AARP Public Policy Institute

Affordable Home Energy and Health: Making the Connections

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Research Report

Schedule 7

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AARP's Public Policy Institute (PPI) informs and stimulates public debate on the issues we face as we age. Through research, analysis, and dialogue with the nation's leading experts, PPI promotes development of sound, creative policies to address our common need for economic security, health care, and quality of life.

The views expressed herein are for information, debate, and discussion, and do not necessarily represent official policies of AARP.

#2010-05
June 2010

AARP Public Policy Institute
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ACKNOWLEDGMENTS

The authors would like to thank Janee Briesemeister, Marti Doneghy, George Gaberlavage, George Greenberg, John Howat, Naomi Karp, George Luber, Wilhelmine Miller, Jalonne White-Newsome, and Mark Wolfe for their comments, suggestions, and guidance in completing this report. Thanks also go to the experts who participated in a PPI Innovation Roundtable in December 2008 for their insight and enthusiasm.

Contributors: The authors jointly developed the concepts in this paper and collaborated on its organization and the development of themes and recommendations. L. Snyder conducted the literature review and analysis and drafted versions of the report. C. Baker provided extensive revisions to the initial draft and to each subsequent version until the final report was completed.

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EXECUTIVE SUMMARY

Unaffordable home energy bills pose a serious and increasing threat to the health and well-being of a growing number of older people in low- and moderate-income households. For many of these households, high and volatile home energy prices jeopardize the use of home heating and cooling and increase the prospect of exposure to temperatures that are too hot in summer and too cold in winter. The potential consequences of exposure to such temperatures and related financial pressures include a host of adverse health outcomes, such as chronic health conditions made worse, food insecurity, and even the premature death of thousands of people in the United States each year.

Home energy service provides a buffer against the impact of unsafe temperatures and is particularly important for older adults. Aging can impair the body's ability to maintain a normal temperature because of physiological changes, such as the loss of physical fitness, reduction in body mass, and decline in body temperature. Older adults are more likely to have chronic medical conditions and to take multiple prescription medicines, which can further reduce the body's ability to sense and respond to changes in temperatures. These characteristics may indicate particular risk for older adults living in urban areas, where the heat-retaining properties of roads, buildings, and other urban infrastructure magnify and extend hot weather events compared with rural areas.

The significant risks associated with unaffordable home energy are unlikely to diminish any time soon. To the extent that climate change accelerates in the coming years and oppressive temperatures occur more frequently and for longer periods of time, adverse health outcomes are both more likely and more severe. In addition, unaffordable home energy undermines national priorities in the areas of long-term care services and livable communities, destabilizing efforts to support aging in place and hindering opportunities to facilitate independent living.

PRINCIPAL FINDINGS

Evidence connects temperature, health, and safety. Heat and cold challenge the body's ability to maintain a steady core temperature. Anything that impairs the body's ability to regulate its own temperature heightens vulnerability. Significant risk factors include the following:

- Age
- Chronic diseases such as heart disease, stroke, respiratory disease, and diabetes
- Medications that impair thermoregulation (such as antihistamines, tricyclic antidepressants, beta-blockers, and vasodilators)
- Dependency and frailty signaled by cognitive impairment or limited mobility

While exposure to heat and cold kills thousands of people prematurely in the United States each year, the death toll underestimates the true impact of temperature on health. For example, mortality statistics do not distinguish between outdoor and indoor exposure to unsafe temperatures as the cause of death and do not account for a range of adverse health consequences that fall short of premature death. For many older adults, it is the aggravation of existing health conditions from exposure to even moderate temperature changes, rather than extreme exposure, that is both of concern and difficult to measure.

Adverse health outcomes, including death, become more likely as temperatures deviate from a moderate range. Temperature thresholds beyond which adverse health outcomes occur reflect local climate, access to resources (such as prevalence of central air-conditioning), and acclimatization (how adapted the population is to local conditions). Greater numbers of temperature-related deaths occur in warmer regions exposed to unseasonable cold and colder regions experiencing atypical warming. Lack of acclimatization also explains why heat waves early in the summer are more deadly than those later in the season.

Lower socioeconomic status is associated with a greater risk of temperature-related death, particularly for older adults. Strong evidence points to indoor cooling, particularly central air-conditioning, and lower temperatures in upstairs sleeping areas as key to mitigating the health effects of hot weather. Research suggests that access to, use of, and efficacy of home heating and cooling increases as household income increases.

High and volatile home energy costs make heating and cooling increasingly unaffordable to millions of low- and moderate-income households, many of which include older persons. Since 2005, the average cost to heat homes in winter has risen about 27.3 percent and the price of residential electrical service has jumped 22 percent. While energy prices rose, median incomes stagnated, especially for low- and moderate-income households. These trends increased the proportion of a household's budget allocated for utility bills. The average low-income household spends 16 percent of its annual income on home energy costs—more than four times the level that all households, on average, devote to home energy bills.

The Low-Income Home Energy Assistance Program (LIHEAP) improves access to home energy, but it has not kept pace with need and does not guarantee basic, affordably priced utility service. In fiscal year 2009, the federal appropriation for LIHEAP nearly doubled from $2.57 billion to $5.1 billion, yet the 7.7 million households that received LIHEAP during 2009 was less than one-quarter of the number estimated to be income-eligible. Moreover, most states offer limited protections against the shutoff of home utility service for nonpayment.

Unaffordable home energy subjects many older adults to direct and indirect threats to their health and safety. For example, 74 percent of households that include older adults report that they cut back on the purchase of household necessities because of high home energy bills. Thirty-two percent of LIHEAP households that include an older person report going without medical or dental care as a result of high home energy bills in the past five years.

Policies and programs to address the health threats posed by high home energy prices can build on existing efforts in the areas of energy, long-term care and health care reform, and livable communities:

Energy: Affordable energy policies can and do promote public health. For example, energy assistance, shutoff protection rules and other policies that protect vulnerable households against the involuntary loss of home utility service promote health and safety. Conversely, policies that address home energy costs by shifting or dampening consumer demand for energy pose a potential threat to health and safety for consumers who may have to choose between paying more for their energy or going without life-saving air-conditioning during summer heat because they cannot shift their usage from higher cost peak times to lower cost off-peak times.

Health Services and Long-Term Care: Published studies document the greater use of health services that result from exposures to excessive heat or cold and the potential of high home energy burdens to make aging in place and independent living more difficult. One implication of these findings is that efforts to strengthen access to affordable energy and ensure protections against shutoffs of basic service for nonpayment can reduce the economic costs of avoidable health care services, improve patient health status, and facilitate independent living.

Livable Communities: Ultimately, policies that promote adequate and affordable home energy use, and that acknowledge the role of home energy as a support for the effective delivery of long-term care and health services to older adults, in turn promote community dwelling that facilitates personal independence and quality of life.

POLICY RECOMMENDATIONS

- Ensure that subsidies and discounts help make home energy affordable and sustainable for households that include older adults.
- Assess the need for LIHEAP and the total amount of energy assistance for households in terms not only of lowering the home energy burden but also of recognizing the value added through improved health and reduced threats to safety.
- Expand categorical eligibility for LIHEAP, weatherization services, and other affordable energy programs to target groups identified as most at risk of adverse health outcomes, for example, through their eligibility for state Medicaid waiver programs and the Medicare Part D Low-Income Subsidy.
- Ensure that state-regulated utility consumer protections and policies (such as shutoff policies) specifically recognize and address the needs of groups identified as most at risk of adverse health outcomes.
- Ensure that demand-response programs for consumers balance the need to reduce energy consumption with the protection of health and safety for older adults and persons living with serious or disabling conditions.
- Design evaluations of weatherization and energy efficiency programs to assess their impact on health and safety as a way to demonstrate the importance of home energy for health.
- Ensure that intake services for state Medicaid waiver program participation and long-term care case management services include referrals for LIHEAP, weatherization, and other affordable energy programs.

- Support education and outreach efforts to increase awareness—both within the health care community and among older adults, their families, and caregivers—of resources that can help them maintain access to healthy and comfortable temperatures.
- Give priority in home repair or modification programs that serve medically frail participants (such as under a state Medicaid waiver) to cost-effective energy efficiency measures that protect health and safety, for example, special coatings for flat-roofed rowhouses that lower indoor temperatures in summer.
- Identify and implement best practices for communicating with the public, especially older adults, their families, and caregivers, about the risks of heat waves and cold temperatures, the links between temperature and health, and the most effective prevention, education, and response efforts.

CONCLUSION

As the U.S. population ages, as the U.S. health care system shifts toward support for independent living and aging in place, and as urban infrastructure and global warming present new environmental challenges, demand for affordable home energy is growing. Increased demand combined with the rising cost of basic utility service jeopardizes the stability and capacity for self-sufficiency of households that include older adults. Understanding and addressing the implications for energy policy of public and population health priorities, as well as the implications for public health of affordable energy and energy efficiency priorities, requires a fresh approach. Such an approach should unite two diverse groups of practitioners, in the energy and health fields, to craft new solutions to help American households maintain both economic security and good health.

INTRODUCTION

In July 1995, a week of sustained hot weather in Chicago killed hundreds of people, most of whom were low-income, older residents living independently. The extreme heat also hospitalized close to a thousand people with strokes, heart attacks, renal failure, and other conditions.[1] Chicago's experience highlighted the value of social connections, walkable neighborhoods, affordable housing, and basic utility services during extreme weather conditions. Extreme heat events in the United States are still rare, but growth in urban infrastructure and climate change are contributing to a gradual rise in ambient temperature and greater seasonal variation in the weather.[2]

This report has two primary goals: first, to explore the implications of affordable home energy for health services, long-term care, and livable communities; and second, to consider low-income energy assistance and other approaches to lowering household energy burdens (the ratio of a household's energy expenditures to its income) in light of this more explicit connection between affordable home energy and health.

The report begins with a review of literature to characterize the health threats posed by weather and high home energy costs and to describe how affordable home energy protects health and reduces inappropriate use of health services. It then describes the energy burden faced by households across the income spectrum, ways to trace the health impacts of unaffordable home energy, and evidence of these impacts documented through telephone surveys. Next, it frames the discussion of affordable home energy and health in the context of policy interests in energy, health services and long term care reform, and livable communities. Finally, the report offers recommendations that promote adequate and affordable home energy use and that acknowledge the role of home energy in helping older adults and people of all ages maintain both economic security and good health.

1 E. Klinenberg, *Heat Wave. A Social Autopsy of Disaster in Chicago* (Chicago: University of Chicago Press, 2002). Other key sources include J. Dematte, K. O'Mara, J. Buescher, C. G. Whitney, S. Forsythe, T. McNamee, R. B. Adiga, and I. M. Ndukwu, "Near-Fatal Heat Stroke during the 1995 Heat Wave in Chicago," *Annals of Internal Medicine* 129 (1998): 173–81; R. Kaiser, A. Le Tetre, J. Schwartz, C. A. Gotway, W. R. Daley, and C. H. Rubin, "The Effect of the 1995 Heat Wave in Chicago on All-Cause and Cause-Specific Mortality," *American Journal of Public Health* 97 (2007): 158–62; R. J. Rydman, D. P. Rumoro, J. C. Silva, T. M. Hogan, and L. M. Kampe, "The Rate and Risk of Heat-Related Illness in Hospital Emergency Departments during the 1995 Chicago Heat Disaster," *Journal of Medical Systems* 23 (1999): 41–56; J. Semenza, "Acute Renal Failure during Heat Waves," *American Journal of Preventive Medicine* 17 (1999): 97; J. C. Semenza, J. E. McCullough, W. D. Flanders, M. A. McGeehin, and J. R. Lumpkin, "Excess Hospital Admissions during the July 1995 Heat Wave in Chicago," *American Journal of Preventive Medicine* 16 (1999): 269–77; J. Semenza, C. Rubin, K. Falter, J. D. Selanikio, W. D. Flanders, H. L. Howe, and J. L. Wilhelm, "Heat-Related Deaths during the July 1995 Heat Wave in Chicago," *New England Journal of Medicine* 335, no. 2 (1996): 84–90.

2 G. Luber and M. McGeehin, "Climate Change and Extreme Heat Events," *American Journal of Preventive Medicine* 35, no. 5 (2008): 429–35.

EVIDENCE ON TEMPERATURE, HEALTH, AND SAFETY

The use of home energy for heating and cooling buffers the impact of outdoor temperatures. Publication of epidemiological studies on the adverse effects on health of both heat (from heat waves and predicted changes in global climate) and cold (from exposures connected with substandard, energy-inefficient housing during wintertime in temperate climates) has increased appreciation of the importance of this buffering effect.[3]

Heat and cold challenge the body's ability to maintain a steady core temperature. Anything that impairs the body's ability to regulate its own temperature heightens vulnerability. Significant risk factors include the following:[4]

- Age (infants and young children are at greater than average risk, and old age increases risk because of the loss of physical fitness and related physiological changes associated with the aging process)
- Chronic diseases that slow the heart's response to stress; the circulatory system's capacity to dilate or contract blood vessels that convey heat (cardiovascular and cerebrovascular disease); the body's ability to change fluid levels in plasma or through sweating (diabetes, kidney and metabolic conditions, scleroderma, cystic fibrosis, and dehydration)
- Medications that impair thermoregulation (such as antihistamines, tricyclic antidepressants, beta-blockers, and vasodilators)
- Frailty signaled by cognitive impairment or limited mobility (nervous system disorders such as Parkinson's disease)

The most commonly recognized adverse outcomes of heat and cold exposure are hyperthermia (and the range of effects from heat cramps and exhaustion to heat stroke) and hypothermia, but many less severe ailments also exist. For many older adults, it is the aggravation of existing health conditions from exposure to even moderate temperature changes, rather than an extreme exposure, that is both of concern and more difficult to measure.

3 For this research report, a literature review was conducted using the PubMed search engine and the MeSH search terms "heat/adverse effects" and "cold/adverse effects" for publications that included human subjects, reviewing all publications starting in 1990. In addition, a citation searching strategy was used to identify peer-reviewed publications dated before 1990 and those in subject areas not covered comprehensively by Pub Med, such as journals in the areas of meteorology and housing. Approximately 300 peer-reviewed journal articles and monographs and a small number of grey literature reports were identified.

4 Discussion in this paragraph based on E. M. Kilbourne, "Temperature and Health," in *Wallace/Maxcy-Rosenau-Last. Public Health and Preventive Medicine*, ed. Robert B. Wallace, 725–34, 15th ed. (New York: McGraw Hill Medical, 2008); R. S. Kovats and S. Hajat, "Heat Stress and Public Health: A Critical Review," *Annual Review of Public Health* 29 (2008): 41–55; F. Matthies, G. Bickler, N. C. Marin, and S. Hales, *Heat Health Action Plans. Guidance* (Denmark: World Health Organization, Regional Office for Europe, 2008).

EXPOSURE TO HEAT AND COLD

Exposure to heat and cold kills thousands of people prematurely in the United States each year; however, the death toll underestimates the true impact of temperature on health. Accounts of the impact of temperature on health typically focus on the number of deaths reported based on death certificates or estimated by looking at seasonal patterns of excessive numbers that correlate with weather extremes.

Death certificates: The most recent annual count for the United States identifies 688 heat-related deaths and 1,152 cold-related deaths, with older adults accounting for 40 to 50 percent of these deaths.[5] Such counts likely underestimate the impact of exposure to unsafe temperatures, reflecting differences from state to state in how such deaths are defined. In this regard, the more narrow definition taken by many coroners' offices hinges on the body temperature of the deceased, whereas in those counties or states where a medical examiner (physician) determines causation, a broader view is more likely to take into account the circumstances in which a victim is found, such as in an overheated apartment.[6]

Attributable deaths: For heat-related deaths alone in the United States, studies converge on an annual number of between 1,700 and 1,800 per year.[7] These estimates are derived by looking at the experiences of populations statistically, measuring deaths from all causes or deaths from conditions linked to heat or cold exposure (for example, seasonal rises in cardiovascular or respiratory disease), adjusting these measures to account for influences unrelated to temperature exposures or home energy burden (the ratio of a household's expenditures to its income), and counting the estimated number of deaths over and above what is observed at other times of year or during the same time period in the absence of extreme weather. One study of deaths during California's 2006 heat wave finds that the attributed number of deaths is two to three times higher than the number reported by coroners' offices.[8]

Using counts or estimates of deaths as the sole measure of temperature's impact neglects the range of nonfatal health consequences. Such estimates are also of limited utility in understanding the impact of home energy use on health, as most studies fail to distinguish between outdoor and indoor exposure to unsafe temperatures or to account for other risk

5 G. E. Luber, C. A. Sanchez, and L. M. Conklin, "Heat-Related Deaths—United States, 1999–2003," *Morbidity and Mortality Weekly Review* 55 (2006): 796–98; T. Murphy, R. Zumwalt, and F. Fallico, "Hypothermia-Related Deaths—United States, 1999–2002 and 2005," *Morbidity and Mortality Weekly Review* 55 (2006): 282–84.

6 H. G. Mirchandani, G. McDonald, I. C. Hood, and C. Fonseca, "Heat-Related Deaths in Philadelphia—1993," *American Journal of Medical Pathology* 17, no. 2 (1996): 106–08; B. D. Ostro, L. A. Roth, R. S. Green, and R. Basu, "Estimating the Mortality Effect of the July 2006 California Heat Wave," *Environmental Research* 109, no. 5 (2009): 614–19.

7 C. E. Reid, M. S. O'Neill, C. Gronlund, S. J. Brines, D. G. Brown, A. V. Diez-Roux, and J. Schwartz, "Mapping Community Determinants of Heat Vulnerability," *Environmental Health Perspectives*, epub 11 (June 2009); Environmental Protection Agency, *Excessive Heat Event Guidebook*, EPA 430-B-06-005 (Washington, DC: EPA, 2006).

8 Ostro et al., "Estimating the Mortality Effect."

factors not directly related to home heating or cooling (such as the prevalence of influenza or the adequacy of clothing in protecting from cold).[9]

ADVERSE HEALTH OUTCOMES

Adverse health outcomes, including death, become more likely as temperatures deviate from a moderate range. Although mortality rates offer only one perspective on the consequences of inadequate home heating and cooling, they do convey information that is useful for guiding policy choices, for example, in establishing threshold temperatures above and below which public health precautions are needed. For a population, the relationship between temperature and death resembles a U, V, or J shape, with a dip or flat area in moderate temperature ranges and greater numbers of deaths at temperatures both lower and higher than thresholds specific to a given area.[10]

Temperature thresholds reflect local climate, infrastructure (such as prevalence of central air-conditioning), and acclimatization (how adapted the population is to local conditions). More temperature-related deaths occur in warmer regions exposed to the cold and colder areas experiencing unseasonable warming. Heat waves tend to have a stronger impact in the Northeast and Midwest than the South and West, and an index of heat vulnerability mapped nationally indicates that the 20 most vulnerable cities are clustered on the East and West Coasts, while most of the least vulnerable cities are in the Southeast.[11] During California's July 2006 heat wave, the highest rate of heat-related emergency department visits was seen in the Central Coast region, where more moderate temperatures are the norm.[12] The lack of time to acclimatize explains why heat waves early in the summer are more deadly than those later in the season.[13]

For U.S. cities, deaths increase by an estimated 2 to 4 percent per degree Fahrenheit above an area's heat threshold (during a heat wave, daily death rates climb even more quickly), and up to an estimated 6 percent per degree Fahrenheit below the cold threshold.[14] Temperature-related respiratory and cardiovascular deaths are more likely

9 K. L. Ebi, "Climate Change, Ambient Temperature, and Health in the U.S.," unpublished presentation at AARP Roundtable, December 2008; T. A. Reichert, L. Simonsen, A. Sharma, S. A. Pardo, D. S. Fedson, and M. A. Miller, "Influenza and the Winter Increase in Mortality in the United States, 1959–99," *American Journal of Epidemiology* 160, no. 5 (2004): 492–502.

10 A. Braga, A. Zanobetti, and J. Schwartz, "The Time Course of Weather-Related Deaths," *Epidemiology* 12 (2001): 662–67; R. Basu and J. Samet, "An Exposure Assessment Study of Ambient Heat Exposure in an Elderly Population in Baltimore, Maryland," *Environmental Health Perspectives* 110 (2002): 1219–24.

11 Environmental Protection Agency, *Excessive Heat Events Guidebook*, 13–14.

12 K. Knowlton, M. Rotkin-Ellman, G. King, H. G. Margolis, D. Smith, G. Solomon, R. Trent, and P. English, "The 2006 California Heat Wave: Impacts on Hospitalizations and Emergency Department Visits," *Environmental Health Perspectives* 117, no. 1 (2009): 61–67.

13 Braga et al., "The Time Course of Weather-Related Deaths"; F. Curriero, K. Heiner, J. Samet, S. Zeger, L. Strug, and J. Patz, "Temperature and Mortality in 11 Cities of the Eastern United States," *American Journal of Epidemiology* 155 (2002): 80–87.

14 Braga et al., "The Time Course of Weather-Related Deaths"; S. Hajat, R. S. Kovats, and K. Lachowycz, "Heat-Related and Cold-Related Deaths in England and Wales: Who Is at Risk?" *Occupational and Environmental Medicine* 64, no. 2 (2007): 93–100; M. Medina-Ramon and J. Schwartz, "Temperature, Temperature Extremes, and Mortality: A Study of Acclimatization and Effect Modification in 50 United States Cities," *Occupational and Environmental Medicine*, epub (2007); R. Basu, W. Y. Feng, and B. D. Ostro, "Characterizing Temperature and Mortality in Nine California Counties," *Epidemiology* 19 (2008): 138–45; A.

during the summertime for older adults, with premature or what are known as excess deaths seen from kidney failure and electrolyte imbalance.[15] In temperate climates, the winter months bring excess deaths for older adults from circulatory system disease (particularly heart attacks and congestive heart failure), respiratory disease (influenza, bronchitis, emphysema, and chronic obstructive pulmonary disorder),[16] and diabetes.[17]

No consensus yet exists on how global climate change will influence current patterns of heat- and cold-related deaths.[18] Some see an increase in heat-related deaths that will more than exceed an anticipated decrease in cold-related deaths.[19] Others anticipate that new weather extremes will mean more respiratory disease deaths in cities with colder climates.[20] Regardless of any future shift in the range of ambient temperatures related to climate change, many other factors, such as personal behavior (in terms of energy use and decisions about appropriate clothing and outdoor gear) and urban infrastructure capacity to respond to shifts in outdoor temperature, will affect the rate of temperature-related deaths and other adverse health outcomes. The fact that heat waves bring greater adverse health impacts to areas that typically experience moderate temperatures, compared with areas accustomed to a broad range of temperatures, underscores the significance of a population's overall capacity to adapt over time.[21]

Zanobetti and J. Schwartz, "Temperature and Mortality in Nine U.S. Cities," *Epidemiology*, epub (2008); Ostro et al., "Estimating the Mortality Effect."

15 A. Braga, A. Zanobetti, and J. Schwartz, "The Effect of Weather on Respiratory and Cardiovascular Deaths in 12 U.S. Cities," *Environmental Health Perspectives* 110 (2002): 859–63; H. Johnson, R. S. Kovats, G. McGregor, J. Stedman, M. Gibbs, H. Walton, L. Cook, and E. Black, "The Impact of the 2003 Heat Wave on Mortality and Hospital Admissions in England," *Health Statistics Quarterly* 25 (2005): 6–11; Hajat et al., "Heat-Related and Cold-Related Deaths"; A. Ishigami, S. Hajat, R. S. Kovats, L. Bisanti, M. Rognoni, A. Russo, and A. Paldy, "An Ecological Time-Series Study of Heat-Related Mortality in Three European Cities," *Environmental Health* 7 (2008): 5.

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17 Elevated wintertime death rates may be influenced by influenza as well as cold stress. T. A. Reichert, L. Simonsen, A. Sharma, S. A. Pardo, D. S. Fedson, and M. A. Miller, "Influenza and the Winter Increase in Mortality in the United States, 1959–1999," *American Journal of Epidemiology* 160, no. 5 (2004): 492–502.

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INTERIOR HEATING AND AIR-CONDITIONING

Interior heating in the wintertime and air-conditioning in the summertime protect against deaths from heart disease, stroke, and respiratory disease. For populations over time and in regions facing episodes of extreme weather, adequate heating in winter and air-conditioning in summer play key roles in promoting public health:[22]

- Poorly insulated dwellings and low indoor temperatures in bedrooms and living rooms are associated with greater numbers of deaths, especially in regions with warmer winters.[23] Among people living with chronic obstructive pulmonary disorder, those whose living rooms in the wintertime are warm (21 degrees Celsius or 70 degrees Fahrenheit and higher) fewer than nine hours per day have significantly poorer respiratory health than those whose living rooms are warm for at least nine hours per day.[24] Older residents in East London are 60 to 70 percent more likely to experience an emergency hospitalization in wintertime if they live in a neighborhood where high home energy burdens are more common.[25] Central heating lowers the odds of wintertime death for older residents,[26] and studies from the United Kingdom and New Zealand as well as the United States document the improved health and quality of life reported by low-income residents of newly weatherized dwellings.[27]

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25 J. Rudge and R. Gilchrist, "Excess Winter Morbidity among Older People at Risk of Cold Homes: A Population-Based Study in a London Borough," *Journal of Public Health* 27 (2005): 353–58.

26 P. Aylin, S. Morris, J. Wakefield, A. Grossinho, L. Jarup, and P. Elliott, "Temperature, Housing, Deprivation and Their Relationship to Excess Winter Mortality in Great Britain, 1986–96," *International Journal of Epidemiology* 30, no. 5 (2001): 1100–108.

27 E. L. Lloyd, C. McCormack, M. McKeever, and M. Syme, "The Effect of Improving the Thermal Quality of Cold Housing on Blood Pressure and General Health: A Research Note," *Journal of Epidemiology and Community Health* 62 (2008): 793–97; P. Howden-Chapman, A. Matheson, J. Crane, H. Viggers, M. Cunningham, T. Blakely, C. Cunningham, A. Woodward, K. Saville-Smith, D. O'Dea, M. Kennedy, M. Baker, N. Waipara, R. Chapman, and G. Davie, "Effect of Insulating Existing Houses on Health Inequality: Cluster Randomised Study in the Community," *British Medical Journal* 334, no. 7591 (2007): 460; N. Shortt and J. Rugkasa, "'‘The Walls Were So Damp and Cold’: Fuel Poverty and Ill Health in Northern Ireland: Results from a Housing Intervention," *Health Place* 13, no. 1 (2007): 99–110.

- Indoor cooling, especially central air-conditioning, is key to saving lives and mitigating the heat-related impacts of climate warming.[28] Studies of heat waves in Philadelphia, Chicago, and Cincinnati confirm the risk posed by high temperatures in upstairs sleeping areas and the efficacy of air-conditioning to reduce the frequency of heat-related death.[29] Looking at the general population over time, people living in homes with central air-conditioning are 42 percent less likely to die than those living in homes without air-conditioners, with positive effects seen for window air-conditioning units in smaller residences.[30] And a study of deaths in Pittsburgh, Chicago, Detroit, and Minneapolis-St. Paul finds a 5 percent higher heat-related death rate among African Americans than white residents and concludes that more than two-thirds of this racial disparity reflects the lack of central air-conditioning among African-American households surveyed.[31]

LOWER SOCIOECONOMIC STATUS

Lower socioeconomic status is associated with a greater risk of temperature-related death, particularly for older adults. Poverty and low-income status in the United States are associated with unsafe indoor temperatures and, through this link, with adverse health outcomes.[32] Research suggests that access to, use of, and efficacy of home heating and cooling increase as household income increases.

28 E. M. Kilbourne, K. Choi, T. S. Jones, and S. B. Thacker, "Risk Factors for Heatstroke: A Case-Control Study," *Journal of the American Medical Association* 247 (1982): 3332–36; Mirchandani et al., "Heat-Related Deaths in Philadelphia–1993"; M. P. Naughton, A. Henderson, M. C. Mirabelli, R. Kaiser, J. L. Wilhelm, S. M. Kieszak, C. H. Rubin, and M. A. McGeehin, "Heat-Related Mortality During a 1999 Heat Wave in Chicago," *American Journal of Preventive Medicine* 22 (2002): 221–27; G. C. Donaldson, W. Keatinge, and S. Nayha, "Changes in Summer Temperature and Heat-Related Mortality Since 1971 in North Carolina, South Finland, and Southeast England," *Environmental Research* 91, no. 1 (2003): 1–7; Barnett, "Temperature and Cardiovascular Deaths"; Medina-Ramon et al., "Temperature, Temperature Extremes, and Mortality"; Ebi et al., "Effects of Global Change on Human Health."

29 Naughton et al., "Heat-Related Mortality"; Mirchandani et al., "Heat-Related Deaths in Philadelphia—1993"; Semenza et al., "Heat-Related Deaths During the July 1995 Heat Wave"; R. Kaiser, C. H. Rubin, et al., "Heat-Related Death and Mental Illness During the 1999 Cincinnati Heat Wave," *American Journal of Forensic Medical Pathology* 22 (2001): 303–07.

30 E. Rogot, P. D. Sorlie, and E. Backlund, "Air-Conditioning and Mortality in Hot Weather," *American Journal of Epidemiology* 136 (1992): 106–16.

31 M .S. O'Neill, A. Zanobetti, and J. Schwartz, "Disparities by Race in Heat-Related Mortality in Four U.S. Cities: The Role of Air Conditioning Prevalence," *Journal of Urban Health* 82, no. 2 (2005): 191–97.

32 The relationship between indoor exposures and poverty or socioeconomic status in European Union (EU) countries differs from that in the United States, given stronger supports for affordable housing in EU countries and the quality of the housing stock more generally. P. Wilkinson, M. Landon, B. Armstrong, et al., *Cold Comfort: The Social and Environmental Determinants of Excess Winter Death in England, 1986–1996* (Bristol: The Policy Press, 2001); N. Gouveia, S. Hajat, and B. Armstrong, "Socioeconomic Differentials in the Temperature-Mortality Relationship in Sao Paulo, Brazil," *International Journal of Epidemiology* 32 (2003): 390–97; F. Canoui-Poitrine, E. Cadot, A. Spira, Groupe Régional Canicule, "Excess Deaths During the August 2003 Heat Wave in Paris, France," *Revue d'Epidemiologie et de Sante Publique* 54 (2006): 127–35; Hajat, Kovats, and Lachowycz, "Heat-Related and Cold-Related Deaths in England and Wales"; P. Wilkinson, S. Pattenden, B. Armstrong, A. Fletcher, R. S. Kovats, P. Mangtani, and A. J. McMichael, "Vulnerability to Winter Mortality in Elderly People in Britain: Population Based Study," *British Medical Journal* 329, no. 7467: 647.

Heating:[33]

- Almost all households have space-heating equipment, but households eligible for the Low-Income Home Energy Assistance Program (LIHEAP)[34] are less likely to have such equipment (1.6 percent, versus 1.1 percent of all households) and twice as likely to not use heating equipment that they have (1.6 percent, versus 0.7 percent of all households).

- LIHEAP-eligible households are more likely to live in homes that lack adequate insulation (24.9 percent, versus 18.4 percent of all households) and are more likely to report that their home is too drafty most of the time (14.5 percent, versus 10.5 percent of all households).

Cooling***:***

- LIHEAP-eligible households with air-conditioning are much more likely than all households with air-conditioning to have window or wall air conditioning units (45.3 percent versus 30.9 percent, respectively).[35]

- A recent national survey of LIHEAP-recipient households finds that only 62 percent use air-conditioning as a primary means to keep cool in summer.[36]

Lower socioeconomic status means greater risk of temperature-related death, especially for older adults.[37] Other socioeconomic indicators of temperature-related death include social isolation, gender, black ethnic or racial identity, and housing conditions that

33 Data in this section are from the U.S. Department of Energy, Energy Information Administration (2009), Table HC7.5, "Space Heating Usage Indicators by Household Income, 2005," http://www.eia.doe.gov/emeu/recs/recs2005/hc2005_tables/hc5spaceheatingindicators/pdf/tablehc7.5.pdf (accessed 04/08/10).

34 Federal statute limits LIHEAP eligibility to households with incomes that do not exceed 150 percent of the federal poverty level or 60 percent of the state median income, whichever is greater.

35 U.S. Department of Energy, Energy Information Administration (2009), Table HC7.6, "Air Conditioning Usage Indicators by Household Income, 2005," http://www.eia.doe.gov/emeu/recs/recs2005/hc2005_tables/hc7airconditioningindicators/pdf/tablehc7.7.pdf (accessed 04/08/10).

36 National Energy Assistance Directors Association (NEADA), "2008 National Telephone Sample Survey" (Washington, DC: Apprise, Inc., unpublished and available from NEADA).

37 Kilbourne, "Temperature and Health."

concentrate heat indoors.[38] The income gradient widened by high home energy prices also contributes to health disparities related to home energy, such as food insecurity:[39]

- Older residents in low-income households of the northern United States are more likely to go hungry in late winter, while similar households in the South are more likely to go hungry in late summer, reflecting the costs of heating and cooling.[40]

- In northern states, poor families with children spend less on food and more on home fuel, and their children have lower caloric intake during the winter months, than higher income families.[41]

HIGH AND RISING HOME ENERGY PRICES: A THREAT TO LOW- AND MODERATE-INCOME HOUSEHOLDS

According to data from the Energy Information Administration, the average cost to heat homes in winter has increased by 27.3 percent since 2005.[42] During the same time period, the use of air conditioning has also become more expensive as the price of residential electrical service (cents per kilowatt hour) has jumped 22 percent.[43] The trend is likely to continue as electrical utilities invest in more modern infrastructure, pay more for fuel, and respond to new regulatory policies related to climate change.[44]

38 Curriero et al., "Temperature and Mortality in 11 Cities"; J. Diaz, A. Jordan, R. Garcia, C. Lopez, J. C. Alberdi, E. Hernandez, and A. Otero, "Heat Waves in Madrid 1986–1997: Effects on the Health of the Elderly," *International Archives of Occupational and Environmental Health* 75 (2002): 163–70; Kaiser et al., "The Effect of the 1995 Heat Wave in Chicago"; Naughton et al., "Heat-Related Mortality"; M. O'Neill, A. Zanobetti, and J. Schwartz, "Modifiers of the Temperature and Mortality Association in Seven U.S. Cities," *American Journal of Epidemiology* 157 (2003): 1074–82; O'Neill, Zanobetti, and Schwartz, "Disparities by Race in Heat-Related Mortality"; M. Medina-Ramon, A. Zanobetti, D. P. Cavanagh, and J. Schwartz, "Extreme Temperatures and Mortality: Assessing Effect Modification by Personal Characteristics and Specific Cause of Death in a Multi-City Case-Only Analysis," *Environmental Health Perspectives* 114 (2006): 1331–36; J. Schwartz, "Who Is Sensitive to Extremes of Temperature? A Case-Only Analysis," *Epidemiology* 16 (2005): 67–72; Zanobetti and Schwartz, "Temperature and Mortality in Nine U.S. Cities."

39 N. Adler and D. Rehkopf, "U.S. Disparities in Health: Descriptions, Causes, and Mechanisms," *Annual Reviews in Public Health* 29 (2008): 235–52; M. S. O'Neill, A. J. McMichael, J. Schwartz, and D. Wartenberg, "Poverty, Environment, and Health: The Role of Environmental Epidemiology and Environmental Epidemiologists," *Epidemiology* 18 (2007): 664–68.

40 M. Nord and L. S. Kantor, "Seasonal Variation in Food Insecurity Is Associated with Heating and Cooling Costs among Low-Income Elderly Americans," *Journal of Nutrition* 136 (2006): 2939–44.

41 J. Bhattacharya, T. DeLeire, S. Haider, and J. Currie, "Heat or Eat? Cold-Weather Shocks and Nutrition in Poor American Families," *American Journal of Public Health* 93 (2003): 1149–54.

42 Expenditures are in nominal terms and not adjusted for inflation. U.S. Department of Energy, Energy Information Administration, Short-Term Energy Outlook (March 2010), Table WF01, "Average Consumer Prices and Expenditures for Heating Fuels During the Winter," http://www.eia.doe.gov/pub/forecasting/steo/oldsteos/mar10.pdf (accessed 5/18/2010).

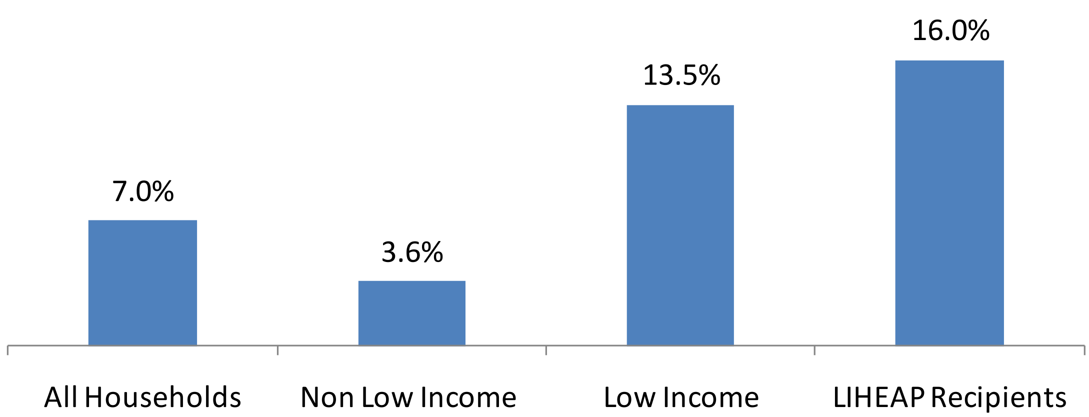
43 U.S. Department of Energy, Energy Information Administration (2010), Table 5.3, "Average Retail Price of Electricity to Ultimate Customers: Total by End-Use Sector, 1996 through February 2010," http://www.eia.doe.gov/cneaf/electricity/epm/table5_3.html (accessed 5/18/2010).

[44]U.S. Department of Energy, Energy Information Administration (2010), *Annual Energy Outlook 2010*, p.66; Rebecca Smith, "Utilities Seek Round of Rate Increases," *Wall Street Journal* November 27, 2009; Scott DiSavino, "U.S. Power Bills Down, But Not For Long," *Reuters*, August 25, 2009.

In fiscal year (FY) 2007, the most recent year for which such data are available, the average residential energy expenditure for all households was $1,986, the mean home energy burden (the proportion of a household's budget allocated for utility bills) was 7 percent, and heating costs and cooling costs accounted for about 41 percent (28 percent and 13 percent, respectively) of residential energy expenditures.[45] Households *eligible* for LIHEAP spend less on energy ($1,715) on average but carry nearly twice the home energy burden (13.5 percent), while households *enrolled* in LIHEAP spent about an average amount ($1,900) but 16 percent of their annual income (see Figure 1). On average, LIHEAP-enrolled households have lower incomes than LIHEAP-eligible households.

Figure 1.

Low Income Households Carry Heavy Home Energy Burden



Source: U.S. Department of Health and Human Services, Administration for Children and Families, Office of Community Services, Division of Energy Assistance. *LIHEAP Home Energy Notebook for FY 2007* (Washington, DC: USDHHS, 2009).

High and rising energy prices have a disparate impact on households that include older adults, even though they consume less energy than households without older adults. In fact, households that include older adults use about 5 percent less energy, reflecting smaller homes, and among these households, those at or below the federal poverty level use about one-third less energy.[46] Nationally, and in all regions of the country (Northeast, Midwest, South) except the West, low-income households that include older adults use energy more intensively—that is, they consume more energy per square foot of living

45 U.S. Department of Health and Human Services, Administration for Children and Families, Office of Community Services, Division of Energy Assistance, *LIHEAP Home Energy Notebook for FY 2007* (Washington, DC: USDHHS, June 2009).

46 J. Howat and P. Taormina, "Home Energy Costs: The New Threat to Independent Living for the Nation's Low-Income Elderly," *Clearinghouse REVIEW. Journal of Poverty Law and Policy* 41 (2008): 552–68.

space—than do households above the poverty line. This use reflects the fact that these households are more likely to have older, less energy-efficient appliances such as refrigerators and heating equipment. Because of this disparity, these households pay more and receive less, in terms of home energy, than the average household.[47]

While energy prices have risen, median incomes have stagnated, especially for low- and moderate-income households. As a result, home energy burdens, have increased:

- Between 2001 and 2006, home energy burdens for poor, older adults living in two-person households rose significantly.[48] For such households whose incomes are less than 150 percent of the federal poverty levels, average energy burdens grew by almost 25 percent in the Northeast (to 9.6 percent) and South (to 8.2 percent), and by more than 10 percent in the Midwest (to 7.5 percent).[49]
- The home energy affordability gap, which illustrates differences between what low-income households are billed and what they can afford to pay, has more than doubled between 2002 and 2007.[50]
- Since the early 1970s, while median household incomes have risen, the volatility of income has increased; and the chance that a household headed by a working-age adult (ages 25 through 65) will experience a significant loss of income has increased by almost 50 percent.[51]

LIHEAP Improves Access to Home Energy

LIHEAP improves access to home energy, but it has not kept pace with need and does not guarantee basic, affordably priced utility service. LIHEAP, the single largest source of federal income support for home energy costs, provides eligible low-income households with financial assistance to offset the costs of heating and cooling their homes. According to the most recent data from the U.S. Department of Health and Human Services (FY 2007), an estimated 5.3 million households received an average of $320 in winter heating or winter crisis assistance, and 600,000 households received an average of $171 in summer cooling or summer crisis assistance.[52]

47 Howat and Taormina, "Home Energy Costs: The New Threat."

48 Ibid.

49 Ibid. These figures do not reflect significant energy price increases seen in 2007 and those predicted for the future.

50 This measure aggregates county-level measures of total energy bills, weighted by the proportion of low-income residents (households earning less than 185 percent of the poverty level); see http://www.homeenergyaffordabilitygap.com. A home energy burden is defined as affordable if bills are less than 10 percent of household income.

51 P. Gosselin and S. Zimmerman, "Trends In Income Volatility and Risk, 1970–2004," Urban Institute Working Paper (Washington, DC: The Urban Institute, 2008).

52 USDHHS, *LIHEAP Home Energy Notebook for FY 2007*.

Unfortunately, LIHEAP benefits cover only a portion of home energy costs. In fact, the percentage of the total home heating bill covered by LIHEAP benefits decreased from 23 percent in 1981 to 10 percent in FY 2007.[53]

Moreover, the number of households that receive LIHEAP assistance represents only a small fraction of income-eligible households. More than 33.8 million households—which included more than 13.7 million households that had at least one member 60 years of age or older—were income-eligible for LIHEAP in FY 2007.[54] Millions more households became eligible during FY 2009 as many states increased their maximum income eligibility guidelines for LIHEAP from 60 percent to 75 percent of state median income.

Congress nearly doubled the federal allocation for LIHEAP from $2.6 billion in FY 2008 to $5.1 billion for FY 2009. The increase provided a much-needed infusion of support for the program:

- The purchasing power of LIHEAP dollars jumped to approximately 56 percent of the average cost to heat a home, the highest percentage since the program began.
- The average grant increases modestly to an estimated $543.
- The number of households served rose by 25 percent, or an additional 1.9 million households.[55]

Nevertheless, the 7.7 million households who received LIHEAP during 2009 was less than one-quarter of the number estimated to be income-eligible.[56]

Households that cannot afford to pay their utility bills face the possibility of having their utility service disconnected. While LIHEAP can help prevent shutoff of essential utility service by making payment more affordable, millions of residential consumers, including many LIHEAP-eligible and -assisted households, have their electricity or natural gas service terminated for failing to pay their bills.[57] Most states offer only limited protections to prevent the shutoff of regulated home utility service for nonpayment, and there are no regulatory protections governing delivered fuels, such as heating oil, propane, and wood. According to the National Center for Appropriate Technology's LIHEAP Clearinghouse, 40 states have seasonal moratoria on the shutoff of electricity or natural gas during the wintertime, 10 states have seasonal moratoria for the summer

53 USDHHS, *LIHEAP Home Energy Notebook for FY 2007*.

54 The number of eligible households is calculated using state-level income guidelines. USDHHS, *LIHEAP Home Energy Notebook for FY 2007*.

55 NEADA, "Low Income Home Energy Assistance Program – Program Purchasing Power," (unpublished memo: NEADA, October 6, 2008, available from Mark Wolfe, mwolfe@neada.org),**;** NEADA, "Table 1: LIHEAP Winter Heating Households Served FY 09 & FY 10 Projected (Revised 02-23-10)," press release available at http://www.neada.org/communications/press/2010-02-22/Table1-LIHEAP10ProjServed.pdf (accessed 04/08/10).

56 Ibid.

57 S. Sloane, M. Miller, B. Barker, and L. Colosimo, "2008 National Association of Regulatory Utility Commissioners (NARUC) Collections Survey Report," http://www.naruc.org/Publications/2008%20NARUC%20Collections%20Survey%20Report.pdf (accessed 04/08/10).

months, and 43 states have limited protections against shutoffs on the grounds of life-threatening or serious illness (usually a delay in a scheduled shutoff for nonpayment if a health care practitioner certifies poor health).[58] Only eight states have utility shutoff protections specifically for older adults, two of which protect against shutoffs during summertime and wintertime, while six offer protection only during the wintertime.

Low-income energy assistance, and related utility rate discount programs, where offered, help increase access to moderate indoor temperatures and temper the stress that high utility bills place on household budgets. Smart public policy, however, also involves weatherization and energy efficiency measures, utility shutoff protections, and guaranteed basic levels of service, as well as public education to inform individual decision making about using and conserving home energy.

NATIONAL ENERGY ASSISTANCE SURVEY

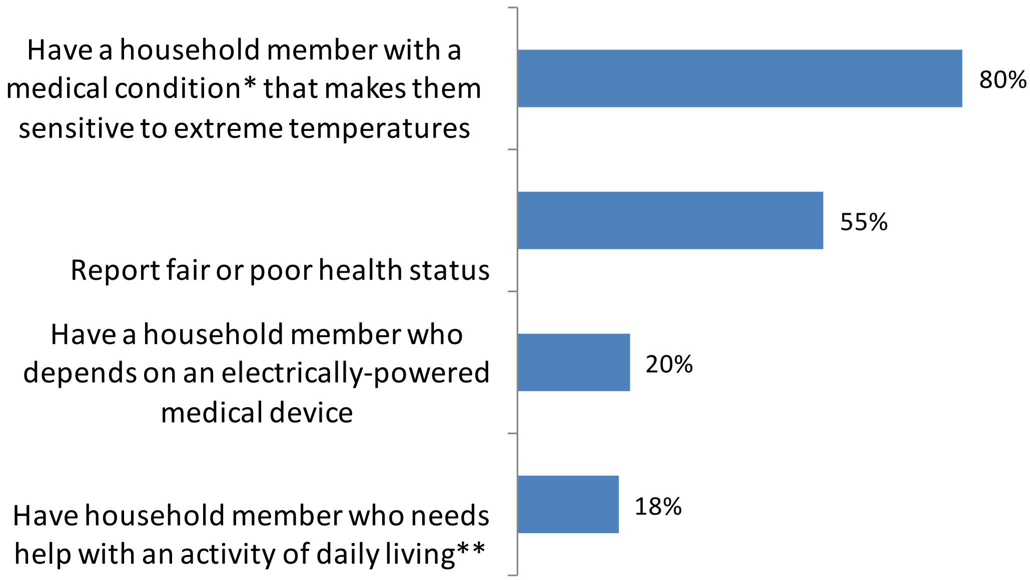
Unaffordable home energy subjects many older adults to direct and indirect threats to their health and safety. A survey released by the National Energy Assistance Directors' Association indicates that LIHEAP-enrolled households that include an older adult are particularly vulnerable to adverse health outcomes related to high home energy burdens (see figure 2) and frequently make difficult choices that pose both *direct* and *indirect* risks to health.[59,]

58 LIHEAP Clearinghouse, "Seasonal Termination Protection Regulations," table prepared by the National Center for Appropriate Technology, 2009, http://liheap.ncat.org/Disconnect/SeasonalDisconnect.htm (accessed 12/25/09).

59 The concept of two main pathways through which household energy burden affects health is developed in Child Health Impact Working Group, *Unhealthy Consequences: Energy Costs and Child Health* (Boston, MA: Child Health Impact Working Group, 2006). Unless otherwise noted, all findings reported in this section are from a 12-state telephone sample survey of households receiving an LIHEAP benefit. See NEADA, "2008 National Energy Assistance Survey" (Washington, DC: Apprise, Inc., 2009), available from Mark Wolfe, mlwolfe@neada.org.

Figure 2.

Health Status Makes LIHEAP Households with an Older Adult Particularly Vulnerable to Unaffordable Home Energy



* including asthma, emphysema, chronic obstructive pulmonary disorder (COPD), diabetes, high blood pressure, heart disease, or stroke

** help with personal care needs because of a physical, mental or emotional problem

Source: National Energy Assistance Directors' Association. *2008 National Energy Assistance Survey* (Princeton, NJ: Apprise, Inc., 2009). Available from Mark Wolfe, mwolfe@neada.org.

Direct threats to health:

Health is at risk *directly* through exposure when heat is turned down in winter or air-conditioning is turned off in summer, when unsafe means are used to heat or light homes, and when utility service is lost due to nonpayment. Substandard dwellings may be hard or impossible to keep within a moderate temperature range, and excessive humidity may lead to mold growth that increases the likelihood of respiratory disease. The following statistics pertain to LIHEAP-enrolled households that include an older adult:

- In response to high home energy prices perceived as unaffordable, 46 percent report closing off part of their home for at least one month a year, 24 percent maintain their home at what they perceived as an unsafe or unhealthy temperature, and 17 percent report leaving their home for part of the day because they were unable to maintain moderate indoor temperatures.[60]

- More than one-quarter (27 percent) report using the kitchen stove or oven for heat, and 4 percent use candles or lanterns because of loss of utility service for nonpayment.[61]

- More than one-quarter (28 percent) report skipping payment of a utility bill or paying less than the full amount, 19 percent received a shutoff notice for nonpayment within the past year, and 6 percent report the loss of either electrical or natural gas service for nonpayment.[62]

- One in six (17 percent) report that they were unable to use their main heating source at some point during the previous year because they did not have the money to accomplish one or more of the following: fix or replace a broken furnace; purchase bulk fuel such as heating oil, propane, or wood; or prevent the shutoff of utility service for nonpayment.[63]

- One in eight (12 percent) report that they were unable to use their air-conditioning at some point during the previous year because they did not have the money to accomplish one or both of the following: fix or replace a broken air conditioner; or prevent the shutoff of electricity for nonpayment.[64]

Indirect threats to health:

Financial stress poses *indirect* threats when households must make difficult decisions in the face of competing demands for limited dollars. This scenario is commonly described as “heat or eat,” making vivid the trade-offs between paying a utility bill and purchasing groceries or medications. The following statistics pertain to LIHEAP-participating households that include an older adult:

- Three-quarters (74 percent) report cutting back on the purchase of household necessities because of high home energy bills.[65]

- Nearly one-quarter (24 percent) report going without food for at least one day because of energy bills in the past five years.[66]

60 NEADA, “2008 National Energy Assistance Survey,” Table IV-17B, Table IV-18B, Table IV-19B.

61 Ibid., Table IV-20B, Table IV-37B.

62 Ibid., Table IV-22B, Table IV-23B, Table IV -27B.

63 Ibid., Table IV-31B.

64 Ibid., Table IV-34B.

65 Ibid., Table IV-14B.

66 Ibid., Table IV-50B.

- Almost one-third (32 percent) report going without medical or dental care because of energy bills in the past five years, and 31 percent report neglecting to fill a medical prescription or taking less than a full dose because of high energy bills.[67]

- One in six (15 percent) report being unable to pay energy bills because of medical or prescription drug expenses during the past year.[68]

MAKING THE CONNECTIONS: HIGH HOME ENERGY BURDENS AND POLICY PRIORITIES

Policies and programs to address the health threats posed by high home energy prices can build on existing efforts in the areas of energy, long-term care and health care reform, and livable communities.

ENERGY

The high cost of basic home utility service threatens the economic security of low- and moderate-income households and by extension, the health and well-being of household members. Affordable energy policies promote population health.

The ultimate goal of home heating and cooling is to maintain moderate indoor temperatures. Meeting energy needs affordably has been a consistent challenge for too many households and could become even more problematic as energy prices increase in response to efforts to reduce greenhouse gas emissions. Full funding of LIHEAP in recent years has enabled many states to raise their maximum income eligibility guidelines, the size of individual awards, and the numbers of households enrolled. However, LIHEAP still services only about one-quarter of eligible households.[69]

Recognizing that a host of issues can make young children and older adults more vulnerable to temperatures that deviate from a moderate range, some states prohibit or limit the disconnection of residential energy services for households with members of certain ages.[70] Many states offer a limited protection against involuntary loss of home utility service for people facing life-threatening circumstances or serious illness. Typically, these protections take the form of a delay or extension in the schedule for a shutoff, which is set in motion by the periodic filing of a medical certification with the state energy office or utility company.[71] Only a handful of states prohibit shutoffs

67 Ibid., Table IV-51B, Table IV-52B.

68 Ibid., Table IV-53B.

69 NEADA, '"LIHEAP Program Purchasing Power," unpublished memo, November 11, 2009, available from Mark Wolfe, mlwolfe@neada.org .

70 LIHEAP Clearinghouse, "State Disconnection Policies," table prepared by the National Center for Appropriate Technology, 2009, http://liheap.ncat.org/Disconnect/disconnect.htm (accessed 12/25/09).

71 LIHEAP Clearinghouse, "Seasonal Termination Protection Regulations," table prepared by the National Center for Appropriate Technology, 2009, http://liheap.ncat.org/Disconnect/SeasonalDisconnect.htm (accessed 12/25/09).

altogether for people facing significant health challenges. Current practice does not acknowledge the difficulty that the average low-income household has in maintaining regular access to appropriate health care so that a medical provider can file such a notice.

Some recent policy initiatives pose threats to the health of older people. At the local, state, regional, and national levels, policymakers and industry groups have initiated efforts to shift and dampen consumer demand for electricity. These efforts have focused on the deployment of advanced metering technology and a variety of new pricing programs that vary the price of electricity based on the time of day.[72] These demand-response policies not only create financial incentives and indirect pressure to reduce consumption but also pose a potential threat to health and safety for consumers who must pay more for electricity because they cannot shift their usage from higher cost peak times to lower cost off-peak times. These policies raise other concerns as well:

- Installing advanced meters, and related technology is expensive and expected to be financed by utility customers, adding to the cost of residential electricity.

- While traditional meter technology requires a visit to the customer's premises to disconnect service for nonpayment or other reasons, advanced meters typically include a switch that allows the utility to disconnect service from a remote location. The use of this functionality could result in an increase in the volume of disconnections for nonpayment and have adverse impacts on health and safety if utilities do not visit the customer's premises at the time of disconnection. In this regard, a site visit allows utility field personnel to observe individual customer circumstances and identify signs of potential medical emergencies and other safety risks associated with the loss of service. It also provides customers with opportunity to pay any delinquencies on their bill and ensures that they are aware of the impending action. The potential danger of remote disconnections is exemplified in the case of a 93-year-old Michigan resident who died of hypothermia inside his home, the result of a service limiter being tripped.[73]

HEALTH SERVICES AND LONG-TERM CARE

Exposures to extreme temperatures and lack of access to home energy assistance are associated with greater use of health services, especially by older adults with chronic health conditions. Published studies document the greater use of health services that result from exposures to excessive heat or cold and the potential of high home energy burdens to destabilize the national movement to promote aging in place and independent living.

72 B. Alexander, "Smart Meters, Real Time Pricing, and Demand Response Programs: Implications for Low Income Electric Customers," unpublished paper, revised May 30, 2007, available from Barbara Alexander, barbalex@ctel.net.; N. Brockway, "Advanced Metering Infrastructure: What Regulators Need to Know about Its Value to Residential Customers" (Silver Spring, MD: National Regulatory Research Institute, 2008); N. Walters, *Can Advanced Metering Help Reduce Electricity Costs for Residential Consumers?* AARP Insight on the Issues no. 18 (Washington, DC: AARP, 2008).

73 D. Eggert, "Freezing Death of Michigan Man, 93, Inside House Sparks Anger; City Utility Cut Power with Limiter," Associated Press, January 28, 2009.

One implication of these findings is that efforts to strengthen access to affordable energy and ensure protections against shutoffs of basic service can reduce the economic costs of avoidable health care services, improve patient health status, and facilitate independent living. This relationship between home energy and health services is analogous to the connection between the use of primary health care and potentially avoidable hospitalization. Hospitalizations can be avoided with sufficient access to primary care.[74] Similarly, in the context of high home energy burdens, avoidable hospital visits and admissions for heat- and cold-sensitive conditions suggest the need to strengthen access to affordable energy and to ensure protections against shutoffs of basic service.

In the federal LIHEAP statute, Congress recognizes that affordable home energy has important implications for the health and safety of older adults (defined as at least 60 years of age), young children (up to age 6), and people living with a disability. The statute identifies these three populations in its definition of households that have the "highest home energy needs" and identifies them as priorities for outreach and enrollment.

The federal statute gives each state and tribal LIHEAP program the option of allowing households to demonstrate eligibility for the program based on their participation in other means-tested programs rather than having to provide evidence of income. Known as categorical eligibility, the option of using other low-income assistance programs, including Temporary Assistance for Needy Families (TANF), Supplemental Security Income (SSI), and the Supplemental Nutrition Assistance Program (food stamps), as proxies for income eligibility gives states more flexibility and provides the opportunity to identify and serve households that are at risk of adverse health outcomes from high home energy burdens. For instance, SSI provides monthly benefits to 7.5 million low-income individuals who live with a significant disabling condition, who are legally blind, or who are at least 65 years old.[75] States likely would reach even more of those most at risk of adverse health outcomes if categorical eligibility were extended to targeted groups of medically frail individuals, as identified through their participation in health services and receipt of long-term care services. For example, consider the following statistics that pertain to approximately 12.6 million Medicare beneficiaries who are at least 65 years old and who live in households that are income-eligible for LIHEAP (earning no more than 150 percent of the federal poverty level):[76]

74 A. B. Bindman, K. Grumbach, D. Osmand, M. Komaromy, K. Vranizan, N. Lurie, J. Billings, and A. Stewart A, "Preventable Hospitalizations and Access to Care," *Journal of the American Medical Association* 274, no. 4 (1995): 305–11.

75 SSI is a federal entitlement program providing monthly income support for members of low-income households who live with a significant disabling condition, who are legally blind, or who are at least 65 years of age. Social Security Administration, *SSI Annual Statistical Report, 2007,* SSA Pub. No. 13-11827 (Washington, DC: SSA, 2008).

76 Estimates cited in this paragraph are from Kaiser Family Foundation (KFF), Urban Institute, and Kaiser Commission on Medicaid and the Uninsured, based on the U.S. Census Bureau, "March 2007 and 2008 Current Population Survey," CPS: Annual Social and Economic Supplements (Washington, DC: U.S. Census Bureau, 2008, 2009), http://statehealthfacts.org (04/20/09).

- Nearly 9.4 million are eligible to enroll in the Medicare Part D Low-Income Subsidy for assistance paying for prescription drugs.[77]

- About 6.2 million are fully eligible for Medicaid subsidy of health care expenses not covered under Medicare.[78]

Long-term care arrangements for older adults who are seriously ill or disabled should acknowledge the importance of affordable home energy. Most states have Medicaid waiver programs that pay for home- and community-based services for income-eligible people who otherwise might enter a nursing home. Some 1.3 million people receive support to stay in their homes under Medicaid waivers, and many more are eligible and

Box 1.
Extreme Temperatures, LIHEAP, and Potentially Avoidable Hospitalization

- **Hospital admissions attributed to exposure:** In 2005, about 12,700 people were hospitalized in the United States for weather-related reasons, with residents of lower income communities more than twice as likely as those from higher income areas to be hospitalized.[a] Aggregate costs for these admissions are significant—$38.7 million for heat-related stays and $81.5 million for cold-related stays.

- **Hospital visits and admissions during heat waves:** During a two-week heat wave in California in July 2006, emergency department visits rose more than sixfold and hospital admissions more than tenfold for heat-related diagnoses for the state as a whole.[b] Chicago's July 1995 heat wave boosted hospital admissions 35 percent over the average for older Americans.[c]

- **Positive impact of energy assistance:** Young children in families eligible for but not enrolled in LIHEAP are more likely to need hospital admission on the day of a health care visit.[d]

a C.T. Merill, M. Miller and C. Steiner, "Hospital Stays Resulting From Excessive Heat and Cold Exposure Due to Weather Conditions in U.S. Community Hospitals, 2005," *Healthcare Cost and Utilization Project*, Statistical Brief No. 55 (Rockville, MD: U.S. Department of Health and Human Services, Agency for Healthcare Research and Quality, 2008).

b Knowlton et al., "The 2006 California Heat Wave."

c Semenza et al., "Excess Hospital Admissions."

d D.A. Frank, N.B. Neault, A. Skalicky, J.T. Cook, J.D. Wilson, S. Levenson, A.F. Meyers, T. Heeren, D.B. Cutts, P.H. Casey, M.M. Black and C. Berkowitz, "Heat or Eat: the Low Income Home Energy Assistance Program and Nutritional and Health Risks Among Children Less Than 3 Years of Age," Pediatrics 118, no.5 (2006): e1293-1302.

77 KFF statehealthfacts.org, estimate for 2008 from Centers for Medicare and Medicaid Services (CMS), Office of External Affairs, released January 31, 2008.

78 KFF, statehealthfacts.org, Urban Institute estimates for 2003 based on data from the Medicaid Statistical Information System (MSIS) prepared for the Kaiser Commission on Medicaid and the Uninsured.

on waiting lists for waiver slots.[79] Affordable home energy and adequate indoor temperatures are an important support for the success of home- and community-based services, stabilizing the home environment and freeing up dollars in the household budget. Although federal Medicaid funds may not be used to pay for home utility service, some states, such as Florida, have carried out demonstration projects (cash and counseling) that give participants greater latitude in how funds for long-term care services are used, including to pay utility bills.[80] Access to basic home utility service can be considered part of accommodations made under the Americans with Disabilities Act to guarantee that people who are ill or disabled enough to live in a nursing home have the option to live in a community setting instead.[81]

Strengthening the connections between affordable home energy and health requires a greater understanding of affordable energy issues among clinicians, health care administrators, and analysts. Many in the health care community fail to recognize the role of home energy as a support for the effective delivery of health services and long-term care. Various studies indicate that health care and public health professionals, and the clients and family caregivers they serve, need better information about the health and safety threats posed by inadequately heated and cooled homes and the high home energy burdens borne by low- and moderate-income households.[82] Preparing the health care community for climate change will involve training providers and safety net workers to recognize heat-related ailments and making them aware of the resources that can help at-risk patients maintain access to healthy and comfortable temperatures. For example, a health care practitioner's ability to protect people facing life-threatening circumstances or serious illness against involuntary loss of home utility service (as discussed above) depends significantly on the practitioner's awareness of and able to comply with the consumer protection regulations that govern utility service shutoffs.[83]

LIVABLE COMMUNITIES

Ultimately, policies that promote adequate and affordable home energy use, and that acknowledge the role of home energy as a support for the effective delivery of long-term

79 Estimate for 2004 from AARP, *A Balancing Act: State Long-Term Care Reform* (Washington, DC: AARP, 2008), Table A3.

80 On the cash and counseling demonstration in Florida, see B. Phillips and B. Schneider, "Commonalities and Variations in the Cash and Counseling Programs across the Three Demonstration States," *Health Services Research* 42, no. 1 (2007): 397–413.

81 A state's Olmsted plan, required under federal law, details how the state will provide long-term care supports to residents in the least restrictive setting available. R. Desonia, *Is Community Care a Civil Right?* National Health Policy Forum Background Paper, 2003, http://www.nhpf.org (12/14/09).

82 R. Jackson and K. N. Shields, "Preparing the U.S. Health Community for Climate Change," *Annual Reviews in Public Health* 29 (2008): 57–73; F. Matthies, G. Bickler, N. C. Marin, and S. Hales S., eds., *Heat-Health Action Plans. Guidance* (Copenhagen, Denmark: World Health Organization, 2008); J. Balbus, K. Ebi, L. Finzer, C. Malina, A. Chadwick, D. McBride, M. Chuk, and E. Maibach, *Are We Ready? Preparing for the Public Health Challenges of Climate Change* (New York: Environmental Defense Fund, 2008), http://www.edf.org/documents/7846_AreWeReady_April 2008.pdf (accessed 04/08/10).

83 One such strategy, the Energy Clinic, has been developed at the Boston Medical Center. Energy Clinic activities include training for clinicians about how to prepare medical certification letters to prevent shutoffs of home utility services for the families of pediatric patients –Adam Sege, Utility Access and Health. A Medical-Legal Partnership Patients-to-Policy Case Study (Boston, MA: National Center for Medical Legal Partnership, 2010). Available at http:// www.medical-legalpartnership.org.

care and health services to older adults, promote community dwelling that facilitates personal independence and quality of life.

For example, prudent land-use planning recognizes that the urban heat island effect, or how buildings and paved space retain heat locally, increases ambient temperatures and raises the risk of premature death.[84] Studies of differences in neighborhood temperatures during the summer underscore the importance of access to air-conditioning in protecting against the heat. In urban St. Louis, older adults are more likely to die during a heat wave if they live in the more crowded blocks adjacent to the central business district, where older, red brick buildings are more likely to retain heat overnight and where residents tend to be from lower-income households and therefore less likely to have air-conditioning.[85] In Phoenix, Arizona, temperatures vary by up to 7 to 12 degrees Fahrenheit among urban, suburban, and urban fringe neighborhoods.[86] The highest temperatures are seen in the poorest neighborhoods, which are densely populated and have little green or open space, and in newer middle-class areas that by design also feature homes built in close proximity and that substitute desert landscaping for green space. For residents of these middle-class Phoenix neighborhoods, access to central air-conditioning and to swimming pools lowers the risks associated with the heat.

Policies that make affordable housing energy efficient lower the costs of heating and cooling, preserve household budgetary assets, and protect the health and safety of occupants. As such, these policies leverage the impact of public benefit dollars spent for health care (Medicaid, Medicare) and food (Supplemental Nutrition Assistance Program, Commodity Foods).

Policies that promote walkable neighborhoods discourage crime, nurture intergenerational social networks, and minimize (through these networks) social isolation and the chances that weather extremes will lead to premature deaths, hospitalizations, and an increased burden of disability and disease among low- and moderate-income households that include older adults.[87] For example, the Philadelphia Department of Health maintains a partnership with a network of neighborhood block captains to support the outreach efforts of city's heat health warning/watch system during heat waves. Working with city Health Department staff, the block captains—volunteers elected by residents to organize neighborhood activities and projects with the city—disseminate information as a heat wave develops and identify and evaluate the health status of vulnerable local residents.[88] This active and personal approach to conveying public health information is particularly important for socially isolated and older adults, who

84 K. E. Smoyer, "Putting Risk in Its Place: Methodological Considerations for Investigating Extreme Event Health Risk," *Social Science and Medicine* 47, no. 11 (1998): 1809–24.

85 Ibid.

86 S.L. Harlan, A.J. Brazel, L. Prashad, W.L. Stefanov and L. Larsen, "Neighborhood Microclimates and Vulnerability to Heat Stress," *Social Science and Medicine* 63, no. 11 (2006): 2847-2863.

87 During heat waves, the most vulnerable are older people who live alone, have limited mobility, and are socially isolated. E. Klinenberg, *Heat Wave. A Social Autopsy of Disaster in Chicago* (Chicago: University of Chicago Press, 2002); Kovats and Hajat, "Heat Stress and Public Health."

88 Environmental Protection Agency, *Excessive Heat Event Guidebook.*

tend to be less responsive to information disseminated through brochures and other more passive means.[89]

Finally, effective risk communication efforts help the public understand the threats to health and safety posed by inadequate home heating and cooling, as well as exposures to outdoor temperatures that are likely to vary dramatically and to change from historic patterns because of climate change.[90] For example, in implementing heat health warning and watch systems in their communities, policymakers have taken advantage of various communication strategies, including the following:

- Developing and disseminating information that summarizes health and safety risks
- Instructing members of the public about available municipal services to mitigate summertime heat or winter cold
- Targeting messages to specific groups of at-risk residents
- Developing warnings that function effectively, for example, to discourage older adults from using electric fans as a cooling strategy when temperatures climb into the upper nineties[91]

The reviews of the heat health warning/watch system in Philadelphia indicate impressive results.[92] Over its first three years (1995–1998), Philadelphia's Hot Weather-Health Watch/Warning System is estimated to have saved about 2.6 lives per day when a warning is issued and for the three-days following the warning, for a total of 117 lives, at an estimated total cost of $210,000.[93] This cost is about 5 percent of the valuation of a statistical life of one older adult, as estimated by the Environmental Protection Agency, making a communications-based strategy a practically no-cost approach to saving lives.

POLICY RECOMMENDATIONS

The following recommendations could help address the serious and increasing health threats posed by unaffordable home energy:

- Ensure that subsidies and discounts help make home energy affordable and sustainable for households that include older adults. These households should have

89 Matthies et al., *Heat-Health Action Plans.*

90 E. W. Maibach, C. Roser-Renouf, and A. Leiserowitz, "Communication and Marketing as Climate Change-Intervention Assets: A Public Health Perspective," *American Journal of Preventive Medicine* 35, no. 5: 488–500.

91 Environmental Protection Agency, *Excessive Heat Event Guidebook.*

92 Environmental Protection Agency, *Excessive Heat Event Guidebook*, citing M. A. Palecki, S. A. Chagnon, and K. E. Kunkel, "The Nature and Impacts of the July 1999 Heat Wave in the Midwestern United States: Learning from the Lessons of 1995," *Bulletin of the American Meteorological Society* 82: 1353–67.

93 K. L. Ebi, T. J. Teisberg, L. S. Kalkstein, L. Robinson, and R. F. Weiher, "Heat Watch/Warning Systems Save Lives. Estimated Costs and Benefits for Philadelphia 1995–1998," *Bulletin of the American Meteorological Society* 85, no. 8: 1067–73.

the option to pay down utility arrearages (amounts due) while not jeopardizing current payments, and should have priority access to energy-efficiency and conservation services and to appliance replacement programs.

- Assess the need for LIHEAP and the total amount of energy assistance for households in terms not only of lowering the home energy burden (the percentage of household income that must be spent for essential home energy services) but also the value added through improved health and reduced threats to safety. Such an approach is rooted in the perspective of the household, rather than that of the utility company.

- Expand categorical eligibility for LIHEAP, weatherization services, and other affordable energy programs to target groups identified as most at risk of adverse health outcomes through their eligibility for Medicaid and Medicare programs, such as state Medicaid waiver programs and the Medicare Part D Low-Income Subsidy.

- Ensure that state-regulated utility consumer protections and policies specifically recognize and address the needs of groups identified as most at risk of adverse health outcomes. For example, shutoff protections based on certification of serious illness should be extended to at least 120 days or one full year (before requiring recertification). In addition, states should adopt policies to lessen the likelihood of a shutoff, such as in-person notification of intent to disconnect and the option to make alternative payment arrangements.

- Ensure that demand-response programs for consumers balance the need to reduce energy consumption with the protection of health and safety for older adults and persons living with serious or disabling conditions.

- Design evaluations of weatherization and energy-efficiency programs to assess their impact on health and safety to demonstrate the importance of home energy for health, for example, how improvements in asthma symptoms can lower health care costs.

- Ensure that intake services for state Medicaid waiver program participation and long-term care case management services include referrals for LIHEAP, weatherization, and other affordable energy programs.

- Support education and outreach efforts to increase awareness both within the health care community and among older adults, their families, and caregivers of the resources that can help at-risk individuals maintain access to healthy and comfortable temperatures. For example, in each state, clinicians and public health officials should be trained in regulated utility consumer protections and in procedures to prepare letters to certify medical shutoff protections for their patients.

- Give priority in home repair or modification programs that serve medically frail participants (such as under a state Medicaid waiver) to cost-effective energy-efficiency measures that protect health and safety (for example, special coatings for flat-roofed rowhouses that lower indoor temperatures in summer).

- Identify and implement best practices for communicating with the public, especially older adults, their families, and caregivers, about the risks of heat waves and cold temperatures, about the links between temperature and health, and about which prevention, education, and response efforts are most effective. Implementation should bring together public officials from health departments, energy offices, and state emergency preparedness.

CONCLUSION

As the U.S. population ages, as our health care system shifts toward support for independent living and aging in place, and as urban infrastructure and global warming present new environmental challenges, the rising cost of basic utility services jeopardize the stability and capacity for self-sufficiency of households that include older adults. Understanding and addressing the implications for energy policy of public and population health priorities, and the implications for public health of affordable energy and energy efficiency priorities, requires a fresh approach. Such an approach should unite two diverse groups of practitioners, in the energy and health fields, to craft new solutions to help American households maintain both economic security and good health.

When a heat wave recurred in Chicago in 1999, four years after hundreds of deaths and hospitalizations during the July 1995 heat wave, city officials and civic groups responded with an effective, coordinated approach informed by the research done in the wake of the 1995 disaster. Chicago implemented a heat health emergency plan that included the opening of cooling centers and outreach to homebound older adults. Far fewer residents died prematurely on account of this second heat wave. Nevertheless, the summer of 1999 in Chicago exposed a number of critical issues, including the following:

- High home energy burdens
- Limited subsidies under LIHEAP and related programs
- Lack of coordination among Medicaid and other public benefit programs with low-income home energy subsidies or residential utility consumer protections
- The realities of life in neighborhoods that remained unsafe and socially isolating for older adults

Ten years later, these and many other related issues remain unresolved, a fact that must change if the United States is to address the widespread problem of insufficient access to affordable heating and cooling as the public health threat it has become.

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Schedule 7

Schedule 3 has been deemed highly confidential

Customer Incentives for Energy Efficiency Through Electric and Natural Gas Rate Design

A RESOURCE OF THE NATIONAL ACTION PLAN FOR ENERGY EFFICIENCY

SEPTEMBER 2009

Schedule 7

The Leadership Group of the National Action Plan for Energy Efficiency is committed to taking action to increase investment in cost-effective energy efficiency. *Customer Incentives for Energy Efficiency Through Electric and Natural Gas Rate Design* was developed under the guidance of and with input from the Leadership Group. The document does not necessarily represent a consensus view and does not represent an endorsement by the organizations of Leadership Group members.

Customer Incentives for Energy Efficiency Through Electric and Natural Gas Rate Design is a product of the National Action Plan for Energy Efficiency and does not reflect the views, policies, or otherwise of the federal government. The role of the U.S. Department of Energy and U.S. Environmental Protection Agency is limited to facilitation of the Action Plan.

If this document is referenced, it should be cited as:

National Action Plan for Energy Efficiency (2009). *Customer Incentives for Energy Efficiency Through Electric and Natural Gas Rate Design.* Prepared by William Prindle, ICF International, Inc. <www.epa.gov/eeactionplan>

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List of Abbreviations and Acronyms

CO_2	carbon dioxide
CPP	critical peak price
FERC	Federal Energy Regulatory Commission
kW	kilowatt
kWh	kilowatt-hour
MW	megawatt
SFV	straight fixed-variable
TOU	time of use

Acknowledgements

This brief, *Customer Incentives for Energy Efficiency Through Electric and Natural Gas Rate Design*, is a key product of the Year Four Work Plan for the National Action Plan for Energy Efficiency. This work plan was developed based on Action Plan Leadership Group discussions and feedback expressed during and in response to the January 2009 Leadership Group Meeting. A full list of Leadership Group members is provided in Appendix A and at www.epa.gov/eeactionplan.

With direction and comment by the Action Plan Leadership Group, the paper was developed by Bill Prindle of ICF International, Inc. Rich Sedano of the Regulatory Assistance Project and Alison Silverstein of Alison Silverstein Consulting provided their expertise during review and editing of the brief.

The U.S. Environmental Protection Agency (EPA) and the U.S. Department of Energy (DOE) facilitate the National Action Plan for Energy Efficiency. Key staff include Larry Mansueti (DOE Office of Electricity Delivery and Energy Reliability), Dan Beckley (DOE Office of Energy Efficiency and Renewable Energy), and Kathleen Hogan, Stacy Angel, and Katrina Pielli (EPA Climate Protection Partnerships Division).

Eastern Research Group, Inc., provided copyediting and production services.

Executive Summary

This brief,* Customer Incentives for Energy Efficiency Through Electric and Natural Gas Rate Design*, summarizes the issues and approaches involved in motivating customers to reduce the total energy they consume through energy prices and rate design. The scope of this brief is limited to how the multi-objective ratemaking process can address customer incentives to reduce total energy consumption, which also contributes to reductions in peak demand.[1] This brief is provided as part of a comprehensive suite of papers and tools to assist organizations in meeting the National Action Plan for Energy Efficiency goal to achieve all cost-effective energy efficiency by 2025.

Improving energy efficiency in our homes, businesses, schools, governments, and industries—which consume more than 70 percent of the natural gas and electricity used in the country—is one of the most constructive, cost-effective ways to address the challenges of high energy prices, energy security, air pollution, and global climate change. Despite these benefits and proven approaches, energy efficiency remains critically underutilized in the nation's energy portfolio. Regulators can address this problem in part by removing one of the persistent barriers to energy efficiency by creating effective customer incentives for energy efficiency through electric and natural gas rates.

Prices, Rates, and Energy Efficiency

Customers respond to increases in energy prices by (1) changing energy usage behavior, (2) investing in energy-using technologies and practices, or (3) making no change to their energy usage. Customers see energy prices through their rates, which are typically embedded in a "tariff," a document approved by a regulatory commission (for investor-owned utilities) or by a utility's leadership (for publicly owned utilities). Rates differ across customer classes and are offered in various forms, consisting of charges they must pay regardless of how much energy is consumed[2] and charges they can avoid by using less energy. Both rates and prices affect the total energy bill paid by customers. Some states are considering how to encourage all types of customers to become more energy-efficient as one of the many objectives of rate design.[3]

Key Findings

States may consider rate design changes due to a number of drivers, including rising energy prices and utility investments in advanced meter infrastructure, as well as new energy efficiency policies. This brief explains how retail electricity and natural gas rate design affects customers' energy use behavior and investment choices. The key findings include:

Overarching Findings

- Ratemaking is a complex process that serves multiple policy and business goals. Encouraging energy efficiency is one of those goals, but it must be balanced with equity and other considerations.
- Utility tariffs and the prices they convey can motivate energy efficiency, but high rates and prices alone are not likely to overcome the well-documented barriers to cost-effective energy efficiency.

- Utilities and regulators should continue to examine rate and pricing approaches that encourage customer energy efficiency, while recognizing their limitations and pursuing non-price approaches as well.

- Price transparency and the ability for customers to understand their rates and energy usage are important elements of providing customer incentives through rate design.

Specific Findings

- Shifting costs from volumetric to fixed charges, through rate designs such as straight fixed-variable, does not encourage customer energy efficiency.[4]

- Some rate designs, such as declining block rates and bill adders, send price signals that mask the true cost of incremental units of energy and thus can encourage more rather than less energy consumption.

- Rate designs that encourage energy usage should be examined. Alternatives such as inclining block rates offer greater customer incentives for energy efficiency.

- New time-differentiated rate options referred to as "dynamic pricing" have delivered energy use reductions under specific, short-term conditions, although their long-term impacts on total customer energy use remain uncertain.

- Enabling technologies and programs, such as energy information to customers and grid-connected measures, have been shown to increase customer savings.

As states proceed with rate and pricing policy changes, additional information would be useful to inform considerations of using rate design to encourage energy efficiency, including:

- Additional and more consistent data on emerging rate and pricing options, including their effect on total energy consumption and the persistence of savings over the long term.

- Assessing the limits of rates to achieve desired energy efficiency levels, maintain political acceptance, and meet other ratemaking objectives.

- More reliable methods for projecting the longer-term impacts of rate and pricing designs on load forecasts, so as to better incorporate their effects into resource plans.

Achieving All Cost-effective Energy Efficiency—A Vision for 2025

This brief has been developed to help parties pursue the key policy recommendations of the National Action Plan for Energy Efficiency and its Vision for 2025 implementation goals. It directly supports Vision Implementation Goal Seven, which encourages utilities and ratemaking bodies to align customer pricing and incentives to encourage investment in energy efficiency. The Action Plan has identified this as an area of minimal progress (National Action Plan for Energy Efficiency, 2008a, Chapter 2); significant state progress is needed in order to achieve the Action Plan Vision to achieve all cost-effective energy efficiency by 2025.

This brief necessarily focuses somewhat narrowly on the effects that rate design and pricing may have on customer energy efficiency behavior and investment. It therefore does not address the many other considerations involved in ratemaking, nor does it encompass the numerous non-price policies and programs that states and utilities can pursue to encourage customer energy efficiency. Many of these issues are addressed in other Action Plan documents.

Within this context, state public utility commissions, publicly owned utility boards, and all energy utility companies are encouraged to consider how the rates and pricing they provide to customers can be part of a comprehensive solution to energy efficiency. All parties, including policy-makers, utilities, and stakeholders, are encouraged to consider the role of rates and pricing within a comprehensive suite of policies and programs to remove persistent barriers to energy efficiency. For information on the full suite of policy and programmatic options to remove barriers to energy efficiency, see the Vision for 2025 and the various other Action Plan papers and guides available at www.epa.gov/eeactionplan.

Notes

[1] Discussion of rate design options commonly designed to incent customer reductions during limited days and hours of peak demand is limited in this brief, addressing only the incentives these rates and pricing provide to customers to reduce total consumption throughout the year. Further, the brief does not encompass additional issues in the multi-objective ratemaking process, such as utility cost recovery and inter-class customer equity.

[2] These charges are often referred to as customer charges, which recover costs that do not vary with kilowatt-hour (kWh) usage (e.g., transmission and distribution assets, billing and customer care services).

[3] As of December 31, 2007, seven states have examined and modified electricity rates considering the impact on customer incentives to pursue energy efficiency. Two states have done the same for natural gas rates. See National Action Plan for Energy Efficiency (2008a).

[4] While fixed charges are being considered to reflect utility costs, the focus of this brief is customer incentives for efficiency. For more information on ratemaking considerations to incent utility investment in energy efficiency, see the Action Plan's utility incentives guide (National Action Plan for Energy Efficiency, 2007).

Customer Incentives for Energy Efficiency Through Electric and Natural Gas Rate Design

This brief examines utility rates and pricing policies to encourage customers to pursue energy efficiency. The need for this brief stems from the Action Plan's Vision for 2025, which observed that minimal progress has been made in examining and modifying rates considering the impact on customer incentives to pursue efficiency.[5]

This brief is designed to discuss the key concepts and issues surrounding rate design and the incentives/disincentives they provide for customer energy efficiency, in terms of both behavior changes and investment in efficient technologies. The brief reviews existing common rate design approaches and summarizes selected case studies of rate design approaches for their impact on energy efficiency. The brief also highlights the typical steps a state would need to take to implement new rate designs and identify areas where additional information is needed to understand the contributions rate design can make to achieving all cost-effective energy efficiency.

After reading this brief, parties are encouraged to turn to one of the many references provided in the brief for additional information and detailed guidance on implementing changes in rate design. Changing rates is a state-specific process, supported by localized analysis of how the rates can encourage customers to save energy. During these and other processes, states may also explore options to incentivize customer energy efficiency through programs and financing mechanisms.[6] Some utilities are also considering the effectiveness of information delivery and related technologies that communicate usage and price levels to customers to affect their behavior and investment decisions. These options are not covered in this brief, but a separate Action Plan guidance document (National Action Plan for Energy Efficiency, 2008c) is available on the options and benefits of providing commercial customers with standardized electronic billing data.

This brief also does not address issues related to ratemaking such as decoupling of sales and revenues, or incentives to shareholders for utility investments in efficiency resources; these are addressed in other Action Plan documents (see National Action Plan for Energy Efficiency, 2006 and 2007a).

What Are Customer Incentives for Energy Efficiency Through Rates?

In this brief, the term "energy efficiency incentive" is used to refer to any effect that a change in utility rates or pricing may have to encourage or motivate customers to reduce the total amount of energy they consume, without compromising the service they receive. This energy efficiency can be due to an investment in energy-efficient technologies and practices and/or a change in customer behavior. The terms "motivate," "encourage," and "incent" may be used interchangeably.

Effective rate designs can incent customers to pursue more efficient technologies or practices by providing clearer and more timely energy use and price information and by reducing the perceived payback period of the investment from the customers' perspectives. The payback period needed to incent more efficiency varies greatly by customer and customer type. Providing a short payback period with a high degree of certainty to customers can help remove one of the key financial barriers to energy-efficient investments. Factors such as split incentives, lack of information, and transaction cost barriers will also affect a customer's decision to invest in energy efficiency. These barriers and the potential solutions to address them are well known, and they are discussed by the Action Plan in its reports, its Vision for 2025, and its work with commercial customers under the Sector Collaborative on Energy Efficiency.[7] Policy-makers, utilities, and stakeholders are considering changes in utility rates as part of a comprehensive policy framework to motivate customers to use energy more efficiently.

Utility Rates and Energy Prices—Key Concepts

"Electricity and natural gas rates," "ratemaking," and "rate design" are terms used to refer to the regulated process of setting prices for energy delivered to customers. To elaborate:

- A **rate** is typically embedded in a **"tariff,"** a legal document approved by a regulatory commission, which defines the prices to be paid for defined classes of customers under defined terms of service.

- **Prices** are defined more narrowly, as the amount charged for a specific unit of energy under defined conditions.

- A rate may thus contain multiple prices: for example, a time of use (TOU) rate may contain two prices, one for peak periods and one for off-peak periods.

- Prices are based either on the costs incurred to provide the service or on market prices, depending on whether electricity rates are administered pursuant to cost of service regulation or set in competitive markets. In a restructured state with competitive energy service, a regulated distribution utility may have a rate tariff that applies to its distribution service, while an unregulated retail electric or gas provider may charge a separate price for the energy it sells to the consumer. Regardless of regulatory structure, all customers pay rates with various prices embedded in or associated with those rates.

As discussed in the Action Plan report (National Action Plan for Energy Efficiency, 2006), utility ratemaking has evolved to achieve multiple policy goals such as providing universal energy service, recovering utility costs, ensuring that energy is affordable, incenting energy efficiency, and encouraging economic development. The process of designing new rates and changing existing rates is a state-specific, time-consuming process that can often be highly contentious. In this process, regulators balance the increasingly complex linkage between utility system costs and customer rates and prices. Today's utilities incur a complex array of fixed and variable costs, and they use more sophisticated methods to manage these costs. Utility or retail provider rates include:

- Costs of energy acquisition (which include a mix of capital and variable costs of self-production and purchases under spot and long-term contracts).

- Fixed and variable energy delivery costs.

- Other fixed cost components (such as customer service, administration and management, and more).

- Some utilities use techniques to manage price risk, while others have retail rate structures that allow supply prices to flow through to customers, such as fuel adjustment clauses.

Lastly, electricity and natural gas embody different supply, distribution, and consumption characteristics that have led to different rate treatments. Most notably, natural gas usage is typically more uniform throughout the day, and gas utilities have greater flexibility to purchase and store gas supply before distributing to customers. By contrast, electricity use varies significantly throughout the day while the electricity supply cannot be stored in quantities needed to even out these daily changes in demand and, therefore, must largely be delivered as it is generated. Also, electricity transmission and distribution systems are typically subject to more congestion and other constraints, which change the cost of electricity across time and location. Natural gas networks can also be subject to congestion and constraints, but historically these effects have been less pronounced than in power grids.

Due to these differences, electric rate design has become more complex, more variable, and more subject to experimentation than natural gas ratemaking. While many of the principles in this brief are also relevant to natural gas rates and prices, most of the discussion focuses on electricity-specific issues. This is not to suggest that natural gas rates and prices cannot be used to provide customer energy efficiency incentives; it means only that the range of considerations in the gas utility industry is somewhat narrower.

The Economics of Energy Prices and Customer Incentives

For the purpose of this brief, “price response” means the change in customer energy consumption as the price of energy supply changes. From a policy-maker’s viewpoint, it is important to understand the economic theory behind price response, which is the concept of price elasticity. Price elasticity is based on the concept that consumption of a good or service is elastic, or changeable, and that consumption tends to change inversely to changes in price—higher prices cause consumption to drop, and vice versa.

While the general theory of price elasticity is well established, applying it to specific ratemaking/pricing policies requires real-world experience and effective measurement methods that policy-makers can use. To bring theory into effective practice, investigation and debate continues on the magnitude of elasticity effects, the differences between short-term and long-term elasticity, and related issues.

Measuring elasticity involves different methods, depending on the framework of analysis. Long-term, economy-wide analyses typically examine elasticity over periods as long as 10 to 30 years. Short-term elasticity effects are estimated more narrowly, sometimes just for a period of hours or less when a particular price signal is in effect. Electricity rates that change by time of day and load management programs[8] can create short-term elasticity effects, though estimating sustained effects on energy usage over a multi-year basis is more difficult.

For example, a long-term price elasticity may be expressed in terms of “-0.15,” which means that for every 10 percent increase in electricity prices in such timeframes, usage would be expected to fall by 1.5 percent. Short-term elasticities are often measured as hourly peak demand or energy use reductions, and are not consistently measured as changes in annual energy use. In programs that encourage short-term price response, initial hourly demand reductions can decline over subsequent hours or days, making longer-term usage impacts especially difficult to predict.

Price response, whether short-term or long-term, also varies by customer class and end-use. Smaller customers, such as residences and small businesses, are typically seen as less price-responsive overall than larger commercial and industrial customers, although providing residential customers with enabling technologies and programs can narrow this gap (see Sachs, 2007). Such differences can be attributed to several factors, including:

- Ability to prioritize energy cost control and invest in the personnel, monitoring capabilities, and load management capabilities needed to make significant price-responsive changes in energy use.

- Varying degrees of price transparency—customers' ability to see and understand price and rate information, in a timeframe and format that enables them to make price-response decisions. Customers need to get usage and cost information that allows them to connect their energy use decisions with the resulting cost impacts.

- Availability of technical options to manage energy use, such as substituting the type of energy used, shifting operating hours, or changing processes to respond to price signals.[9]

- Inelasticity when energy is used to provide an essential service.

- Additional persistent market barriers to energy efficiency across customer types.

This discussion suggests that for ratemaking purposes, it may be most useful to estimate price elasticity by customer type and location.[10] Localized analysis can determine the magnitude of price signals associated with local utility system costs: in some regions, on-peak energy is much more expensive compared with off-peak energy than in other areas. Customer end-uses and their relative importance also vary geographically; for example, customers in some climates may show different tolerances for comfort effects associated with changing air conditioning settings than customers in other climates.

Other, non-energy elasticity effects can affect net changes in energy consumption. For example, income elasticity tends to increase energy demand in economies with rising incomes; e.g., a household may buy a larger home or purchase more energy-using devices when its income increases, increasing net energy use. Also, cross-elasticity tends to deflect energy price effects onto other goods; e.g., a household whose utility bills rise may elect to reduce other expenditures, such as dining out, rather than reducing energy use.

As part of implementing rate designs to encourage customer energy efficiency, policy-makers, utilities, and states may also consider options to increase transparency, or visibility, of prices such as billing statement enhancements and providing electronic usage and cost data to customers (National Action Plan for Energy Efficiency, 2008c). Unlike other energy products such as gasoline, which are typically quite transparent to customers at the time of purchase, utility prices are typically embedded in billing statements that (1) are not seen until after energy is consumed and (2) may not lend themselves to simple understanding of prices. As discussed above, large energy-intensive customers typically are more price-responsive, in part because they have assigned staff or specialist consultants to interpret their utility bills, and may invest in their own metering, data reporting, and other methods to make energy cost information both transparent and linked to operational behavior and capital investment decisions.

Utility Rate Design and Pricing Options

Rate design is a multi-objective process in which policy-makers seek to balance goals for utility cost recovery, equity among customers, economic efficiency, and other considerations along with energy efficiency. In recent decades, many different energy rate and pricing options have been offered to customers to meet different policy goals and address the regulatory, business, and technical issues of the time.[11] This section reviews the main pricing options in use today. These options are organized in three categories:

- Fixed rates
- Variable rates
- Emerging approaches to blend fixed rates and variable pricing

The section discusses the rate options and their link to energy efficiency incentives. A high-level summary of key issues to consider for the rate options when incentivizing customer rates for energy efficiency is provided in Table 1. This table, in a necessarily oversimplified fashion, provides a qualitative assessment of rate options with respect to the following five variables:

- **Customer types**—indicates which customer types are typically appropriate for each rate option.

- **Customer incentive for overall energy savings**—indicates the degree to which the option encourages customers to reduce overall energy use over the entire year or during limited hours, days, or months.

- **Customer incentive for peak demand savings**—indicates the extent to which the option encourages customers to reduce peak demand during limited hours, irrespective of total energy use.

- **Financial risk to utility**—indicates the extent to which the option tends to place more risk on the utility; for example, TOU rates are judged lower-risk than flat rates, because rates are more closely linked to utility costs, and so the risk of failing to recover costs is reduced.

- **Financial risk to customer**—indicates the extent to which customers take on relatively more risk; for example, customers' risk is assessed as relatively lower with flat rates than with TOU rates, in that their total bill is less likely to vary based on when they use energy.

Table 1 builds on Chapter 5 of the Action Plan report (National Action Plan for Energy Efficiency, 2006, p. 5-9), which contains a more detailed discussion of ratemaking options to support customer energy efficiency actions, including references to utility tariff examples in Table 5-2. *Aligning Utility Incentives With Investment in Energy Efficiency* (National Action Plan for Energy Efficiency, 2007a) provides greater discussion on utility financial risk.

Table 1. Overview of Customer Incentives for Energy Efficiency From Various Rate and Pricing Options

Rate/Price Type	Description	Customer Types*	Customer Incentive for Overall Energy Savings**	Customer Incentive for Peak Demand Savings**	Financial Risk to Utility**	Financial Risk to Customer **
Fixed Rate Options						
Flat rates	▪ Customer charge for direct service costs. ▪ Other fixed and variable costs allocated on an average basis, per kWh consumed.	A	M	L	M	L
Inclining block rates	▪ Basic customer charge. ▪ Fixed volumetric rate for first usage block. ▪ Higher fixed volumetric rate for subsequent "tail" block(s).	A	H	M	M	M
Seasonal rates	▪ Fixed volumetric rates, but with seasonal increase.	A	M	M	M	M
TOU rates	▪ Basic customer charge. ▪ Volumetric charges that vary by time of day (typically with two or three periods, e.g. peak/off-peak or peak/mid/off-peak).	A	M	H	L	M
Declining block rates	▪ Basic customer charge. ▪ Fixed volumetric rate for first usage block. ▪ Lower fixed volumetric rate for subsequent "tail" block(s).	A	L	L	M	L
Bill adders/ surcharges	▪ Recover various costs such as franchise fees, universal service charges. ▪ Some fee structures use fixed charges, some use volumetric. ▪ Absolute amounts typically small.	A	L	L	L	M

Schedule 7

Rate/Price Type	Description	Customer Types*	Customer Incentive for Overall Energy Savings**	Customer Incentive for Peak Demand Savings**	Financial Risk to Utility**	Financial Risk to Customer **
Demand charges	▪ Separate billing charge for peak demand, separate from customer or energy charges. ▪ May include "ratchet" feature, where peak demand charges carry over for up to a year.	C I	M	H	L	M
Straight fixed-variable (SFV) rates	▪ Customer charge recovers all fixed costs. ▪ Volumetric charge covers only variable costs.	A	L	L	L	M
Flat/fixed-bill rates	▪ Billing charges are fixed over a 12-month or longer period. ▪ In budget billing, charges are adjusted in the following year. ▪ In flat bill contracts, no automatic adjustment.	R C	L	L	M	L
Variable Rate/Dynamic Pricing Options						
Critical peak pricing	▪ Basic customer charge. ▪ Basic fixed volumetric rate. ▪ Critical peak price (CPP)—substantially higher rate for usage during CPP periods. ▪ CPP periods not preset, but infrequent.	R C	M	H	L	H
Peak time rebate	▪ Offers a rebate for reduced usage during CPP times, rather than a higher price. ▪ Requires baseline and savings calculation.	R C	M	H	L	L
Variable peak pricing	▪ A variant of TOU pricing, in which on-peak prices vary, typically daily. ▪ Requires interval metering.	C I	M	H	L	H

Schedule 7

Rate/Price Type	Description	Customer Types*	Customer Incentive for Overall Energy Savings**	Customer Incentive for Peak Demand Savings**	Financial Risk to Utility**	Financial Risk to Customer **
Real-time pricing	▪ Beyond basic fixed customer charges, prices vary hourly, typically based on wholesale power market prices.	C I	M	H	L	H
Blended Fixed and Variable Rate Options						
	▪ Mainly unregulated price offerings. ▪ Generation price only—customer can choose a mix of fixed and variable prices.	A	M	M	L	M

Source: National Action Plan for Energy Efficiency analysis.

* A = all; R = residential; C = commercial; I = industrial

** H = high; M = moderate; L = low. Note that "low" can include cases where there is no effect or a negative effect.

Fixed Rates

Within the fixed-rate category, the rate options that tend to provide customer incentives for energy efficiency are:

- **Flat rates.** Flat rates are constant rates that do not vary by TOU, though they are also volumetric, in that they are based on the volume of energy consumed. They are designed to produce revenue for the utility to cover its fixed and variable costs of service and its allowed rate of return. While flat rates are neutral in the sense that they charge the same for each unit of energy consumed, they do not convey the signal that the cost of electricity supply varies by TOU. They do convey that customer bills will be in proportion to consumption, and thus signal to customers that controlling consumption can control costs.

- **Inclining block rates.** By making incremental consumption beyond a minimum block more expensive (a "block" is simply a defined amount of usage, for example 1,000 kilowatt-hours [kWh]), customers get price signals that should encourage them to moderate additional usage. The effectiveness of this incentive depends, however, on customers understanding this price signal through billing statements or other sources, and in knowing when they have exceeded their initial block of consumption and are thus in higher-price territory. These transparency issues can limit the effectiveness of this incentive; utilities can and often do provide information to help customers understand these issues.

- **Seasonal or TOU rates.** These rate types signal to customers that energy consumption can become more expensive depending on when it is used. Customers might then, for example, invest in products, such as high-efficiency air conditioners, that use less energy in higher-priced seasons, or higher-cost times of day, and might modify their behavior to shift usage like dishwashing or clothes drying to lower-cost hours. While such incentives are somewhat indirect and may have limited transparency without specific customer information on when or in what devices to reduce usage, they nonetheless encourage customers to reduce usage at least at certain times.

Other fixed-rate options, however, tend to discourage customer energy efficiency:

- **Declining block rates.** Because they offer lower prices for consumption beyond the basic block of consumption, declining block rates encourage customers to increase rather than decrease energy consumption and convey the message that using more power is good, and that the utility can always provide more power at cheaper costs.

- **Bill adders.** Many states include various charges, such as specific-purpose surcharges, franchise fees, or other charges, on utility bills in addition to base tariff charges. If such charges appear on the customer bill as fixed costs, they may be efficient ways to recover fixed costs, but they do not encourage customers to reduce energy use because they cannot be avoided through energy efficiency.[12] If the charge is volumetric, but shown as a separate line item without a total volumetric charge, it can reduce price transparency and inhibit customers' understanding of the full price and how much they can save, and thus can indirectly reduce incentives to cut consumption.

- **Straight fixed-variable (SFV) rates.** This approach places all utility fixed costs in a fixed charge and all variable costs in a variable charge. Because it tends to shift costs out of volumetric charges, it tends to reduce customers' efficiency incentive, because the marginal price of additional consumption is reduced. While SFV rates are being considered to better reflect the utility's costs behind the rate, these rates do not encourage customers to change energy usage behavior or invest in efficient technologies. Such customer disincentives persist even when SFV rates are applied to individual components of the bill, such as charges for distribution service.

- **Flat/fixed-bill pricing.** Many utilities offer a "budget billing" option, which levelizes billing payments over 12 months. This reduces efficiency incentives in the short run, because customers do not see any bill impacts from consumption changes until the following year. However, there is an annual adjustment, which may provide a longer-term efficiency incentive. Some companies offer a fixed annual bill without an automatic annual adjustment. This approach can produce both short and long-term disincentives for customers to become more energy-efficient, in that the customer's actions may have little effect on their bill.

Variable Rates/Dynamic Pricing

Variable rates and dynamic pricing are under active development and are being implemented in some states, with substantial pilot program activity and associated research and evaluation. Table 1 summarizes the four main options in this category. Due to the differences in physical characteristics and system economics between electricity and natural gas service providers, no evidence was found of these kinds of rates being pursued for natural gas service. Hence this brief discusses only electric rates in this category.

In simple terms, variable rates and dynamic pricing are designed to reflect the actual cost of electricity during specific hours of the day and year, to change customers' hourly load shapes with reductions in peak demand or shifts of peak usage to other hours of the day. Energy efficiency is typically a secondary effect of such pricing approaches, although measured short-term energy usage reductions have been documented.[13] Because the specifics of these pricing plans vary substantially, it is difficult to make generic assessments of their effectiveness as customer energy efficiency incentives. The incentive effect can depend heavily on implementation details, including customers' capabilities to see and respond to price signals, the effectiveness of control technologies, and whether customers are given effective education on their price response options. Rates intended to reduce peak usage often build a large price differential between on-peak and off-peak energy, so that the high on-peak cost strongly dissuades on-peak use.

For example, a residential customer who participates in a dynamic pricing program may have pre-agreed to an automated adjustment in their thermostat set point during critical peak periods. Assuming that the customer simply reduces energy use during the critical peak period, and does not over-consume energy in a recovery period, there will be a net reduction in daily energy use. However, this behavioral effect is likely to be limited, because the customer may not be willing to accept more than minimal comfort losses lasting only a few hours on a limited number of days. In addition, usage in some cases could simply be shifted to off-peak periods, resulting in no overall savings or in some cases a small increase in use. However, if the critical peak price level were high enough and sustained over a period of time, it might create a "tipping point" effect that would encourage the customer to invest in a more efficient air conditioner in the longer term. This would allow the customer to save energy through the entire cooling season without sacrificing as much comfort on peak days, and would thus create both short-term behavioral and long-term investment changes that over time can help transform energy use markets and change customer demand for more energy-efficient products and services.

As a commercial sector example, a large customer may combine dynamic pricing with a sophisticated energy management system and technologies to reduce peak, such as thermal storage optimized with chiller plant design and operation, dimmable lighting systems linked to daylighting controls, and a building automation system programmed to respond to price signals using advanced controls that adapt building systems operation to price signals. In this example, the rate gave the customer the incentive to reduce energy and peak demand, but may also have encouraged the customer to examine and act on other efficiency opportunities.[14,15]

Emerging Approaches to Blend Fixed Rates and Variable Pricing

In competitive retail energy markets, some electricity providers offer blends of fixed and variable prices. Typically, this kind of offering provides a portion of a customer's consumption at an agreed fixed rate and prices the remaining amount at a variable set linked to market prices. In some cases, customers can select different amounts of fixed-price energy, and these blended offers may also vary in terms of pricing details by time of day or seasonally. Such offerings are typically provided by unregulated power marketers rather than regulated utilities, and they are most commonly marketed to larger customers, who are seen as better able to use the risk management value such price offerings may promise.

The effectiveness of blended price offerings as energy efficiency incentives depends greatly on the specific design of the offering. If a customer elects a plan in which the great majority of consumption is priced at fixed rates, it would tend to create a longer-term incentive, in that most of the customer's energy bill will not vary in the short term. But if there is a substantial difference between the fixed price and the variable price, this could create a strong short-term behavioral focus on avoiding high energy bills when variable prices are in effect. If the majority of the customer's bill is driven by variable rates, this would tend to shift the focus more strongly to short-term load management to control energy costs.

Current State Examples—Rate Design to Incent Energy Efficiency

States are making minimal progress in encouraging utilities and ratemaking bodies to align customer pricing and incentives to encourage investment in energy efficiency (National Action Plan for Energy Efficiency, 2008a, Chapter 2). Those states that have advanced activities within this space are listed in Table 2.

A recent national summary of utility pricing data is also available from the Federal Energy Regulatory Commission's (FERC's) 2008 report on demand response (FERC, 2008). Table 3 summarizes the relevant information from that report; it is limited to time-based pricing, but still indicates some of the trends emerging in the utility pricing arena.

Key observations from this recent pricing and ratemaking experience include:

- In the fixed-rate category, in addition to the general trend toward overall rate increases in many jurisdictions, a trend is emerging away from declining block rates toward inclining block rates. Five states have eliminated declining block rates.

- In the variable rate category, an increasing number of jurisdictions are experimenting with several varieties of dynamic pricing and rate-setting. The reported peak demand

and energy savings results from the selected programs in Appendix C range from peak reductions of 3.7 to 41 percent and short-term energy savings of 3.3 to 7.6 percent.[16]

- The trends in time-based or dynamic pricing show an overall 9 percent growth in total offerings from 2006 to 2008. TOU rates remain the majority of total time-based pricing offerings, though their share dropped between 2006 and 2008.
- Most of the dynamic rate results are from pilot efforts lasting less than a full year. This limits the ability to project longer-term price response effects from these initiatives, especially effects on customers' longer-term energy efficiency investments.

Table 2. Summary of State Actions on Electricity and Natural Gas Rates

	States That Have Taken Electricity Rate Action	States That Have Taken Natural Gas Rate Action
Impact on energy efficiency a consideration when designing retail rates?	AZ, CA, IA, ME, NY, OR, WI	IA, NY
Declining block/fixed-variable rates eliminated?	CA, ID, OR, VT, WI	
Time-sensitive rates in place?	AL, CA, CT, DC, DE, GA, IA, ID, IL, KY, MD, MI, MN, MO, ND, NM, NV, NY, OK, SD, TX, VT, WI, WY	IL, NM
Usage-sensitive rates in place?	CA, DC, DE, MD, OR, VT	

Source: Supporting data used in National Action Plan for Energy Efficiency (2008a).

Note: Table 2 reflects state actions through December 31, 2007, as compiled in support of the Action Plan's Vision measuring progress efforts. See Appendix D of the Vision 2025 report (National Action Plan for Energy Efficiency, 2008a) for more information on this methodology.

Table 3. Total U.S. Time-Based Rate Offerings

Rate/Price Type	Number of Offerings Reported in 2006 FERC Survey	Number of Offerings Reported in 2008 FERC Survey
TOU rates	366	315
Real-time pricing	60	100
Critical peak pricing	36	88
Total	462	503

Source: FERC (2008)

Note: The 2008 survey was sent to 3,407 entities across the United States, representing investor-owned utilities, municipal utilities, rural electric cooperatives, power marketers, state and federal agencies, and demand response providers. Respondents include all entities covered by EIA Form 861 reporting requirements, plus regional transmission organizations/independent system operators and curtailment service providers. A total of 2,094 entities responded to at least part of the survey; the entities reported in this table thus represent about 24 percent of respondents.

Implementing New Pricing and Rates

Change is never easy, and changing utility rates is typically a contentious process. Rate changes viewed as excessive, arbitrary, or unfair by some parties can lead to legal and political action with potentially major repercussions. In such environments, customers, utilities, and policy-makers can benefit from ratemaking and related processes that emphasize proactive outreach, communication, and stakeholder participation.

Based on a review of current practices in utility ratemaking, policy-makers and utilities may want to consider three key principles to guide future activity on changing rates to increase energy efficiency incentives to customers:

1. **Incremental vs. radical changes can be effective.** Energy efficiency incentives can be provided to customers without requiring rates and prices that are very complex or radically different from current practices. For example, shifting from declining block rates to inclining block rates can provide energy efficiency incentives to customers, as or before a state or utility considers more complex dynamic pricing designs.[17]

2. **Implementation processes should keep focus on rate design goals while addressing other issues.** Because ratemaking is a public and somewhat judicial process, many of the key details of rate design can be distorted in the process. It is thus important to understand the analytical issues and their implications, as well as the participants and their interests, before entering the potentially long and difficult process of implementing new rate/pricing plans.

3. **Communicate actively with key stakeholders.** If there is a policy purpose that suggests new rate designs, outreach should be undertaken with key stakeholders before any ratemaking proceedings begin, to communicate the basis and the importance for these changes. During the ratemaking process, opportunities for stakeholder involvement should be considered, beyond those available through current adjudicatory proceedings. Once decisions are made, further communication efforts are needed to educate customers and sustain support for the decisions.

Several other contextual issues are driving changes to rates and pricing to encourage energy usage changes and efficiency investments, including:

- **Rising supply energy prices.** Some states are facing large rate increases due to higher energy supply prices, especially as rate caps that were put in place during restructuring and deregulation are removed. In areas of price increases, there is more pressure to provide consumers with options to become more energy-efficient, which includes but is not limited to pricing.

- **New efficiency policies.** Many states have enacted new energy efficiency policies and aggressive energy savings goals on electric and natural gas utilities. Utilities are considering rate changes as part of a larger suite of approaches to deliver and encourage energy efficiency.

- **Smart grid technologies.** Proposals for advanced metering and other "smart grid" technology applications are being considered, in part for their ability to offer new rate design and pricing possibilities and customer response options. Because many smart grid proposals claim to offer energy efficiency benefits, it is also important to understand the claims made.

- **Transparency.** Beyond changing rates or pricing, utility billing and customer information delivery affect customers' response to energy prices. As noted above, lack of transparency can limit some customers' ability to understand and respond to the price signals their bills contain. Today's information technologies can allow bills to include more granular information and can also create parallel options for utilities and customers to interact on pricing and energy usage. Further, several utilities and larger customers are working to automate customer information into energy management systems and building benchmarking tools (National Action Plan for Energy Efficiency, 2008c).

Additional factors that should be considered in designing rates that effectively increase customer incentives to change usage behavior and invest in energy efficiency include:

- **Cost allocation.** When rate changes shift costs among times of day, seasons of the year, or customer types, equity issues can arise. Much discussion has been devoted to the issue of identifying "winners and losers" in a given rate or pricing scheme. This requires analytical effort to determine how cost allocation changes affect different customers, and policy decisions on balancing equity concerns with other policy goals. Further, existing unintended and hidden subsidies can be removed so customers currently paying disproportionately more can see bill reductions; this can be an important part of the balancing act involved in ratemaking.

- **Customer protection.** Concerns have been raised about some kinds of rate/pricing approaches, based on the perceived disadvantaging of customers who are unable to respond to the proposed new plan, resulting in net energy bill increases. If new rates are to be mandatory, they should be designed to minimize such disadvantages. One way to address this concern is to create "opt-in" or "opt-out" conditions that give customers degrees of choice. The "opt-out" approach tends to create wider participation. This may lead to explicit subsidies in some cases.

- **Market targeting.** Following the classic "80/20 rule," some rate or pricing designs can achieve the majority of the desired price response effect by targeting a small segment of customers. Effective voluntary marketing of such plans to the segments that can best realize their benefits can help maximize the effectiveness of the plan while managing concerns about customer equity. For example, residential and small commercial customers with high summer monthly consumption can be targeted for marketing of peak pricing programs.

- **Funding priorities.** In some situations, competition may arise between energy efficiency and demand response or load management programs. It is thus important to understand the full range of benefits and costs from each type of customer program, so that policy-makers can allocate resources appropriately.

- **Scale-up.** Most recent pricing/rate innovations have been implemented as pilot programs. Scaling up to cover entire rate classes or broad customer segments raises new challenges, recognizing that challenges are bigger for some options than others. Stakeholders must be engaged to understand issues involving costs, benefits, and equity. This can entail a substantial public participation/communication process if rate changes are large or sweeping.

Processes for Implementing New Rates and Pricing Plans

Rate cases are the most common processes for instituting new rate and pricing offerings. Sometimes, a revenue-neutral rate design proceeding changes the rates that specific customers pay. Depending on state rules, either utility commissions or utilities can initiate such proceedings. In states with competitive retail markets, unregulated power marketers can also offer new pricing plans, typically without extensive (or any) regulatory review, while the default service provider remains governed by the regulator for its rate and rate design. In the context of reviewing new options from an energy efficiency standpoint, the following elements of such a proceeding can be important:

- **Documenting expected customer response and net impacts.** Proponents should be able to estimate with quantitative analysis how the proposed rate or pricing plan will affect customer peak demand and net energy consumption. Demand and energy impacts should be calculated on both short-term and long-term bases. Data sources and assumptions for customer response should be transparent. Stakeholders should be able to review the data, assumptions, and analyses behind these estimates.

- **Documenting benefits and costs.** Proponents should be able to detail projected costs and benefits on both short-term and long-term bases. Stakeholders should be able to review the data, assumptions, and analyses behind these estimates. Costs should include customer education and complementary programs that will be required in order to achieve customer response assumptions.

- **Balancing customer equity and stakeholder interests.** Deciding which customers are covered, be it by mandatory or voluntary rate/pricing plans, is an important part of the process. Some rate/pricing approaches may be appropriate for mandatory application, but only for some customer types. Voluntary eligibility is more a marketing question of where the plan would be most effective and best accepted. For any broad-based change in rates or pricing to be sustainable, though, customers and other stakeholders need to understand and ultimately accept the rationale for the new approach.

- **Staging.** Many jurisdictions have begun their efforts with pilot projects to test impacts, benefits, costs, customer acceptance, and other issues. Scaling up in steps, rather than all at once, may be desirable to ensure long-term success.

While these issues generally apply to all rate innovations, more complex rate and pricing designs may entail greater challenges in documenting customer response, net impacts, and net benefits, and in resolving customer equity issues.

Needs Identification

While this brief summarizes a substantial body of research and market experience, it also has identified several needs for more data and research, covering such topics as:

- **Persistence of energy savings.** Most pilot impact data are relatively short-term, particularly with dynamic rates. To be useful for resource planning purposes, policy-makers will need longer-term, reliable estimates of the expected effects of pricing and rate plans on energy usage forecasts.

- **Understanding changes in benefits at scale and over time.** If significant peak demand reductions occur on a large scale under dynamic pricing, they may begin to reduce the price differential between time periods. They may also modify overall average prices. These effects could reduce and ultimately negate the nearer-term energy and demand price signals they initially contain. Addressing this issue requires better understanding of the total scale of demand, energy, and price effects, beyond their marginal, short-term effects.

- **Developing the best approaches to incorporate dynamic pricing into resource planning.** Because the key benefit of many variable rates and dynamic pricing plans is to reshape load curves and utility costs, policy-makers may need more sophisticated tools for understanding the effects of such pricing and ratemaking approaches on longer-term energy and demand forecasts, which are fundamental to determining future resource needs. While these pricing approaches can reduce risk and costs in the near term, understanding their longer term effects on total energy use can be more complex, and better tools may be needed to fully incorporate these approaches in formal resource plans.

- **Developing new approaches to evaluating energy savings from behavioral changes.** Proven approaches exist for evaluation, measurement, and verification of administered energy efficiency programs (National Action Plan for Energy Efficiency, 2007b). More work is needed, not only to understand the effects rate design could have on customer behavior and the investment choices they make, but also to inform decisions to modify program approaches that maximize energy savings through rate design changes.

Notes

5 The Vision (National Action Plan for Energy Efficiency, 2008a) found less than 20 percent progress under Goal Seven, step 21.

6 A future Action Plan brief will be developed on this topic.

7 See the Action Plan's Vision for 2025 (National Action Plan for Energy Efficiency, 2008a), as well as an upcoming Action Plan paper on energy efficiency and carbon dioxide emissions and the Action Plan Sector Collaborative resources at <http://www.epa.gov/cleanenergy/energy-programs/napee/collaborative.html>.

8 "Load management" traditionally refers to "direct load control" or "active load management" programs that control customer devices via utility-installed control technologies; in these programs, rate designs are typically not directly affected, through incentives may be offered for participation. More recent demand response and dynamic pricing programs tend to encourage customers to change behavior or operational settings of devices (e.g., changing air conditioning thermostat settings or appliance start times) with greater customer choice, in response to utility price signals.

9 Note that the California pilot results showed that the persistence of residential customer response is enhanced through enabling technology. Residential customers who were given remotely controlled thermostats, for example, showed greater average load reductions and also were more likely to sustain such reductions over successive days (George et al., 2006).

10 See Faruqui and Wood (2008). For example, the New Jersey Board of Public Utilities is having Jersey Central Power & Light Co. amend its summer rate pilot program to account for customer differences in ability to reduce usage at certain times.

11 See Appendix B for more background on the history of utility ratemaking.

12 If costs are fixed in nature, the utility still incurs them even if customers reduce their total consumption.

13 For example, see findings by the Center for Neighborhood Technologies, Chicago, Illinois.

14 For more guidance on larger-customer energy and demand control options, see the Sector Collaborative report (National Action Plan for Energy Efficiency, 2008b), Chapter 3.

15 Advanced ratemaking practices such as dynamic rates still must recover the underlying costs of acquiring and delivering electricity, as well as infrastructure and fixed and variable costs. Over time, one would expect well-designed rates to change these underlying fixed and variable cost elements, and one would expect those changes to be passed through in future rates.

16 See summary results for selected dynamic pricing pilots in Appendix C.

17 It should be noted, however, that the analytical effort needed to develop robust numbers for new rate designs may be substantial, even if the price signal and rate structure provided to the customer is relatively simple.

Appendix A: National Action Plan for Energy Efficiency Leadership Group

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Appendix B: A Brief History of Pricing and Ratemaking Practices

Pricing and ratemaking has evolved substantially in the century-plus history of energy utilities in the United States. Some of the first power generation ventures were hydroelectric facilities, such as the Niagara Falls project in New York. Their initial customers, typically industrial facilities, were charged a flat amount based on the amount of capacity they required. Because the hydroelectric facilities' costs were almost all capital costs, this provided a simple rationale for flat capacity payments. As thermal power generation evolved to provide the bulk of power supply, as grids evolved into universal service networks, and as utility commissions emerged to set pricing and ratemaking policies, the practices involved in setting customer utility rates grew more complex.

It is also worth recalling that for most of the 20th century, expanding the electricity grid was associated with public policy goals of providing universal service at affordable rates. Economies of scale predominated in most electricity markets in this era, such that adding customers, load, and power supply capacity to the grid tended to reduce average costs. In this environment, ratemaking remained a relatively straightforward process of calculating utilities' fixed and variable costs into rate tariffs on an averaged basis. Because rate cases most often resulted in reduced average rates, there was little perceived need to examine costs and rates more closely.

One of the few departures from pure average-cost ratemaking was the practice of declining block rates. These typically included:

- A fixed customer charge, designed to recover the direct costs associated with serving an individual customer in that rate class.
- A rate assigned to the first block of energy consumed for the billing period (e.g., 500 kWh).
- A lower rate assigned to additional energy consumed above the first block.

This practice was based on the assessment that marginal additional consumption imposed lower marginal costs on the utility, as most of its fixed costs would be recovered through fixed customer charges, plus the initial block of energy consumption. Because it was also true in most cases that adding generation to the grid would tend to reduce average costs, the potential load growth that declining block rates might stimulate was generally seen to be a public good. In an era of declining energy and capital costs, with few perceived limits on grid capacity or natural resources, and with little accounting for environmental impacts, this straightforward system of pricing and ratemaking worked well for decades.

Since 1970, at least three important shifts occurred to disrupt traditional ratemaking practices:

- Capital costs stopped declining for many power supply and grid technologies. Maturation of the U.S. grid, flattening economies of scale, and natural resource constraints began to drive power plant and other system costs higher, resulting in rate increases and the phenomenon popularized as "rate shock."

- Energy costs stopped falling in many markets with spikes in global oil prices. Coupled with rising capital costs, higher energy prices exacerbated the rate shocks that began in the 1970s.

- Environmental laws and regulations came into energy markets, adding new compliance costs for utilities and shifting the earlier perception that additional energy consumption was beneficial.

Energy and environmental legislation of the 1970s reflected these trends. The Public Utility Regulatory Policies Act of 1978 and subsequent amendments called for states to examine a number of standards or practices for ratemaking, among other things:

1. **Cost of service.** Rates charged by any electric utility for providing electric service to each class of electric consumers shall be designed, to the maximum extent practicable, to reflect the costs of providing electric service to such class, as determined under section 2625 (a) of this title.

2. **Declining block rates.** The energy component of a rate, or the amount attributable to the energy component in a rate, charged by any electric utility for providing electric service during any period to any class of electric consumers may not decrease as kilowatt-hour consumption by such class increases during such period except to the extent that such utility demonstrates that the costs to such utility of providing electric service to such class, which costs are attributable to such energy component, decrease as such consumption increases during such period.

3. **Time-of-day rates.** The rates charged by any electric utility for providing electric service to each class of electric consumers shall be on a time-of-day basis which reflects the costs of providing electric service to such class of electric consumers at different times of the day unless such rates are not cost-effective with respect to such class, as determined under section 2625 (b) of this title.

4. **Seasonal rates.** The rates charged by an electric utility for providing electric service to each class of electric consumers shall be on a seasonal basis which reflects the costs of providing service to such class of consumers at different seasons of the year to the extent that such costs vary seasonally for such utility.

5. **Interruptible rates.** Each electric utility shall offer each industrial and commercial electric consumer an interruptible rate which reflects the cost of providing interruptible service to the class of which such consumer is a member.

6. **Load management techniques.** Each electric utility shall offer to its electric consumers such load management techniques as the State regulatory authority (or the non-regulated electric utility) has determined will—

a. be practicable and cost-effective, as determined under section 2625 (c) of this title,

b. be reliable, and

c. provide useful energy or capacity management advantages to the electric utility.

These policy developments spurred a wave of studies and experiments in pricing and ratemaking; the late 1970s and early 1980s were studded with groundbreaking work in ratemaking and related analysis, and several states instituted ratemaking changes accordingly.

Energy market conditions stabilized to a large extent later in the 1980s, and the wave of ratemaking experimentation subsided somewhat accordingly. Energy prices moderated, system capacity was adequate in most areas, and the urgency for further action became somewhat muted, though industry researchers, utility commissions, and advocates continued to work on many of these issues.

In the current decade, the urgency for action on utility pricing and ratemaking has risen once more. The growth in peak electricity demand has created the risk of capacity shortages in many regions (North American Electric Reliability Corporation, 2008). This is driving a new round of capacity construction proposals; however, rising energy prices and capital costs promise to make new builds more expensive, raising new rate shock concerns. Additionally, the emergence of climate change as a public policy issue, and specifically the designation of carbon dioxide (CO_2) as a pollutant covered under the Clean Air Act, has created the likelihood that U.S. CO_2 emissions will soon be regulated, raising energy prices and adding new risks for CO_2-emitting energy facilities. Because energy efficiency is viewed as a cornerstone of the policy solution to today's energy and climate challenges, utilities and their regulators are looking for new ways to encourage customer energy efficiency.

As this new era of carbon constraints and higher energy and capacity costs unfolds, the utility industry is a much more complex business than it was in the last century. Restructuring and deregulation of electricity and natural gas markets in wholesale and many state retail markets has added new layers of complexity to calculating and managing utility system costs and risks. At the same time, technologies have advanced to enable substantial new capabilities in managing grid operations and customer price response, in a wave known generically as the "smart grid."

These factors have converged to increase both the urgency and the complexity of pricing and ratemaking in the utility sector. This brief seeks to highlight the electricity pricing options that utilities and policy-makers can best use to help customers become more energy-efficient, both in near-term behavioral changes and in long-term technology investments. In the broadest sense, customer awareness of rising energy prices and the need to reduce carbon "footprints" provides a general set of signals to use energy more carefully. However, because of the issues raised earlier in this section, differences in price response between customer types and end-use markets call for a more focused assessment of the specific techniques most likely to produce desired reductions in peak demand, energy consumption, and CO_2 emissions.

Appendix C: Summary of Recent Dynamic Pricing Programs

Table C-1 summarizes five well-documented dynamic pricing experiments. (The table begins on page C-2.)

Table C-1. Summary of Recent Dynamic Pricing Programs

Program	Rate/ Price Type	Location	Customer Type/Load Size	Participants	Customer Incentive	Duration	Peak Demand Reductions	Energy Savings
California Statewide Pricing Pilot	CPP	Southern California Edison Service Area	Commercial/ industrial <20 kW	59 in 2004: 57 in 2005; about 33% accepted thermostats	Free installation of smart thermostat that automatically adjusts air conditioning setting in CPP periods	4 months x 2 years: June–October 2004 and 2005	<20 kW: Peak-period energy use fell 4.83%; with thermostats, savings rose to 13%	Savings calculated for peak hours only, not monthly or annual
			Commercial/ industrial 20–200 kW	83 in 2004: 76 in 2005; about 60% accepted thermostats			20–200 kW: Peak-period energy use fell 6.75%; with thermostats, savings rose to 9.57%	
Gulf Power Company—Energy Select	Price-responsive load management with CPP	Gulf Power Company service territory—northwest Florida	Residential	8,500	None—customers pay $4.95/month to participate in the program for the opportunity to save on their electric bill by purchasing electricity at prices lower than the standard rate 87% of the time	March 2000 to present	Summer peak reduction of 1.73 kW/home or 14.7 MW to date Winter peak reduction of 3 kW/home or 25.5 MW to date	Savings calculated for peak hours only, not monthly or annual
Ontario Energy Board/ Hydro One	Regulated Price Plan TOU rates	Hydro One service area	Residential, farm, small business under 50 kW	500	Real-time in-home display monitors for half the participants	5 months: May–September 2007	Peak load reductions averaged 3.7% With displays, impact averaged 5.5%	Annual energy savings averaged 3.3%; with displays, savings averaged 7.6%

Program	Rate/ Price Type	Location	Customer Type/Load Size	Participants	Customer Incentive	Duration	Peak Demand Reductions	Energy Savings
Ontario Energy Board—Smart Price Pilot	Regulated Price Plan TOU; TOU with CPP; TOU with critical peak rebate	Hydro Ottawa's service territory	Residential TOU scheduled to have smart meters installed prior to the start of the pilot	373 participants total: 125 in a critical peak rebate price group, 124 each in TOU-only and CPP groups	CPP participants: off-peak rate cut to 3.1 cents per kWh to offset critical peak price TOU with rebate participants: refund of 30 cents per kWh below baseline usage +$75 at end of pilot	7 months: August 2006–February 2007	Peak load reductions were: 5.7% for TOU-only participants, 25.4% for CPP participants	6.0% average annual conservation effect across all customers
Community Energy Cooperative—Energy Smart Pricing Plan	Hourly pricing pilot program; air conditioning cycling added as an option	Chicago	Residential	750 in 2003, rising to 1,100 in 2006	Cooperative provided outreach, education, information materials, high price alerts	2003–2006	Peak reductions up to 25% in first hour; greatest reductions through air conditioning cycling Peak reductions declined after first hour and over successive high-price days	Summer-month energy usage reduced 3–4%; no annual net usage impact reported

Sources: California Statewide Pilot: George et al. (2006); Gulf Power Company: comments from Ervan Hancock III, Georgia Power Company; Ontario Energy Board: Hydro One (2006); and Community Energy Cooperative: Summit Blue Consulting (2004).

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Funding and printing for this report was provided by the U.S. Department of Energy and U.S. Environmental Protection Agency in their capacity as co-sponsors for the National Action Plan for Energy Efficiency.