examples of how energy-efficiency improvements can yield abundant nonenergy benefits.

Focusing on California, the study found that laboratory-type buildings represent 51 million square feet of floor area in the state, with energy intensities four to five times higher than those found in ordinary office buildings. In the case of cleanrooms, intensities are 10 to 100 times higher, depending on the cleanliness classification. Statewide, laboratory-type facilities consumed 111 x 10^{12} BTUs of energy in 1993, including 8.8 billion kilowatt-hours of electricity (2100 megawatts) and 21 TBTUs of natural gas. In the absence of energy-efficiency improvements, projected demand growth is 131 percent (3.9 percent/year) to the year 2015. The annual energy cost in 1993 was $700 million, growing to $1,640 million by the year 2015. The study found an overall savings potential of 50 percent.

Within this project, the A-Team developed a new publication entitled *A Design Guide for Energy-Efficient Research Laboratories*, which will be described in the next issue. The project also generated a research agenda, identifying promising research frontiers in the general areas of design processes and energy data diagnostics; technology and systems integration; and indoor environmental management and control strategies.



Scenarios of Electricity Demand in California Laboratory-Type Facilities

—Evan Mills

This work was supported by the California Institute for Energy Efficiency.
The full edition of this report can be found on the World Wide Web.