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Energy Efficiency: No-Regrets Climate Change Insurance for the Insurance Industry

Evan Mills, Ph.D.

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Abstract

The worldwide insurance industry faces great financial risks from natural disasters caused by global climate change. Insured losses from extreme weather events with potential links to climate change, such as windstorms, drought, and floods, have been steadily rising; a twenty-fold increase in annual insured losses (inflation-adjusted dollars) from windstorm damage since the 1960s is a dramatic indicator of the growing threat to insurers. The insurance industry is becoming increasingly outspoken in its concern about global climate change, as evidenced by an industry-authored report for the Intergovernmental Panel on Climate Change (IPCC) Working Group II, a declaration signed at the United Nations by 62 insurance companies from 23 countries, and a formal statement by the group at the recent Climate Change Framework meeting in Geneva. U.S.-based Employers Re is a recent signatory to the U.N. statements, and the Reinsurance Association of America has issued public statements expressing concern and has endorsed energy efficiency as a practical response option. (See ***Appendixes A** and **B**.)*

Introduction

The insurance industry can take a reactive approach to mitigating climate-change risk by limiting or withdrawing coverage. Alternatively, the industry can take a proactive approach by, for example, encouraging actions to reduce greenhouse-gas emissions.

Energy consumption is the largest contributor to global climate change, so promoting energy efficiency is a particularly promising strategy. Many energy-efficient technologies and associated indoor environmental quality strategies also have

Evan Mills, *Ph.D., has worked in the energy field as an economist, engineer, and policy analyst since the early 1980s and has lectured around the world on energy and environment topics. He received his Masters of Science degree from the Energy and Resources Group at the University of California at Berkeley and his Ph.D. from the Department of Environmental and Energy Systems Studies at the University of Lund in Sweden. Dr. Mills now leads Lawrence Berkeley National Laboratory's Center for Building Science.*

The U.S. Department of Energy's Center for Building Science, with an interdisciplinary staff of 225 people, conducts research on a wide spectrum of technical, economic, and regulatory aspects of energy-efficiency and indoor environmental quality. The Center is an international leader in developing new energy-efficient technologies and formulating strategies for utilizing energy efficiency as a climate-change mitigation strategy. The Center provides technical support to energy and environmental policymakers, carries out field applications of advanced technologies, performs market assessments, trains students in the energy field, and transfers information and technology to the private sector. Lawrence Berkeley National Laboratory is part of the family of DOE National Labs conducting research on energy and environmental issues.

the potential to reduce ordinary insured losses involving property, health, or liability. This article illustrates 70 specific ways in which targeted energy-efficiency improvements can translate into reduced risk of insured losses. The measures can reduce losses from: fire, ice, wind, and water damage; temperature extremes; theft; occupational injuries; poor indoor air quality; equipment performance problems; and roadway hazards. These loss-reductions translate into benefits for a variety of insurance providers, including property-casualty, professional liability, health, life, workers' compensation, business interruption, and automobile. Many public and private groups provide their own insurance, and these self-insurers generally have the same interest in loss-prevention as do commercial insurance companies.

The insurance industry and self-insurers could foster increased adoption of risk-reducing energy efficiency measures in the following ways.

- Adopt uniform protocols for quantifying the risk-reducing aspects of energy-efficiency measures.
- Develop innovative insurance products, such as differentiated premiums, that reward energy efficiency and improved indoor air quality.
- Make buildings owned by insurance companies more energy-efficient.
- Foster improved energy efficiency and indoor air quality in the process of financing and purchasing buildings.
- Collaborate with energy regulators, utilities, and other stakeholders.
- Participate in the research, development, and commercialization of new energy-efficient technologies and services.

Global climate concerns aside, any measure that decreases insurance losses contributes to the bottom lines of both insurers and insureds. By supporting strategic energy-efficiency and indoor environmental quality options, the insurance industry could reduce near-term business risks caused by insured losses and payout levels that consistently exceed premium revenues, while making a considerable contribution 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 damages related to global climate change.

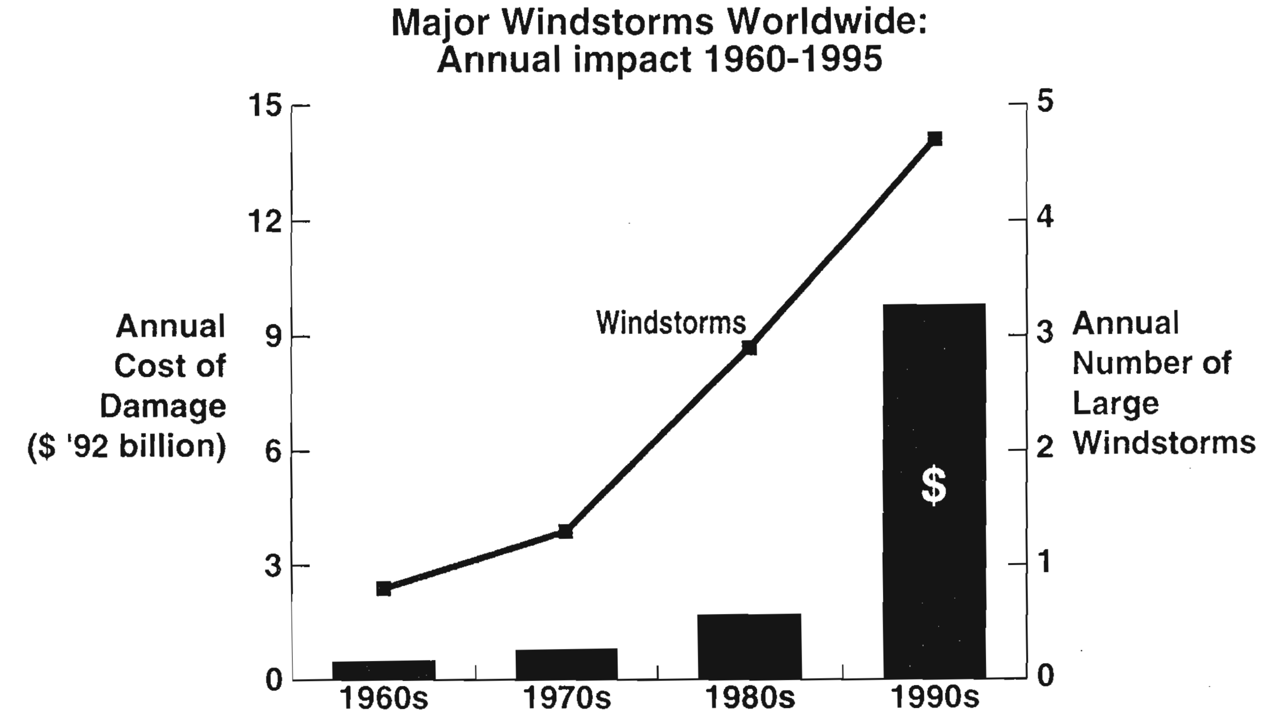
Context

The world's 2-trillion-dollar insurance industry is increasingly concerned about the prospect of financial risks from natural disasters precipitated by global climate change. As early as 1990 the insurance industry began linking climate change with increased windstorm-related losses. **[1]** Natural disasters represent 85% of insured losses globally, or $12.4 billion in 1995. Windstorms, wildfires, drought, and flooding cause some of the costliest insured losses. Average annual insured losses from windstorms increased by twenty-fold between the 1960s and 1990s. (Please see **Figure 1.**) Between 1966 and 1987 there were no disasters with insured losses of over one billion 1990 U.S. dollars; between 1987 and 1992 there were 15. **[2]** 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. **[3]**

The insured damage from Hurricane Andrew ran up to $16 billion, pushing seven insurance companies to insolvency and prompting many others to reduce their exposure or to leave the market altogether. Flooding of the Mississippi River in 1993 cost $10-20 billion; federal payments to farmers for drought-related damage in 1988 reached $4 billion; a 1995 hailstorm in three southern U.S. states caused insured losses of $1.1 billion. Multiple disasters of this magnitude over short periods of time or in more highly populated areas could bankrupt segments of the insurance industry.

In **Figure 1,** a *major windstorm* is defined as an event with insured losses greater than $30 million, and/or quantifiable total losses greater than $60 million, and/or fatalities greater than 20, homeless greater than 2000. The costs are in inflation-corrected 1992 U.S. dollars. **Figure 1** shows that increased frequency of windstorms is associated

Figure 1



with increases in insured losses, reflecting demographic trends resulting in more concentration of property and populations in high-risk (e.g. coastal) areas and growing numbers of policy holders.

The aftermath of Hurricane Andrew illustrated the complex nature of losses caused by natural disasters. About 20% of insured economic losses were related to business interruption. Considerable property losses affected people who resided far from the site of the storm (e.g., midwestern boat owners vacationing in the Caribbean), thereby impacting insurance companies that initially assumed they would be unaffected by the hurricane. Following the hurricane, homeowner insurance premiums rose by 72% in Florida. [4] Allstate insurance company moved to cancel 50,000 residential homeowner policies and CIGNA Corporation stopped writing new policies in South Florida. [5]

In addition to windstorms, insurance companies are at risk from climate-change impacts such as drought-related agricultural losses and adverse impacts on human health. The primary classes of anticipated health impacts are: (1) mortality and morbidity related to heat waves and increased urban air pollution, (2) re-emergence of serious vector-borne infectious diseases, (3) spread of water-borne diseases from hydrological extremes and elevated sea surface temperatures, (4) malnutrition from threatened food supply, and (5) general public health infrastructure damage from weather disasters and sea-level rise. In a scenario of doubled atmospheric CO_2 concentrations, the annual incidence of malaria could rise by 50-80 million cases per year. [6]

To the insurance industry, and to the large self-insurance market, the absence of certainty about trends and consequences in global climate is not synonymous with the absence of risk or the imperative for action. [7] The industry is familiar with acting to reduce risk even in the face of imperfect information, determining loss probabilities and associated costs and making business decisions based on those calculations. Recent writings and public statements by high-level insurance industry representatives indicate a growing consensus that human-induced climate change poses a strategic threat to their industry. The most prominent expression of concern is the *Statement of Environmental Commitment by the Insurance Industry* signed at the United Nations in 1995 by 62 insurance companies from 23 countries. [8] The industry has also articulated its concerns in a chapter prepared for the Intergovernmental Panel on Climate Change (IPCC) and in a Position Paper presented at the Climate Change Framework meeting in Geneva in 1996. In the U.S., Employers Re has signed the statement. The Reinsurance Association of America has issued public statements of concern, and has endorsed energy efficiency as a practical response option. [9]

Excerpts from the United Nations Insurers Group Statement [10]

- *We are committed to work together to address key issues such as pollution reduction, the efficient use of resources, and climate change.*
- *We are convinced that it is not possible to quantify anticipated economic and social impacts of climate change fully before taking action. Research is needed to reduce uncertainty but cannot eliminate it entirely.*
- *We are convinced that the most efficient precautionary measure is substantial reduction of greenhouse gas emissions.*
- *We insist that negotiations for the Framework Convention on Climate Change must achieve early, substantial reductions in greenhouse gas emissions ... the position of the insurance and reinsurance sector must be represented when discussing or negotiating possible solutions.*

It is notable that only one U.S. insurance company -- Employers Re -- has as yet signed the U.N. statement. The reasons for this are not clear, but there are several likely explanations.

- In Europe it is currently more advantageous for a company to represent itself as "green" than is the case in the U.S.
- European insurance companies have more scientists on staff and arguably have a better grasp of the climate-change problem.
- In the U.S., most flood insurance is provided by the government, thereby insulating private companies from this particular kind of climate risk.
- Lastly and probably most importantly, European insurance and reinsurance companies have more international exposure to climate-related losses.

The insurance industry can address the risk of global climate change in many ways. For example, it can de-insure high-risk customers or increase deductibles. These strategies are already being used in high-risk regions of the world (e.g., flood and windstorm insurance is increasingly hard to come by). As will be discussed at length below, the industry can also adopt a proactive approach, combining actions that establish it as a "good citizen" in the environmental arena with actions that can yield reduced risk of losses as well as near-term profit for consumers.

Some insurance is provided by governments, e.g., flood insurance in the United States. Thus, governments should share many concerns about climate change currently being articulated by private insurance companies. Furthermore, governments can influence the insurance industry through regulation. For example, regulators could consider efforts to address climate-change issues when awarding quality ratings to insurance companies.

The self-insurance sector is worth special mention. A large portion (valued at approximately $85 billion per year) of all commercial insurance in the U.S. is provided "in-house" rather than being procured from a private insurance company. The largest single component of self insurance is work-related injury (about 60% of all workers' compensation payments nationally), which has particular bearing on the discussions of indoor air quality.

The logic of loss prevention

The insurance industry is no stranger to the notion of loss prevention, and often engages in proactive efforts to reduce losses. Promoting loss prevention is not only good corporate citizenship, it directly improves payout/premium ratios -- the fundamental indicator of industry profitability. In the U.S. the approximately $30 billion annual insurance industry revenues from investments barely compensate for the core-business shortfall between payouts and premium revenues.

Other sectors of the insurance industry provide examples of changing customer behavior to cut insurance losses. The insurance industry operated fire departments and promoted early fire and building codes that were then adopted by state and local and then the federal governments. Underwriters Laboratories represents an insurance industry initiative focused on loss prevention through better technology. More recently, the insurance industry has helped drive significant changes to reduce worker injuries and required insurance compensation. Rising costs of workers' compensation and availability of better insurance rates for firms with lower worker compensations costs has pushed companies to adopt proactive practices to aggressively change and enforce lower-risk worker practices. The insurance industry is supporting nationwide rating of building code enforcement by local municipalities. Some insurance firms are now offering premium discounts or lower deductibles to homeowners who install storm safeguards.

The energy connection

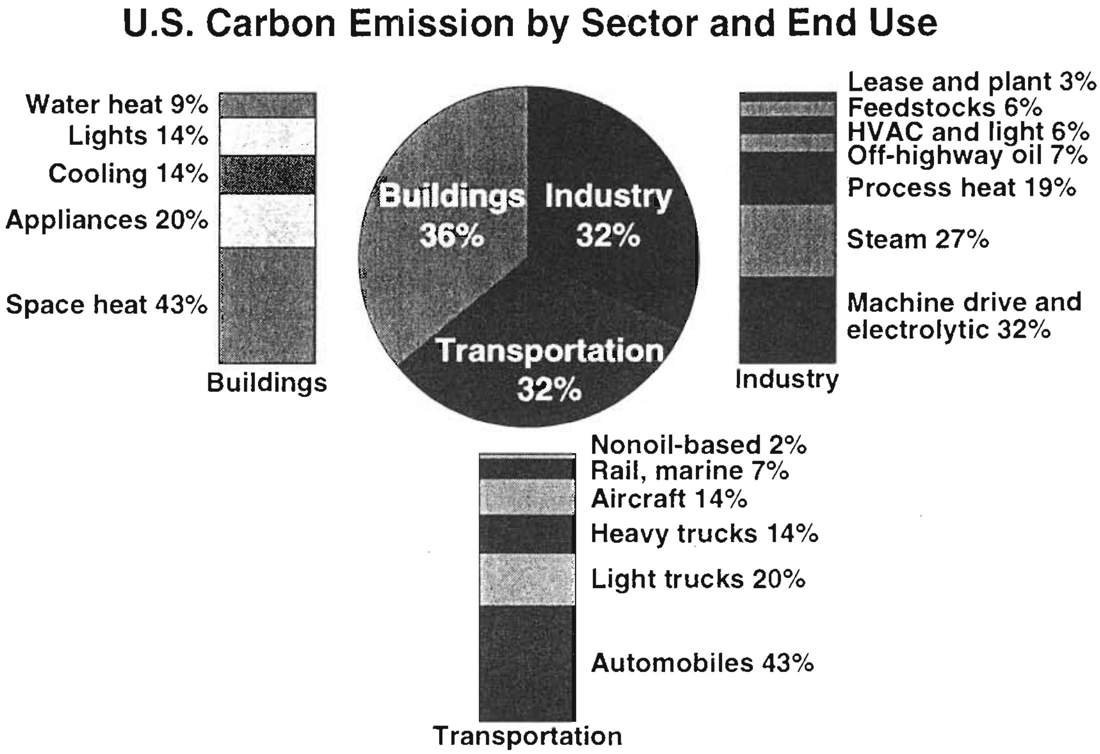
Energy use is responsible for about half of the greenhouse-gas emissions to which global climate change is attributed. A variety of energy-focused strategies can simultaneously foster a more sustainable energy system while reducing the near-term probability of insured losses involving property, health, or liability. [11]

There are two broad -- and complementary -- means of reducing the energy-related emissions of greenhouse gases. The first is to develop renewable, zero-emission energy sources. The second is to reduce the demand for energy at the point of end-use. Although much attention has been given to the potential strategic role of renewable energy for the insurance industry, increased end-use efficiency offers comparable if not greater near-term potential. Furthermore, increased end-use efficiency is generally less expensive per unit of energy saved than is an incremental unit of new energy supply (whether it is renewable or fossil-based). Thus, increased end-use efficiency investment is consistent with sound business practices. This exemplifies the "no-regrets" nature of many energy-efficiency options; that they have quick payback times and thus benefit the decision maker -- beyond the possible long-term environmental benefits. [12]

In the United States, energy efficiency has resulted in approximately 30% less energy used since the oil crises of the 1970s. [13] In contrast, renewable energy supplies about 7% of all primary energy in the U.S. Nonetheless, both strategies are underutilized and have considerable potential internationally. To achieve maximum reductions in greenhouse-gas emissions, both renewable energy sources and end-use energy reduction must be pursued, with care to optimize the timing and mix of the two families of technologies. [14, 15] The fundamental objective is to provide energy services at the lowest economic and environmental cost. [16]

In order to "mine" the energy-efficiency resources in the attics of homes, under the hoods of cars, and in the furnaces of industry, it is essential to understand where the energy goes. Each end use can also be described in terms of the carbon emissions associated with it. In **Figure 2**, for example, we see that lighting is responsible for 14% of carbon-dioxide emissions in the U.S. buildings sector, according to the U.S. Congress, Office of Technology Assessment. [17]

Figure 2



Formal assessments show a technical potential on the order of 75% savings from increased energy efficiency, with a cost-effective, achievable potential of 25-50%. One of the most widely noted studies was conducted by the U.S. utility industry's own Electric Power Research Institute (EPRI). The study concluded that, by the year 2000, the U.S. could save 24-44% of total projected electricity demand. **[18]**

Although not further addressed below, it is worth noting that decreased energy demand has the side benefit to the insurance industry of reducing risky energy-sector activities such as those associated with offshore oil production facilities and oil-tanker trips. In an interesting analogy, the space-heating energy saved by one factory that puts energy-efficient "low-emissivity" coatings on window glass equals the amount of energy produced by a large offshore oil platform.

Technologies that prevent insured losses while increasing energy efficiency

Many energy-efficient technologies offer non-energy benefits, **[11]** including reduced risk of such insured losses from fire, ice, water damage, temperature extremes, theft, occupational injuries, problems resulting from poor indoor air quality, and roadway hazards. By supporting the measures summarized in **Table 1**, the insurance industry could reduce the risk of such insured losses while promoting energy efficiency. We identify approximately 70 ways in which such losses could be reduced. In each case, the measures described will also reduce energy use and thus greenhouse-gas emissions, thereby indirectly addressing insurance industry concerns about increased windstorm damage and the like.

Table 1. Potential for energy-efficient technologies to prevent insured losses.

Energy Efficiency Measure	Insured Risk Mitigated: Fire & Wind Damage	Ice & Water Damage	Extreme Temperature Episodes	Power Failures	Professional Liability	Roadway Safety	Theft	Health & Safety (Lighting)	Health & Safety (IndoorAir)
Air Vest for spray booths									√
Building commissioning	√	√			√			√	√
Central heating controls									√
Compact fluorescent lamps								√	
Daylighting				√				√	
Demand-controlled ventilation	√			√					√
Economizer cooling					√				√
Efficient appliances	√			√	√				√
Efficient duct systems	√	√			√				√
Efficient outdoor/road lighting							√	√	
Efficient roadway lighting						√			
Efficient windows	√	√					√		
Electrochromic glazings							√		
Electronic lighting ballasts	√							√	
Energy mg't. & control system							√		
Energy audits & diagnostics					√			√	√
Extra interior gypsum board	√								
Heat-recovery ventilation		√							√
Insulated water pipes		√	√						
LED exit signs				√		√		√	
LED traffic signal lights									
Light-colored roofs	√		√	√					√
Measurement & Verification	√	√			√			√	√
Natural ventilation				√					√
Pay-As-You-Drive insurance						√			
Radiant barriers	√								
Radiant hydronic cooling				√					√
Radon-resistant housing									√
Reduce indoor poll. sources					√			√	√
Reduced mercury in lighting									
Roof/attic insulation		√	√						
Sealed-combustion appliances	√				√				√
Thermal energy storage	√								
Torchiere light fixture with CFL	√								

Source: Lawrence Berkeley National Laboratory

Some benefits result from a single strategy targeting a specific end use, while others result from a host of measures, such as energy-efficiency improvements that have the side benefit of reducing electromagnetic fields (EMF) that are proportional to total current. EMF-related claims are a growing concern for insurance companies. [19] Similarly, comprehensive strategies, such as uniform protocols for measurement and verification of energy savings and proper equipment performance, apply to a wide range of efficiency options.

The list presented below is not intended to be comprehensive, and the risk reductions described here are not well quantified in some cases. More in-depth study is needed. Care should be taken that new measures do not inadvertently introduce new sources of loss. In addition, it is important to note that not all measures described below are relevant to all lines of insurance.

Reducing fire & wind damage

- **Install energy-efficient windows**. During a fire, heat-stressed windows can shatter as a result of differential expansion near the frames (the edges are cooler than the center of the window), and the increased supply of air through the broken window accelerates the spread of fire and the circulation of toxic chemicals that cause illness or death or property damage. Efficient windows (e.g., those with double glazing or low-emissivity coatings) reduce the likelihood that fire will break the window. [20] Proposed modifications to traditional low-emissivity coatings would make windows considerably more fire-resistant. [21]

- **Install energy-efficient window retrofit films**. Energy-saving plastic window retrofit films may offer safety benefits during earthquakes and hurricanes by holding shards of broken glass together and maintaining a barrier against blowing wind and rain.

- **Install foil-based radiant barriers in walls and attics**. These barriers reduce air-conditioning energy requirements in hot climates and may also reflect radiation from fires, slowing their spread.

- **Install multiple layers of gypsum board in homes**. These layers provide "thermal mass", which can drastically reduce air conditioning energy use and significantly raise a wall's fire rating. [22]

- **Install energy-efficient appliances**. Residential appliances, especially those that are old and in disrepair, can cause fires and be a source of dangerous carbon monoxide gas. Problems range from burned-out pilot lights (resulting in explosive build-up of natural gas) to "flame roll-out" from fuel-fired water heaters or furnaces caused by pressure differentials from improperly designed mechanical ventilation and fireplaces in the home. Energy-efficient appliances are on for a smaller percentage of time than other models and may therefore be less likely to cause this type of fire. In the U.S., mandatory energy-efficiency standards have banned pilot lights and replaced them with electronic ignition in some types of appliances. This example shows the need for systematic analysis of specific measures. Although the absence of pilot lights could enhance safety, the relationship between firing time/frequency and fire risk is not known. A disadvantage of switching to electronic ignition is that appliances cannot operate during power outages while appliances with pilot lights can.

- **Develop a "torchiere" light fixture that uses compact fluorescent lamps**. Typical torchieres (tall floor lamps that throw light onto the ceiling) use very high-wattage incandescent lamps (up to 1000 watts) that can cause fires. Data from the National Fire Protection Association show that 2,800 fires and 25 fire-related deaths are caused each year in the U.S. from lamps and light bulbs, of which 37% of the fires are due to lamps operated too close to combustibles. Torchiere fixtures operate at exceptionally high temperatures (up to 1100 degrees Fahrenheit, far above the ignition temperature of wood or fabric. [23]

  In light of fire incidents, halogen torchiere fixtures have been banned in some university student dormitories. Among the worst university fires, the one at Hendrix College in Arkansas in 1995 caused $450,000 damage. The $90 million fire at Windsor castle in 1992 was caused when a halogen lamp ignited a stream of cleaning fluid being applied by a painting restorer. Underwriters Laboratories has withdrawn their UL safety listing for certain torchiere fixtures and has established more stringent testing procedures. The Consumer Products Safety Commission is moving to recall one particularly dangerous product line. Neither of these steps will address the safety hazard posed by products already in place, an estimated 40 million in the U.S. alone. Torchiere fixtures are increasingly popular in Europe and Asia.

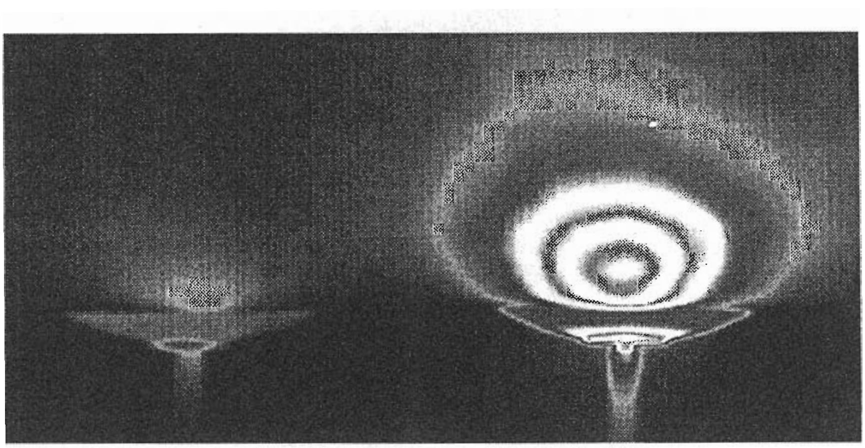
Because of the particular inefficiency of torchiere fixtures, retrofits of "dimmable" compact fluorescent lamps offer one of the most attractive lighting retrofit opportunities available. Recent tests have shown that the light levels can be matched with compact fluorescent lamps with as little as one-twelfth as much power demand and an operating temperature far lower than necessary to cause fires. **[24]**

Figure 3 shows infrared thermographs of two torchiere light fixtures (side view): the bulb within the standard fixture (right) reaches temperatures significantly above the combustion temperature of household furnishings. An alternative design with an energy-efficient compact fluorescent lamp (left) provides the equivalent light output, but with bulb temperatures far below those which could cause a fire.

- **Use thermal energy storage systems as backup water supply for fire fighting**. In some situations, the considerable cold water storage capacity involved in thermal energy storage systems for off-peak cooling in non-residential buildings can serve as an economical and convenient backup supply of water for fire fighting.

- **Use light-colored building and road materials and plant urban trees**. Large cities are typically several degrees warmer than their surroundings because of the "urban heat island effect." This results in more urban smog (and associated health costs) and increased air conditioning energy use. Research has demonstrated that lightening the color of roads and buildings, and planting

Figure 3



urban trees can dramatically reduce average urban temperatures. [25] Detailed field studies have shown as much as 40-60% air conditioning savings in a series of buildings where these strategies were used. [26] Lightened (or aluminized) exterior surfaces can also make a building less vulnerable to fire, especially if the materials are "tuned" to reject near-infrared radiation. An analysis of optimized paints found a potential 3.5-fold improvement in the "fire reflectance" compared to typical white paint. [21] The use of trees to lower temperatures around buildings has also been found to have the side benefit of reducing the rate of water flow onto streets during downpours, and thus local flooding. [27]

Reducing ice & water damage

- **Insulate water pipes**. Uninsulated pipes can freeze and break, causing water-damage losses. According to the Disaster Recovery Business Alliance, the U.S. insurance industry paid $4.5 billion in claims during a 10-year period for freezing pipes in 17 southeastern states (a region not normally expected to have significant freezes). Pipe insulation is a simple energy retrofit that saves energy and reduces the likelihood of freeze damage. Hot water pipes that run outside the heated "envelope" of a building (e.g. in a crawl space) lose energy and can freeze if water is not drawn for a period of time. Insulated cold water (supply) pipes save energy because water is conditioned by the temperature of the soil surrounding underground municipal supply pipelines and cools down only when the pipe comes into contact with the air in the house crawl space.

- **Weatherize to prevent "ice dams."** Ice dams are rooftop ice build-ups that result when melting snow re-freezes at the uninsulated eave. Melting water collects behind the ice dams, damaging the roof and often causing severe damage to gutters. Water leakage also wets roof and wall insulation, reducing its heat-retaining value and thereby accelerating the rate of snow-melting heat loss. Other potential causes of insurance losses include mold and mildew formation that can aggravate occupant allergies and other health problems, and corrosion of metal fasteners that can make wall or roof sheathing more vulnerable to damage in subsequent windstorms. A single large blizzard in the U.S. in early 1996 was estimated to have resulted in 10,000-15,000 such water damage claims, with an average cost of $2,000 per home. [28] As illustrated in **Figure 4**, ice dams can be prevented by better attic and roof insulation, better air leakage control, and better insulated duct systems (which are otherwise a significant source of heat gain into attics). [29] Adding to the energy liability of current practice are electric heating elements often installed along roof lines, intended to melt the ice.

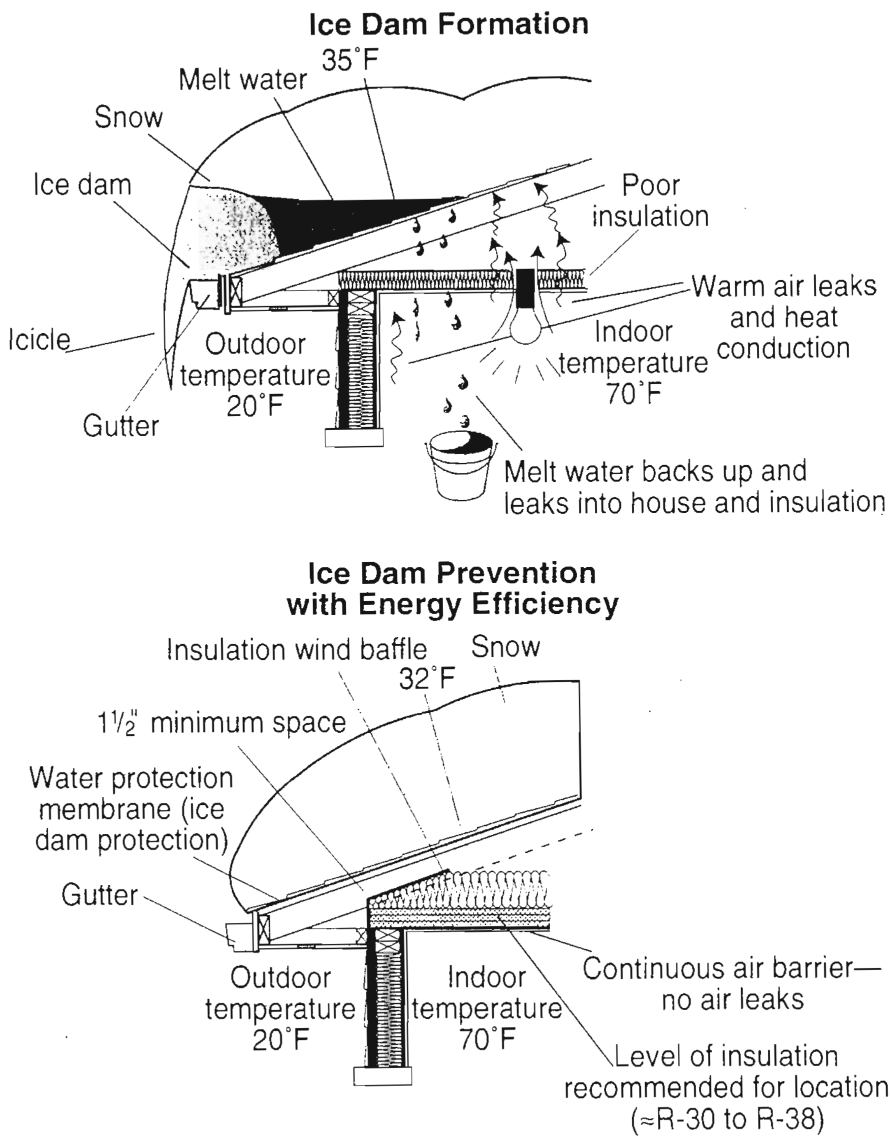
- **Install energy-efficient windows**. Inefficient windows often condense water on their interior surfaces. The moisture can cause serious deterioration of window frames and casements. It is not clear whether this could result in an insured loss (for the owner, designer, contractor, or manufacturer).

Reducing damage from power interruptions & extreme temperature events

- **Increase end-use energy efficiency**. Interruption in energy-related services often leads to insured losses, such as business interruptions and damage to perishable food products. For example, energy-efficient refrigeration systems can maintain cold temperatures for a longer time during power interruptions. Renewable or fossil-based backup power-generation systems could be downsized considerably (and run longer) if the energy loads they serve are highly efficient.

- **Install energy-efficient insulation, light roofing materials, and ventilation**. Power interruptions often occur during extreme temperature episodes. Super-insulated houses stay warm longer during cold-weather power outages. Homes with efficient windows and light-colored roof materials stay cool longer during warm-weather power interruptions. Hundreds of recent "heat deaths" (which result in health and life insurance costs) during peak summertime temperatures in the U.S. often occurred on the top floors of multifamily

Figure 4

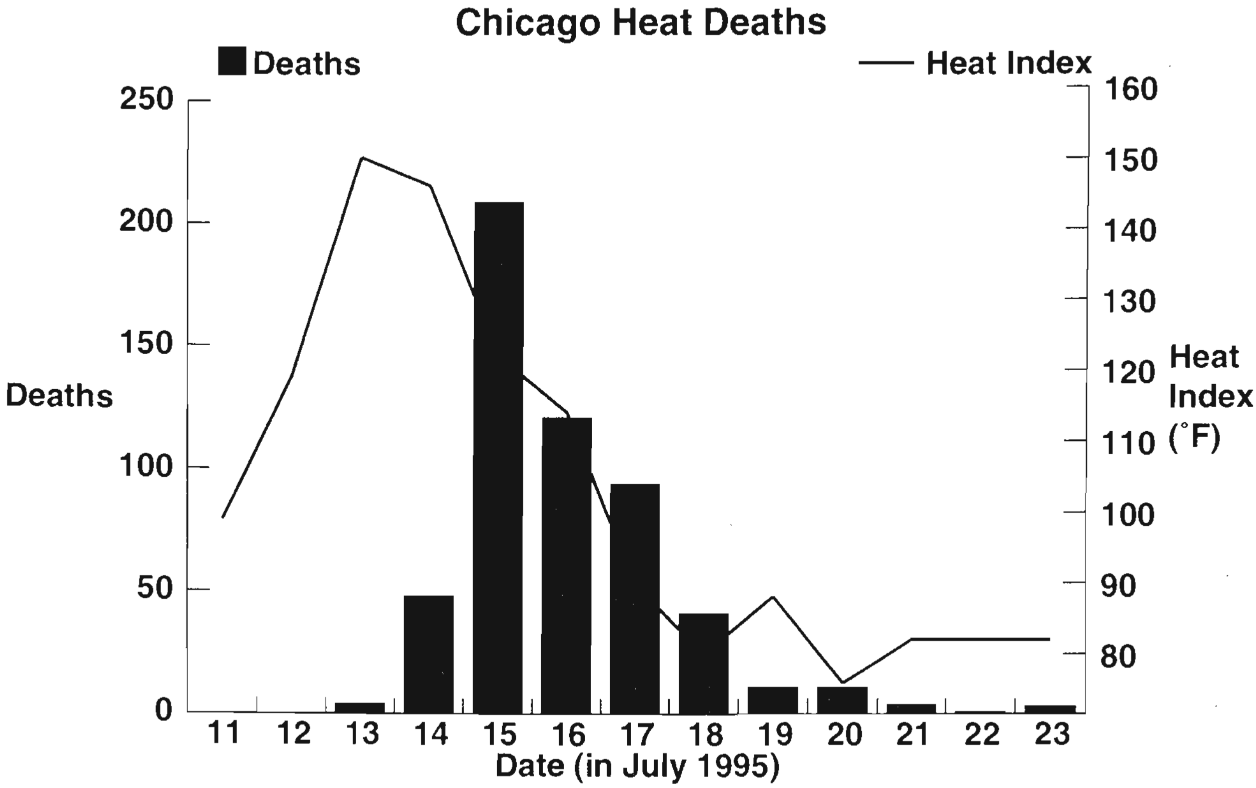


buildings where residents are exposed to intense heat gains through uninsulated roofs and brick walls that accumulate heat and then radiate it inwards. In **Figure 5**, the bars indicate numbers of deaths each day of the July 1995 heat wave in Chicago, and the curve shows the heat index, which reflects the combined effect of temperature and humidity. [**30**] Global climate change could increase the frequency and severity of extreme-heat episodes.

Figure 6 shows how a package of measures including attic insulation, white paint on the roof, and ventilation would bring the indoor air temperature in such an apartment down by over 10°F on a hot day. Ultra-cold weather events, of course, also pose a risk to occupants of poorly insulated buildings, and can also be similarly mitigated by energy-efficiency measures.

Specifically, **Figure 6** shows computer-simulated indoor temperatures in the top floor of a prototypical 1940s two-story apartment building in

Figure 5

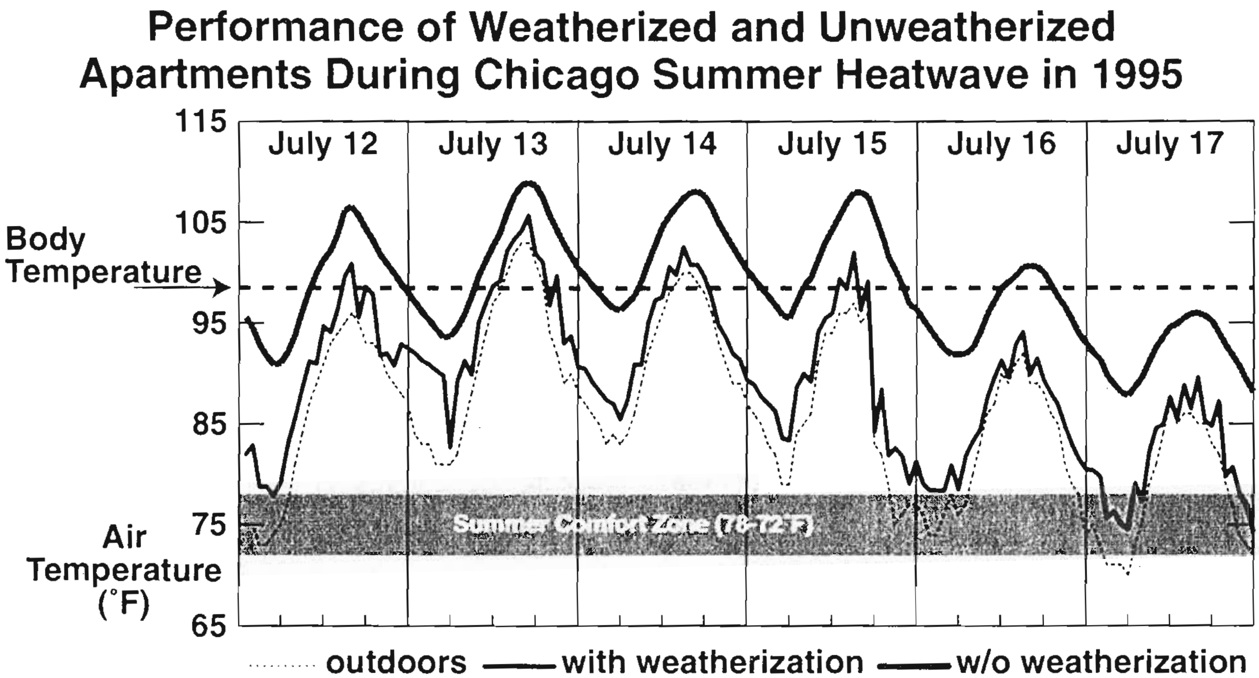


Chicago during the July 1995 heat wave. In the existing building, top-floor temperatures reached 108°F and remained high even after the outdoor temperatures had started to drop. The addition of attic insulation, white paint on the roof, and a ventilation system brought top floor temperatures in line with outdoor temperatures. [31]

Reducing professional liability

- **"Commission" buildings**. Reducing insurance-related losses is one of the primary ways that engineering, design, and contracting firms can increase their profits. [32] According to a recent study, U.S. firms that employ total quality management programs have professional liability costs that are nearly one-third lower than similar organizations without such programs. [33] A major cause of litigation and contractor call-backs in new buildings is improper performance of building heating and cooling systems. A reemerging quality-management 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. Energy savings of 10-30% can result when commissioning is performed in office buildings. [34] The second largest professional liability insurer of U.S. architects and engineers, DPIC, has taken a keen interest in promoting commissioning as a loss-prevention strategy and cites heating, ventilating, and air conditioning cases as the largest source and cost of claims for the company. [35] Legal experts have cited commissioning as a way to decrease the likelihood of professional liability lawsuits. [36] Current insurance industry efforts to

Figure 6



improve quality control to prevent earthquake, wind, or fire damage could be enhanced by verifying proper installation and performance of energy-saving equipment.

- **Perform energy audits**. Instrumented energy audits help identify energy-related problems that can lead to insured losses. One tool used in this work is the infrared (IR) camera, which can detect electrical problems with motors, transformers, etc. that waste energy and can cause fires. Munich Re has recommended the use of IR cameras as a loss-prevention tool, citing the early detection of broken hot water pipes as an example of how to minimize water damage losses and save energy. IR cameras can also identify inefficient windows and gaps in insulation. Blower doors and pressure manometers are also valuable tools for energy audits, enabling a user to identify potentially dangerous pressure imbalances in a building that could lead to fire or health-related insurance losses if not remedied. Auditors can also perform indoor air quality measurements.

- **Install energy-monitoring systems**. An emerging field in energy efficiency uses sophisticated information technology to monitor and diagnose problems with energy-using systems and indoor air quality. [37] Intended energy savings can be verified and deviations from expected equipment operating patterns can be quickly detected and corrected. Undetected malfunctions can jeopardize life and/or operation of the systems. Use of advanced information technology can help reveal and remedy problems that could otherwise lead to professional liability claims.

- **Improve indoor air quality**. As discussed in detail below, indoor air quality can be improved in conjunction with energy efficiency improvements. Indoor air quality and related ventilation-system problems are an increasingly common cause of litigation. [38] In the past, this litigation centered around exposure to contaminants in industry. However, due to increasing problems with asbestos, non-industrial chemicals such as formaldehyde, and radioactive radon gas, litigation has expanded to include the buildings sector. Sick Building Syndrome (SBS) raises the risk of professional liability for a widening array of players, including building owners, building managers, real estate developers, architects, engineers, general contractors, HVAC contractors, building product manufacturers, leasing agents, and consultants. Injuries alleged by plaintiffs include cancer, neurological damage, chemical sensitivity, pulmonary disease, and allergies. Indoor air quality suits have also focused on business interruption resulting from employee illness and reduced productivity.

Reducing security risks

- **Optimize windows for security enhancement.** Electrochromic glazings are a window technology, still under research and development (R&D), in which the optical characteristics can be switched from clear to opaque. Electrochromics offer important energy savings potential due to their solar control capabilities and, in their opaque state (in buildings or automotive applications), also offer security benefits. Multi-glazed windows, or windows with energy-efficient retrofit plastic films, also serve as a deterrent to burglars.

- **Optimize outdoor lighting for security enhancement.** Poorly designed outdoor lighting systems can be energy-wasting and can compromise security (impeding way finding and the locating of vehicles in parking lots, and obscuring safety hazards). Outdoor lighting operated by automatic occupancy sensors is an increasingly popular energy-efficient alternative to constant outdoor illumination.

- **Adapt computerized energy management and control systems (EMCS) to provide security services.** Computerized energy management and control systems (EMCS) are increasingly used in nonresidential buildings, and can be adapted to include security features at a lower cost than installing a stand-alone security system.

Reducing occupational health and safety risks

Lighting

- **Install energy-efficient lighting.** Efficient lighting components often have greater service lives than conventional lighting, which means a lower incidence of replacement-related injuries sustained while servicing the systems. Surveys of households installing long-lasting compact fluorescent lamps show an exceptionally high level of acceptance among senior citizens (who are uneasy about injuries from changing bulbs in hard-to-reach fixtures). [39] Longer-lasting components mean smaller lighting maintenance staffs, which in turn translates into reduced workers' compensation costs.

- **Install high-frequency electronic ballasts for fluorescent lighting.** High-frequency electronic ballasts -- one of the most successful energy-efficient technologies -- offer numerous non-energy benefits. [40] By virtue of their non-flickering operation, electronic ballasts avoid certain negative health impacts linked to standard magnetic ballasts. In a double-blind study in the United Kingdom, office workers with high-frequency ballasts had less than half the incidence of headache and eyestrain as their co-workers in offices with normal 50-Hz magnetic ballasts. Agoraphobia and other manifestations of anxiety have also been observed to diminish in areas with high-frequency lighting rather than standard ballasts. Flickering light, from traditional inefficient ballasts can also trigger epileptic seizures in sensitive individuals. In some cases, electronic ballasts reduce the likelihood of fires that result from overheating the neutral wire by excessive harmonic distortion in some conventional ballasts.

- **Install exit signs using light-emitting diodes (LEDs)**. LED exit signs save considerable energy and may reduce insured losses compared to incandescent or fluorescent exit signs. [41] Their 10 to 20-year service life means vastly improved reliability (and thus safety during emergencies) and less maintenance. The intense red LED light is highly visible. Given their low power demand, LED exit signs will operate longer during a power outage than traditional exit signs run by the same size battery, although power factor may be an issue.

- **Use LED traffic signal lights to minimize loss of service**. LED lamps have a service life many times longer than incandescent lamps traditionally used for traffic signals. A given signal will have dozens of small LED sources, virtually immune to vandalism often inflicted on traffic signals. These two factors combine to mean that LED traffic signals function with much higher reliability, thus improving traffic control and safety at intersections.

- **Install advanced windows; use daylighting**. Two energy-saving strategies that have non-energy benefits are daylighting (facilitated by linking "dimmable" electronic ballasts to photocells) and advanced windows that admit visible light but reject unwanted heat gains or losses. People prefer to work by daylight; the absence of windows has been correlated with an increase in transient psychosis in hospitals and an increase in absenteeism in schools and factories. In humans, levels of melatonin appear to be influenced by daylight which may help explain seasonal affective disorder (SAD), a type of psychological and physiological depression that affects about 5% of the population. [40] In a California study, the absence of a nearby window was associated with increased "Sick Building Syndrome" symptoms. [42] Daylighting availability is also unaffected by power outages which can reduce business-interruption losses.

- **Optimize roadway lighting for safety and efficiency**. Roadway and associated lighting is obviously key to night time driving safety. Abrupt transitions between brightly lit areas (e.g. gas filling stations) and roadways can result in visibility hardships for drivers, given the difficulty had by the eye in adapting to dramatic changes in light levels. Thus, brighter (and more energy-intensive) lighting is not necessarily safety enhancing. Improved optics and reduced "illuminance" directed towards the sky are often synonymous with improved outdoor lighting conditions and reduced energy consumption. [43] More work needs to be done to understand, and to conserve energy by strategically illuminating the highest risk roadway areas. [44]

- **Reduce mercury exposures associated with lighting**. Most kinds of light sources contain mercury. This is a health issue for workers involved in the manufacturing, installation, and disposal. [45] Highly efficient sources tend to contain less mercury and/or result in less mercury handling due to their longer service lives. The new, highly-efficient sulfur lamp meets or exceeds the efficiency of mercury-containing light sources without the use of mercury. [46]

Indoor air quality

People spend 90% of their time indoors, where concentrations of air pollutants often exceed outdoor levels. [47]

Citing a single indoor-air-quality case that resulted in a $26 million dollar settlement, a recent article in *Bests Review* noted the opportunities of insurers to proactively offer loss-prevention analysis of IAQ problems. [48]

Poor ventilation and indoor air quality increases the incidence of several types of adverse health effects including certain infectious diseases, symptoms of allergies and asthma, and sick building symptoms. Sick Building Syndrome (SBS) is indicated by occupant symptoms such as headache and irritation of eyes and nose that disappear when the person experiencing them leaves the building. Five to forty percent of office building occupants report that they have frequent SBS symptoms. The causes of SBS are not yet adequately understood. Indoor pollutants, especially particles and corrosive gases, contribute to failures of electronic equipment. Additionally, the quality of the indoor environment, such as temperatures and lighting quality, can influence cognitive and mental work performance.

About 20,000 deaths and many times more illnesses in the U.S. each year are attributable to indoor air pollution. Although most of these cases result from indoor exposure to environmental tobacco smoke, radon, and carbon monoxide, significant health problems can arise from other contributors to poor indoor air quality.

The cost of lost work days, restricted activity at work, and medical treatment for respiratory infections amounts to an estimated $65 billion per year in the U.S. alone. The corresponding cost for allergies and asthma is about $13 billion each year. Sick building symptoms may cause productivity decreases on the order of 2%, corresponding to $50 billion each year. There is considerable evidence indicating that the incidence of these adverse health effects, and the associated productivity losses, can be significantly decreased by providing better indoor environments. The associated cost savings and productivity gains are estimated to be between $17 and $46 billion. Failure of electronic equipment has also been linked to indoor air contaminants, including 20% of circuit board failures, costing $200 million per year in U.S. telephone switching offices. **[49]**

Increasing ventilation rates (which increases energy use) is the most common strategy for coping with suspected indoor air quality problems. However, potentially more effective and energy-efficient strategies are also available. These include proper pressure balancing, efficient air filtration, reducing air re-circulation, individual control of workplace environmental conditions, improving cleaning practices, and reducing indoor pollutant sources.

In addition to physical design changes to reduce the likelihood of indoor air quality problems, commissioning methods (discussed above) can ensure correct design and construction of building components, and effective response to problems following building occupancy. Specific opportunities for improving energy-efficiency while addressing indoor air quality risks include:

- **Mitigate indoor radon concentrations**. The number two cause of lung-cancer deaths (13,000 per year) in the U.S. today is radon, a naturally-occurring radioactive gas that concentrates in homes. **[50]** Levels in homes can exceed occupational safety standards for uranium miners. There are ways to mitigate this problem, but some consume far more energy than others. Continuously-operating fans for example, use energy and increase ventilation rates, which increases heating and cooling energy demand.

- **Install advanced energy-efficient combustion appliances**. Efficient appliances offer particular indoor air quality benefits in the home. Traditional appliances rely on a thermally-induced stack effect to transport combustion products through the flue and outside the structure; however, outdoor conditions (temperature or wind) can cause backdraft and spillage of pollutants into the living space. This problem can also be triggered by other ventilation devices inside a home (e.g., stovetop or bathroom fans and fireplaces), which create a negative pressure across the building envelope, thereby drawing pollutants back into the building. Efficient fan-assisted appliances can counteract these effects. Efficient sealed-combustion furnaces eliminate the need for a natural-draft flue altogether, so a home's natural air infiltration rate may be lowered without starving the appliance of essential combustion air.

- **Eliminate leaks from residential ducts**. Leaky ducts can cause significant positive or negative pressure imbalances in a home. Negative pressurization can place a dangerous suction force on combustion appliances and fireplaces, leading to backdrafting of carbon monoxide or to fire roll-out. Negative pressurization can also draw carbon dioxide from garages into homes. In hot, humid climates, negative pressurization draws moisture into wall cavities where it can condense, causing mold growth or severe structural damage to buildings. In cold climates, positive pressurization can force moisture-laden indoor air into walls where it condenses as it encounters cold surfaces. Leaky supply ducts can introduce moisture into attic spaces, and leaky return ducts can draw moisture from the living space into the attic. Both scenarios can contribute to the formation of ice dams as warm moist air leaks out through the eaves, or to water damage within the walls or ceiling. Duct retrofits utilizing an innovative new leak-sealing technology have resulted in 60% reductions of duct air leakage and improved home pressure balancing. [51] In 1994, Lawrence Berkeley National Laboratory designed, built, and field-tested an *in situ* aerosol sealing apparatus. (Please see **Figure 7.**) Besides performing the sealing process, the device also measures the leakage of the duct system before and after sealing. By injecting a fine aerosol, the device was found to seal approximately 60% of the leakage in the duct system in 15 minutes using only $6 worth of sealing material.

- **Install energy-efficient heat-recovery ventilation**. This technology can help avoid periods of low ventilation rates that can cause high concentrations of indoor pollutants. Not only does this reduce exposure to indoor pollutants, but it also can reduce the presence of damaging water vapor. [52] One study found that problems with elevated water vapor levels in bedrooms were less severe in a series of homes that used heat exchangers to recover waste heat from exhaust air than in homes that did not. [53] There were more complaints about mold and mildew in the control homes than in the efficient homes using heat exchangers. [54]

- **Use Airvests**. Spray booths are a common sight in industrial buildings. Designed to remove pollutants during processes such as spray painting or welding, a spray booth is open on one side where the worker stands and equipped on the opposite wall or ceiling with a fan and filter to exhaust contaminated air. However, under certain operating conditions, pollutants become trapped in the eddy that forms immediately downwind of the worker, then rising into the worker's breathing zone. A new energy-saving invention known as an "Airvest" (not yet commercially available) eliminates this dangerous eddy in some cases. (Please see **Figure 8.**) [55] Shown are photographs of a prototypical airvest with fan

Figure 7

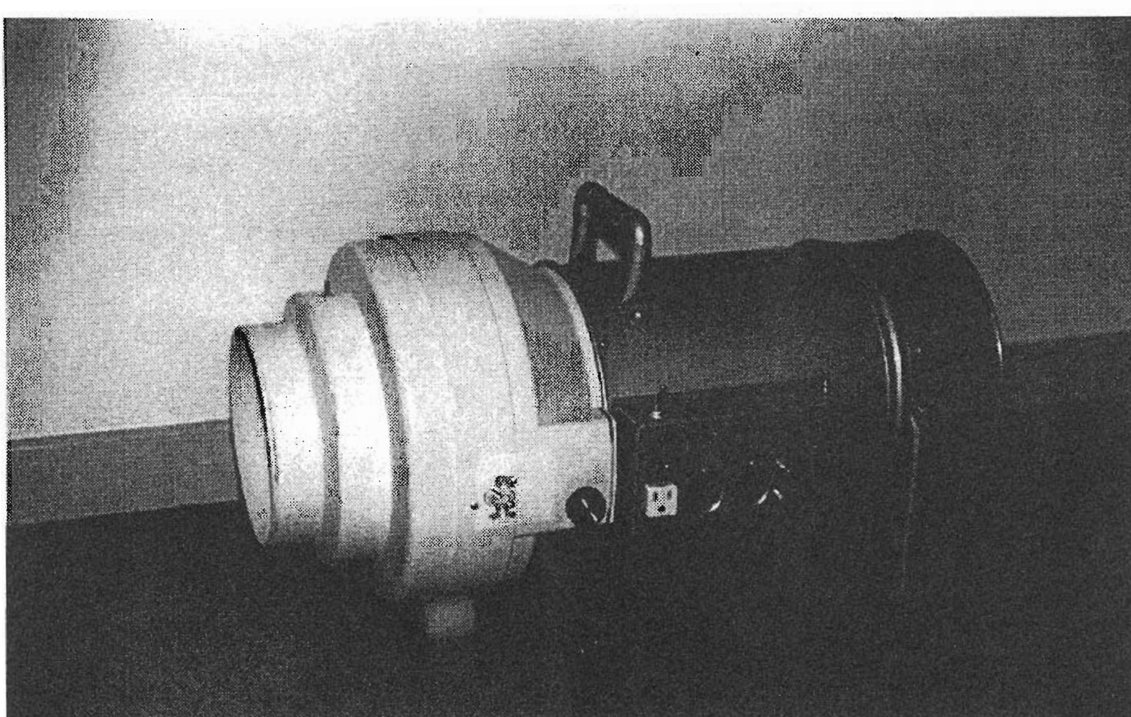
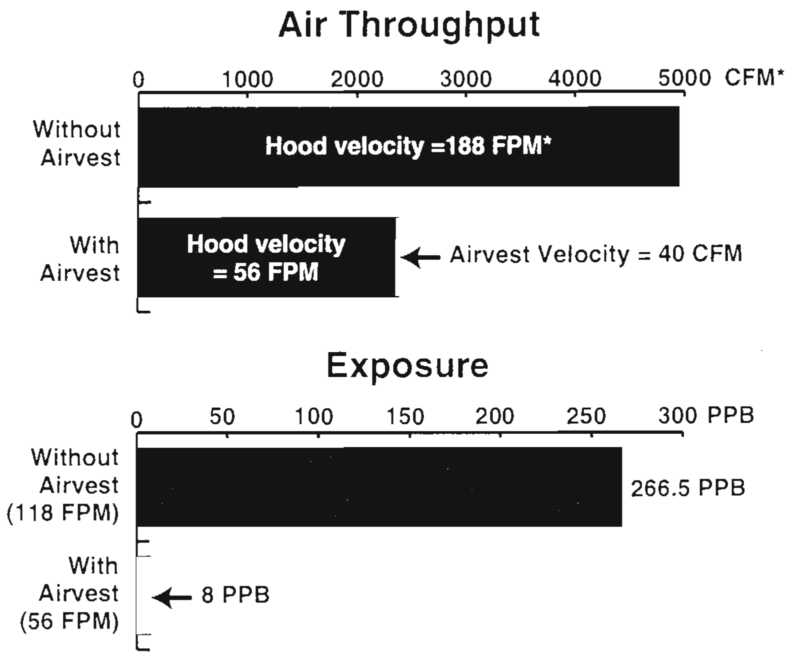


Figure 8



off (left) and on (right). The figure shows that spray booth ventilation rates can be reduced by 50%, while pollutant exposure in the breathing zone of the worker is reduced by about 30-fold. An Airvest consists of a small air supply worn on the chest of a spray booth worker. Laboratory measurements using smoke and a mannequin show enormous reductions of contaminants in the breathing zone, depending on how much air is ejected from the box. With Airvests, the ventilation rate in the spray booth could be substantially reduced. Reduction of the flow rate by a factor of two will save roughly $1,000 per shift per booth each year from reduced heating, cooling, and filtration of incoming make-up air. The potential for this technology will not be known until there is better *in situ* testing.

- **Install demand-controlled ventilation (DCV).** DCV uses variable-speed fans in conjunction with a sensor-feedback system to adjust fan speed. Fixed-speed ventilation allows virtually no outside-air control. The DCV feedback system should reduce incidences of too-low and too-high outside air supply. During power outages, DCV systems can operate at lower speeds to ensure minimal levels of air circulation during a longer period of time than would be possible with full-speed operation of a ventilation system using a backup power supply. Fan variability could prove valuable in certain fire fighting situations.

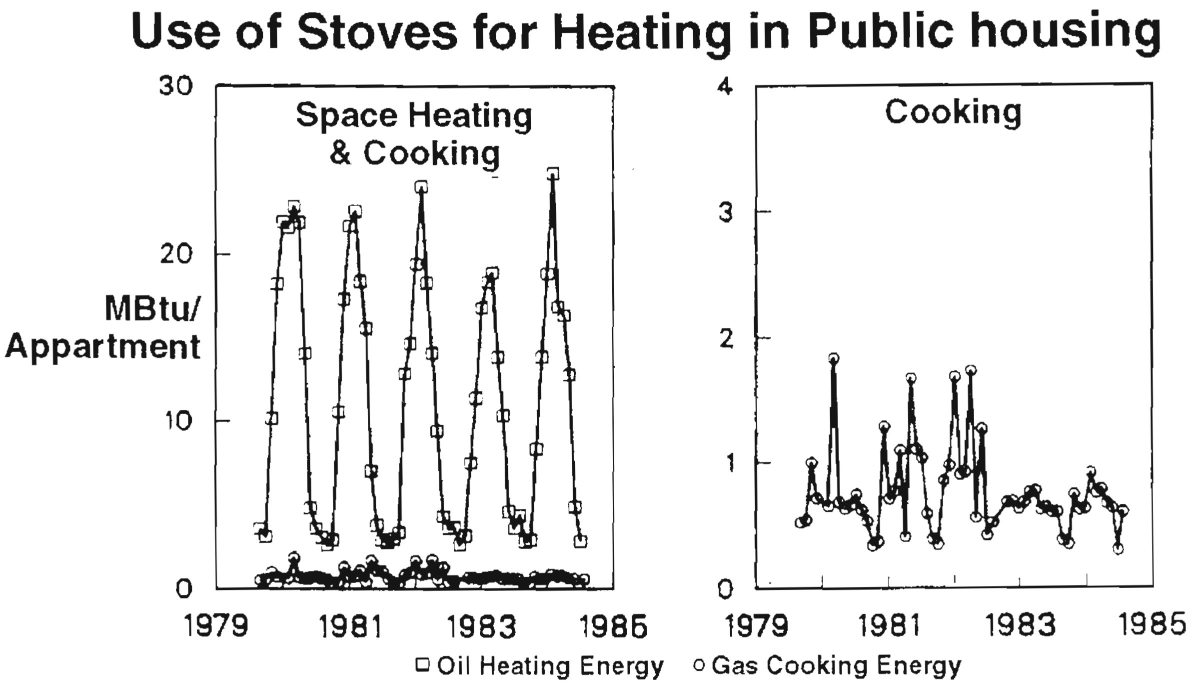
- **Use strategies that save energy while reducing the amount of re-circulated air.** This family of strategies includes better air filtration, economizer cooling, and heat recovery in place of re-circulation. Reduced re-circulation may eliminate some pathways of indoor disease transmission. A controlled study compared the incidence of febrile acute respiratory diseases in army trainees in two sets of barracks. **[56]** Heating, ventilating, and air-conditioning (HVAC) systems in the "modern" barracks provided a low rate of outside-air ventilation and involved extensive re-circulation of indoor air. In the "old" barracks, windows and ceiling exhaust fans were the primary source of outside-air ventilation, ventilation rates were higher, and the HVAC systems re-circulated less air. During 2.6 million trainee-weeks between 1982 and 1986, more than 14,000 acute respiratory disease hospitalizations occurred among soldiers living in the two sets of barracks. The ratio of new-to-old barrack hospitalization rates was 1.5:1, i.e., about 2,700 more admissions for occupants of the barracks that used predominantly re-circulated air.

One such strategy, hydronic radiant cooling, is used in Europe but is little known in North America. It achieves energy savings by separating the tasks of providing cooling and fresh air. [57]

In a radiant cooling system, cold water is used to cool ceilings, thereby achieving improved comfort. Transporting "coolth" by pumping water is much less energy-intensive than using air, although increasing outside-air requirements to maintain indoor air quality standards may erode the savings to some degree. Radiant cooling avoids spreading odors and other airborne contaminants through the building, reduces likelihood of drafts and noise due to lower volumes of air movement, and reduces space needed for the ventilation system. During power outages, cool water can be circulated with much less backup power than is required for a conventional air-conditioning system.

- **Install energy-efficient heating controls.** Especially in low-income housing, poorly managed central heating often means that tenants use gas stoves for space heating. The carbon monoxide and other combustion products thus generated are an obvious health concern here, in addition to the potential for energy waste. In one study, improved heating controls in apartment buildings in the Trenton

Figure 9



Housing Authority showed significantly reduced "cooking" energy use. (Please see **Figure 9**). **[58]** (The energy dimensions of this situation depend on the details; if used to heat only the kitchen area, stoves are not necessarily inefficient.)

- **Reduce indoor pollutant sources**. This is perhaps the most elegant, reliable, and energy-efficient way to mitigate indoor air quality problems. Pollutant sources range from radon gas leaking in through cracked basement floors and walls, to volatile organic compounds used in carpet glues to cigarette smoke. Reducing pollutant sources improves indoor air quality and occupant health and reduces the need for the energy-consumed to provide high rates of outside air supply.

Potential roles for the insurance industry in increasing energy end-use efficiency and indoor environmental quality

As shown above, the insurance industry has a number of options for responding to the threat of global climate change by improving energy efficiency and indoor environmental quality. These options would encourage customers to employ technologies and practices that inherently reduce the likelihood of insured health and property losses.

Some of the opportunities include:

1. Adopt uniform protocols for quantifying the risk-reducing aspects of energy-efficiency measures.

2. Develop innovative insurance products, such as differentiated premiums, that reward energy efficiency and improved indoor air quality.

3. Make buildings owned by insurance companies more energy-efficient.

4. Foster improved energy efficiency and indoor air quality in the process of financing and purchasing buildings.

5. Collaborate with energy regulators, utilities, and other stakeholders.

6. Participate in the research, development, and commercialization of new energy-efficient technologies and services.

Each of these opportunities are discussed in more detail below.

1. Adopt uniform protocols for quantifying the risk-reducing aspects of energy-efficiency measures.

While this report documents numerous likely benefits of energy-efficiency measures for the insurance industry, it does not attempt to quantify those benefits or to precisely target where the measures should be applied (e.g. specific types of buildings, climates). The insurance industry could play a key role in the development and deployment of standards of practice that, if followed, will reduce the likelihood of claims. To this end, the insurance industry would benefit from a universally approved and consistently applied method of quantification, which suggests that there is a role for a centralized effort. The insurance industry could begin by applying such protocols to its own buildings, and ultimately require their use on projects seeking premium reductions or other incentives from insurers.

The U.S. Department of Energy's new Building Measurement and Verification Protocol (BMVP) is an ideal vehicle for this, although it is currently focused strictly on energy impacts. **[59]** The BMVP is a voluntary consensus document written for technical, procurement, and financial experts in government, commerce, and industry. The BMVP provides an overview of current M&V techniques and sets a framework for verifying third-party financed energy projects for public and private sector projects.

Application of the BMVP helps insure accurate verification of project savings in a nationally accepted, impartial, and reliable manner. Extension of the Protocols to include the risk-reducing characteristics of specific energy-efficiency and indoor-air-quality measures is a logical next step.

2. Develop innovative insurance products that reward energy efficiency.

Design differentiated premiums. Insurance companies could develop products that reward customers for implementing energy-efficient measures that lower the risk of insured losses, e.g., by offering discounted premiums when a property has features that are energy efficient or contribute to a healthy indoor environment. This is already a familiar practice in the insurance industry: "good driver" discounts are offered and credits are given for home smoke detectors, fire extinguishers, or burglar alarms.

Insure purveyors of energy-efficiency services. Energy Service Companies (ESCOs) are an important agent of energy-efficiency implementation. ESCOs typically mobilize capital and technical know-how, offering a package of efficiency improvements to building owners or factory managers. Energy users enjoy the convenience of having an outside firm implement the measures, and the ESCO is rewarded with a pre-agreed share of the energy savings. Contracts with ESCOs predict a specific level of energy savings; there is a financial risk to one or both parties if these savings are not achieved. Conventional professional liability insurance does not cover performance-related claims. However, the insurance industry could provide special coverage for building owners or ESCOs, guaranteeing savings through "efficacy coverage" or "systems-performance" types of policies.

Provide radon insurance. Approximately 4 million of the 85 million homes in the U.S. have radon levels that exceed the Environmental Protection Agency (EPA) guidelines. Typical remediation costs are $1,000-$3,000. However, because concentrations vary from day-to-day, short-term monitoring results are highly uncertain. This is problematic when testing is to be conducted during the brief home purchasing process. A remedy would be to provide radon insurance (analogous to the insurance for appliances and heating systems widely available to home buyers today). **[60]** The insurance company would then provide a more reliable long-term measurement and pay for remediation if safe levels were exceeded. Remediation strategies would emphasize energy-efficient techniques.

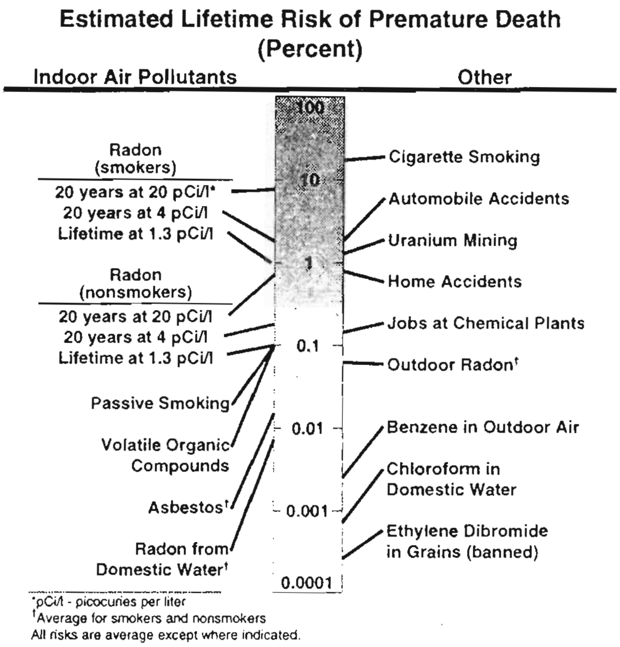
The use of geographic information systems to identify the "high-radon" areas in the U.S. will vastly reduce the cost of finding the homes with dangerous radon levels and help identify the market for radon insurance. For example, in Minnesota predicted average countywide indoor radon levels range to over 5.5 pCi/liter, with the "EPA Action Level" set at 4 pCi/liter. **Figure 10** shows estimated average indoor radon concentrations by county for Minnesota. Darker shades indicate higher radon levels. Homes in white-shaded counties have estimated concentrations below 2.5 pCi/L; predicted levels in the black-shaded counties are greater than 5.5 pCi/L. Also shown is a relative scale of risks from radon and other health hazards.

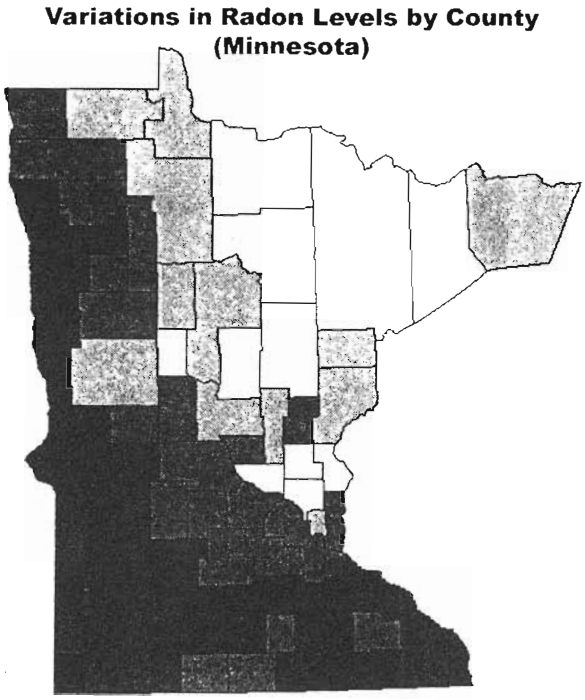
Implement pay-at-the-pump auto insurance. Uninsured motorists pose a significant problem for the insurance industry. A novel concept proposed for improving vehicle energy efficiency is "Pay-As-You-Drive Insurance." **[61]** The essence of the concept is that the driving-dependent portion of the total premium is incorporated in the price of gasoline. Thus, motorists who drive more pay more (for fuel and for insurance). This differentiated premium is an incentive for fuel economy and a risk-indexed payment of insurance by each customer. The gasoline price elasticity could yield both reductions in greenhouse-gas emissions and local public health benefits from reduced air pollution. Pay-at-the-pump insurance would achieve a similar goal as does the existing practice of varying the insurance premium according to the annual number of miles driven, but would provide a much stronger incentive for reduced driving and increased fuel economy.

3. Make buildings owned by insurance companies more efficient.

"Market Pull" strategies are one of the most innovative approaches to improve energy efficiency. These strategies harness the purchasing power of large energy users to steer entire markets toward increased use of efficient technologies. The Swedish government's National Board for Industrial and Technical Development (Nutek) has been a world leader in this area, organizing owners of large numbers of buildings (including insurance companies) to set standards for procurement of efficient energy-using products. **[62]** A U.S.

Figure 10





consortium of government and non-government organizations is also very active in this area, as is the International Energy Agency.

The insurance industry is one of the world's most important owners of real estate. In the United States, life insurance companies alone own $50 billion worth of commercial real estate, 22% of all institutional holdings. [63] If insurance companies adopted state-of-the-art practices for technology procurement and efficient building operations just in the buildings they own, they would make a significant contribution to reducing energy demand. High-visibility demonstration projects based on controlled experiments in insurance buildings could quantify the benefits of energy-efficiency measures and set a model for others.

In the process of making its own buildings highly efficient, the insurance industry would also acquire considerable skill which could be sold to other property owners and managers. Special in-house expertise and services could develop into new business lines in energy auditing, retrofit evaluation, and installation and management of energy-efficient systems, building commissioning, measurement and verification, and ongoing energy-management services.

4. Foster improved energy efficiency and indoor air quality in the process of financing and purchasing buildings.

As financiers of real estate ($202 billion of debt financing or 20% of all debt financing in institutionally-owned buildings in the commercial U.S. market alone), insurance companies can promote energy efficiency in several ways. [63]

- Offer differentiated premiums that favor energy-efficiency improvements. This strategy is well-suited for application when a building is purchased, as new insurance coverage is often purchased at that time.

- Encourage inspection and labeling processes that provide consumers with information about energy efficiency and indoor air quality in buildings. [64] The results of inspections could be combined with other information on safety and features that make the building less likely to sustain damage.

- Formally recognize that the savings enjoyed by owners of energy-efficient buildings improves the owners' cash position, which translates into a slightly lower risk of loan default and the ability to qualify for a proportionately larger mortgage. The insurance industry could participate in "Energy-Efficient Mortgage" programs that are already being developed. These programs typically target residential buildings but could be adapted to the types of commercial loans for which insurance companies typically provide financing.

- Encourage rebuilding after natural disasters to meet or exceed current energy codes (rather than as-built standards); collaborate with FEMA and other government bodies. Design premiums to encourage replacement construction following losses from fire, earthquake, flood, etc. to meet or exceed current energy standards rather than "as-built" performance levels. The U.S. Department of Energy has already begun to provide practical information to people rebuilding their homes following natural disasters. [65]

5. Collaborate with energy regulators, utilities, and other stakeholders.

Because the insurance industry is a major user of energy in its own properties and a major lender to other property owners, it could benefit from participating in regulatory proceedings (setting energy-efficiency standards, planning utility demand-side management programs, etc.) that potentially affect those buildings. Pertinent regulatory proceedings are conducted at both the national and state levels.

To the extent that the insurance industry is interested in R&D and commercialization of new energy-efficient technologies, it should maintain close contact with public energy and environment agencies, utility trade associations, and others conducting such R&D. These entities tend to listen closely to the needs expressed by stakeholders and to welcome collaborative partnerships.

Special opportunities exist for energy utilities and insurance companies to collaborate. These two industries have common interests: (1) improved cash flow for customers and lower probability of default on payments for services, (2) effective code compliance, product labeling, and building commissioning as tools for achieving safety and energy savings and quality control, (3) a desire to reduce business-interruptions, and (4) an increasing imperative to incorporate "green" marketing into their way of doing business. The following are some examples of potential collaborations:

- By joining forces in encouraging energy efficiency, utilities and insurers could share costs and market data. For example, utilities already possess considerable data on the physical characteristics of buildings (e.g., appliance holdings, types of heating systems) in their service territories. Some of these data could be quite valuable to insurance companies attempting to identify energy-related problems and opportunities in those buildings.

- The current process of utility deregulation underway in the U.S. and some other countries has placed utilities in the unfamiliar position of competing for new customers and convincing old customers not to switch to new providers. By offering value-added insurance/energy-efficiency products and services to customers, utilities and insurers could retain customers they might otherwise lose to competitors.

- Utilities already possess technical and financial knowledge of the intricacies of implementing energy efficiency. Insurance companies could take advantage of this resource in exchange for bringing new customers to a utility and/or offering incentives (via insurance product design) or financing for customers to participate in utility-insurer programs. Utilities are increasingly interested in mechanisms for loaning money to consumers; insurers have extensive experience in this area (in excess of

$200 billion in the U.S. alone, as noted above). Existing utility "energy audit" programs could be expanded to include on-site safety-related inspections in residential or small-commercial buildings, which would otherwise not be cost-effective for insurers.

- Lastly, because both industries are interested in new technology research and development, R&D activities could be combined in some areas.

Other logical allies of the insurance industry in energy efficiency efforts are building managers associations. For example, the Building Owners and Managers Association (BOMA) takes great interest in energy efficiency matters and already has ties with the insurance industry.

6. Participate in the research, development, and commercialization of new energy-efficiency technologies and services.

Little research has been done on maximizing the safety-enhancing aspects of energy-efficiency technologies. The insurance industry could help fill this void by supporting strategic research and development (R&D) and/or providing venture capital to move new loss-reducing technologies into the marketplace. The founding of the Underwriters Laboratory early in this century stands as a precedent for such an enterprise. The organization that later became UL was founded by William Henry Merrill, a Boston electrical inspector, with financial backing provided by the insurance industry. Specifically, the Chicago Board of Fire Underwriters and the Western Insurance Association provided funds to support the Merrill lab, which then became the Underwriter's Electrical Bureau. It was later renamed the Electrical Bureau of the National Board of Fire Underwriters when it received national support, and then renamed Underwriter's Laboratories, Inc., in 1901 when it was chartered in Illinois.

Most of the strategies discussed in this article were supported by federal R&D programs now falling victim to widespread budget cutting in the Congress. Difficult economic times have simultaneously led to reduced R&D in the private sector. Further compounding the problem, the current trend toward utility deregulation has also caused many utilities to reduce their R&D activities because the costs show up in the cost of electricity, rendering their product more expensive than that of a competitor who does not do R&D. The insurance industry could serve a vital function by stepping into this growing R&D void.

Examples of promising R&D frontiers include fire-resistant windows, paints, and light fixtures; and development of improved indoor air quality monitoring devices. Other research opportunities include definitive studies on the connections between indoor environmental factors (air quality, lighting, thermal comfort) and worker productivity and health. For example, the causes of Sick Building Syndrome are still not well known.

Important integrating research needs to be done on Building Performance Assurance, which includes building commissioning, operations, and diagnostics, and employs computer-based systems for whole-building monitoring, diagnosis, and performance optimization. The goals are enhanced energy efficiency, occupant productivity, security, and safety.

These goals are of clear value to the insurance industry to reduce insured losses; insurers could also employ such systems to operate their own buildings more efficiently and safely. A special need exists for Building Performance Assurance in the residential sector, where building codes are often incomplete and unclear in directions for safe installation of ventilation systems.

Past experience in the energy sector could be a model for insurance industry R&D. The Electric Power Research Institute (EPRI) and the Gas Research Institute (GRI) spend more than $1 billion a year for technology and market research for energy utilities. They provide a common knowledge base for large and small energy companies and serve as an interface among the numerous energy utility companies, regulatory bodies, and providers of energy technologies.

Given the energy benefits of many insurance loss-reduction strategies, it is easy to imagine effective teamwork among the Department of Energy and/or the Environmental Protection Agency, energy utilities, and the insurance industry. Although quite small in proportion to the size of the industry it serves (an industry even larger than the energy sector), the newly founded Insurance Institute for Property Loss Reduction (IIPLR) is one venue where such research could take place. IIPLR's mission is to reduce deaths, injuries, and loss of property resulting from natural hazards.

Early indications of industry response

A handful of early efforts by insurers and other stakeholders suggest that energy efficiency has begun to find a strategic position in the insurance industry.

- Hanover Insurance company (c. 1980) gave a 10% premium reduction for energy efficient/solar homes with the justification that the combustion systems fired less often, resulting in lower probabilities of fire hazard.

- A major professional liability insurer has identified numerous ways in which commissioning would have helped avoid claims. As a result, they are considering offering a 10%-25% premium credit for design and engineering firms that practice commissioning.

- The Insurance Institute for Property Loss Reduction has endorsed the enforcement of building energy codes.

- The Pacific Gas and Electric Company -- one of the United States' largest utilities -- has formed an alliance with the Western Insurance Information Service to further encourage wise and efficient energy use by its customers. PG&E's goal is to have every potential energy project considered for risk management benefits, in addition to any rebate and/or energy bill savings. Seattle City Light has worked with police departments on energy-efficient outdoor lighting as a deterrent to crime.

- In another utility-related effort, the Electric Power Research Institute has formed the Disaster Recovery Business Alliance (DRBA). DRBA will help catalyze the disaster mitigation objectives of utilities, business leaders, the insurance industry, government agencies, and community leaders by launching regional alliances and ensuring the cohesive deployment of relevant mitigation and socio-economic recover technologies. The program involves a three-pronged approach: distributing information, fostering extensive planning among regional and local businesses, and applying technologies to mitigate losses and expedite recovery. Certain energy-efficiency technologies will no doubt find a place in this process.

- European insurance companies are collaborating with an International Energy Agency project to use the purchasing power of large building owners to create new markets for energy efficient copiers.

- The Oak Ridge National Laboratory has entered into a Cooperative Research and Development Agreement with the Roofing Industry Committee on Wind Issues, which includes all major roofing trade associations in North America and various insurance partners (the Insurance Institute for Property Loss Reduction, K2 Technologies, Risk Management Solutions, and Allstate). The project will investigate energy-efficient ways of making roofs more resistant to damage during windstorms.

- The Consumer Products Safety Commission and Underwriters Laboratories are scrutinizing the safety aspects of halogen torchiere light fixtures, a process which will strongly encourage the use of energy-efficient compact fluorescent lamps as a substitute technology.

- The Zurich-American Insurance Group offers specialized insurance policies for third-party energy service companies that implement energy efficiency technologies in exchange for a share of the savings. The policies protect the installer or building owner against over-achievement of contracted energy savings targets.

- The newly-founded Storebrand Scudder Environmental Value fund is an early example of environmental investing, to which insurance companies (Swiss Re, Gerling, Anova, and Trygg-Hansa) have already contributed $70 million. Energy efficiency is one of the criteria used to evaluate securities being considered for inclusion in this fund.

Recommendations

This article has provided an overview of opportunities for the insurance industry to support energy-efficiency and better indoor air quality as a "no-regrets" strategy for improving its near-term business position while helping to reduce risks from greenhouse-gas emissions that threaten the industry in the long term. The insurance industry could take a variety of specific steps to tap the strategic benefits.

Technology assessment and research & development

- **Conduct a systematic evaluation to further identify and quantify energy-efficiency and indoor-air-quality enhancement strategies that make a property less likely to sustain insured losses.** This activity would seek to evaluate the statistical likelihood of reduced loss for each case and estimate their corresponding economic value. Measures must be linked to the relevant insurance segments (e.g. property, health, professional liability). This paper has focused on measures applicable to buildings. Measures applicable to the transportation and industrial sectors should also be evaluated. Characteristics of efficient technologies that could inadvertently lead to increased insured losses must also be addressed.

- **Use advanced geographic information system approaches to conduct hazard mapping.** Variables such as climate and building stock data could be used to determine where certain buildings-related losses are likely to occur and then to examine the potential for energy savings, emissions reductions, and loss prevention via regionally targeted retrofit and new construction measures. Energy-related conditions that vary geographically include radon gas concentrations in homes, likelihood of water pipe freezing or ice dam formation, and age of appliances (as a proxy of fire or carbon monoxide risks).

- **Conduct focused research and development.** The insurance industry currently conducts only a limited amount of R&D on technologies that reduce risk, especially pertaining to the buildings sector. By contrast, electric and gas utilities conduct hundreds of millions of R&D related to their markets. Considerable leverage could be achieved by partnering with existing government energy-efficiency R&D activities so as to include insurance-related considerations. There is also a critical need to carefully identify indoor air quality problems, understand the sources of indoor air pollutants, evaluate mitigation measures, quantify the impacts of adverse air quality on productivity, develop improved sensors and monitoring strategies, and integrate air quality considerations in the development of building codes and standards.

Market transformation

- **Develop differentiated premiums and other insurance products to reflect the relative costs/benefits associated with energy-efficiency features.** Differentiated premiums would send a "price signal" to risky market segments, encouraging them to implement safe (and energy-efficient) measures recommended by the insurer. Radon warranties, insurance for third-party financing of energy-efficiency improvements, and pay-as-you-drive insurance are examples of innovative insurance products that could stimulate increased investment in energy-efficiency measures that would also reduce insurance losses.

- **Demonstrate "Leadership by Example."** The industry could systematically assess its own buildings, identify cost-effective efficiency-improvement opportunities, and exercise purchasing power to pull new efficient technologies and practices into the market. Identifying and implementing energy-efficient ways to mitigate indoor air quality problems should be a parallel goal. As a major self-insurer, the federal government could adopt these principles in its own facility management programs.

- **Encourage inclusion of strategic energy efficiency measures when retrofitting**

existing buildings for improved fire, flood, wind, and earthquake safety. Considerable economies of scale can be achieved when multiple retrofit packages (i.e., energy and non-energy measures) are implemented simultaneously. The same rationale should apply to replacement of homes lost in natural disasters.

- **Survey the energy-efficiency industry to identify emerging technologies and services that are promising investments**. Build portfolios of investments to stimulate those markets and to benefit from the financial growth of energy-efficiency industries.

- **Evaluate opportunities for selling efficiency services as a new business line**. Possibilities include technologies and operations strategies such as commissioning, measurement and verification, and quality assurance on a fee-for-service basis. This is still a fledgling industry with room for new entrants.

- **Provide strategic information to energy users**. Because insurers communicate with virtually all owners of buildings, major energy-using equipment, and automobiles, they, like electric utilities, are in a powerful position to advise many people about energy efficiency. A promising avenue is labeling systems already being developed to foster energy-efficiency for whole buildings as well as components, but not yet tailored to identify the safety features of efficiency measures. For example, window safety (fire, wind breakage, theft) information could be integrated with the existing National Fenestration Rating Council (NFRC) energy labels, which are already being widely used in the industry.

New partnerships

- **Support the expansion of the Building Measurement and Verification Protocol (BMVP) to include avoidance of adverse health and safety conditions, and energy-wasteful ways of mitigating the problems**. New features could be added, e.g. to incorporate consideration of indoor air quality issues and other safety-related issues of concern to insurance companies.

- **Review existing new-construction and appliance standards for energy efficiency and evaluate more demanding efficiency standards to reduce risk of insured losses**. Current standard setting is based on cost-benefit analyses of energy savings and incremental purchase costs. The economic and social benefits associated with risk-reduction are not included.

- **Support code compliance efforts. DOE, EPA, and various state energy offices are working to improve compliance with energy codes**. Insurance companies have a parallel interest in compliance with safety codes. More than 75% of code enforcement officials failed an competency exam delivered by the Insurance Institute for Property Loss Reduction. The insurance industry could join in efforts to train and provide education and incentives to code officials to improve compliance with both energy and non-energy elements of the codes.

- **Form partnerships with energy utilities**. Insurance companies and utilities could collaborate in mutually beneficial ways, bringing each other new customers and sharing complementary skills and market data. Considerable resources could be saved by pooling resources on projects that would otherwise be performed in duplicate.

- **Give special consideration to problems and opportunities in the Developing World and Formerly Planned Economies**. Special attention should be given to the situation in developing countries and formerly planned economies. Today these countries are responsible for about one-half of greenhouse-gas emissions related to energy use, and their share is rapidly growing. Energy efficiency is particularly poor in these countries, and the rapid rate of development in buildings, industry, and transportation offers immense opportunity for efficiency improvements. Current cooking and heating practices in many rural areas are tremendously inefficient and represent a serious indoor air quality problem. Water treatment practices are also inefficient, but energy-saving alternatives are being developed. **[66]**

Property and health insurers will have an increasing stake in these countries as their economies grow and so have a vested interest in helping those countries change course now. Combined insurance 1994 premiums for Africa, Latin America, and Asia (excluding Japan) were $140 billion. Annual growth rates were 8%, 32%, and 3% respectively. A variety of international aid agencies, multilateral banks, and governmental bodies already have programs to promote energy efficiency in these parts of the world -- such as the Joint Implementation program -- but energy-efficient technologies and their potential to reduce insurance losses are not emphasized.

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[Ed. note: For correspondence with the author, write Dr. Evan Mills, Lawrence Berkeley National Laboratory, MS 90-3058, Berkeley, California, 94720, USA. emills@lbl.gov. Additional information on this subject is organized under the following World Wide Web site: http://eande.lbl.gov/CBS/Climate-Insurance/ci.html] ★