Saving Energy in Urban Areas: Community Planning Perspectives, 1978

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The United States faced rapidly escalating energy prices in the 1970s with the creation of OPEC and the occurrence of the "oil crisis." Two related articles by Dr. Raymond Burby offer a historical perspective on how building design and community design can and should, but do not always, respond to the realities of the energy markets. The first article is a reprint of Burby's analysis in a 1978 planning newsletter. The second article presents his reflections thirty years later on what has changed and what has not. —Coeditors

Urban environments account for a major portion of total energy consumption in the United States. Energy use in urban areas is in large part a function of where we live and the ways in which we live, both of which have been shaped by the unprecedented personal mobility associated with the automobile and an abundance of low-cost fossil fuels. As these fuels have become more precious and energy costs have begun to rise, researchers have started to explore ways in which we can build more energy-efficient communities. This article summarizes some of the findings that have emerged to date and highlights major remaining, unanswered questions.

Energy Conservation in Buildings

The basic building blocks of the urban environment are the structures in which we live, work, and pursue our daily activities. Because space heating and cooling in buildings consume about 20 percent of the nation's energy, building design and operation have been major research targets. Initial study results suggest that large savings in building energy use are possible through structural and equipment modifications, but that achieving the savings will be difficult.

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In a recent study prepared for the U.S. Department of Housing and Urban Development, Hittman Associates, Inc. simulated the energy requirements of four types of residential structures—single-family detached, townhouse, low-rise apartment, and high-rise apartment—that were typical of those being built in each of eleven geographical locations with varying climates, design practices, energy prices, and income levels.[1] This analysis indicated that single-family residences required the most energy for heating and cooling, followed in turn by townhouses, high-rise apartments, and low-rise apartments. For each type of residential unit being built, energy savings between 30 and 60 percent could be achieved through technically feasible modifications in design and construction. Key modifications to current practices included reducing the glass area by approximately 25 percent; using double glazing or reflective glass; installing weatherstripping and caulking; increasing wall, floor, and ceiling insulation; and utilizing more efficient heating and cooling systems.

Similar energy savings, ranging from 11.3 percent in single-family dwellings to 59.7 percent in office buildings, will accompany adoption of the American Society of Heating, Refrigeration, and Air Conditioning Engineers standard (ASHRAE 90-75) for new construction.[2] An economic analysis of related standards indicates that by the year 2000 fuel bill reductions will exceed additional construction costs by almost $8 billion, with a benefit/cost ratio for energy-conserving construction standards of 2.9.[3]

Lack of Incentives for Builders

Given that relatively large energy savings are possible in new construction, why are the new methods not being adopted more rapidly? One reason is the fragmented character of the building and development industry. With tens of thousands of architects, general contractors, and home builders, and an army of associated subcontractors involved in new building construction, new ideas, no matter how beneficial, will take time to be diffused throughout the industry. A second reason is related to the economics of the construction industry. Often buildings are built by one person or firm to be sold or rented to another person who pays the energy costs of building operation. As a result, builders may try to improve their competitive position by sacrificing energy efficiency in an effort to reduce the "first cost" of structures to a minimum.[4] A third reason is simply inertia. In the construction industry, however, "business as usual" is frozen into place through building codes, minimum property standards, and the various handbooks for smaller builders. All of these factors create tremendous resistance to change.

Improving Energy Efficiency

Efforts to improve the energy efficiency of new buildings have focused on producer and consumer education and the addition of energy conservation components to federal minimum property standards and state and local building codes. Most of the major trade and professional associations connected with the building industry have published guides to improved building energy

efficiency. To increase consumer demand for energy-efficient buildings, regulations have been proposed that would require energy labeling on heating and cooling equipment and the disclosure of building energy operating costs when building ownership is transferred. At the federal level, the Energy Conservation and Production Act requires the Department of Housing and Urban Development to develop thermal efficiency standards for new buildings by 1980. These standards are to be adopted by the states and implemented through local building codes.

The effectiveness of programs and approaches for energy conservation in new buildings is difficult to assess at this early point. However, several problems are evident. The Council of State Governments has noted that with the current replacement period of twenty-five years for housing units, it will be decades before savings achieved through energy-efficient new buildings contribute substantially to reduced national energy demand. The Council has also indicated that even though the states revise their building codes, "problems of local code enforcement give little reason to expect that code modification will soon result in significant energy savings in buildings."[5] Finally, voluntary adoption of improved building materials and methods is hindered by the industry fragmentation and consumer resistance to paying higher first costs noted above and by financial intermediaries' reluctance to include the additional costs of energy conservation in the value of buildings for mortgage lending purposes. Clearly, energy conservation in buildings cannot be limited to new buildings. Recognizing this, federal, state, and local policies have been developed to encourage owners of existing buildings to invest in retrofitting and the adoption of solar equipment and to make changes in building operation. Hirst and Carney indicate that energy savings resulting from federal efforts to achieve the national goal of insulating 90 percent of all residences are double the savings possible with new construction standards.[6] As with new construction standards, reductions in fuel bills will substantially exceed increased capital costs, with a projected benefit/cost ratio of 1:9. Measures being considered to meet the national goal include tax credits for retrofits, increased funding of existing low-income weatherization programs, inauguration of a rural home weatherization program, and recruitment of utility companies to assist customers in weatherizing structures.

Programs that have been suggested for state and local governments parallel those of the federal government, but also include energy extension agents to provide technical assistance to building owners; real estate tax exemptions to relieve property owners of increased tax liability due to improvements to increase the energy efficiency of their buildings; higher tax and/or utility rates for inefficient structures; and various consumer information and education programs to increase awareness and knowledge of energy conservation practices. It has also been suggested that state and local governments could contribute to energy conservation by providing tax and other incentives for the recycling of older buildings which might otherwise be demolished. In this way the energy already expended in building construction and the public infrastructure serving older neighborhoods and districts could be saved.

New Lifestyles

None of the changes discussed to this point involves the lifestyles of building occupants. However, studies show that most of the energy saved through efficient construction and by retrofit investments can be lost through wasteful building operating practices. In Twin Rivers, New Jersey, for example, researchers found that even after adjusting for differences in building orientation and other physical characteristics, twice as much energy was consumed in some three-bedroom townhouses when compared with other identical units.[7] On the other hand, energy-conscious building operations can result in substantial additional energy savings: a savings of 15 percent, on average, by setting back thermostats to 68 degrees Fahrenheit in winter; a 7 percent savings by setting thermostats to 60 degrees at night; a 6 to 12 percent savings by setting back water heat from 145 to 120 degrees Fahrenheit; and a 10 to 15 percent savings by maintaining furnace and air conditioning units at maximum efficiency by annual checkups.[8]

Policies designed to produce changes in building operation include information and education programs and increases in energy prices. The latter, which has been shown to be very effective in reducing energy consumption in buildings, however, has been criticized severely because it might discriminate against renters, lower income groups, and others who cannot easily change from energy-inefficient to energy-efficient residences and who have limited ability to retrofit or change their energy consumption patterns.[9] This problem could be alleviated, of course, through tax rebates, in which case the effect of price increases would be to transfer income from high to low energy users.

Energy Conservation through Neighborhood Design

Groups of dwelling units combine with various supporting facilities and services to form urban neighborhoods. Although most attention to energy conservation in urban areas has focused on individual buildings, additional opportunities to save energy are present in the mix and intensity of neighborhood land uses, types and orientations of dwelling units and other buildings, landscaping, and internal circulation patterns. According to a U.S. Department of Energy official, energy savings through the energy-conscious design of new neighborhoods could result in a 5 percent reduction in national energy consumption by the year 2000.[10] Achieving this saving, however, would require major changes in land developer behavior and the attitudes of consumers and local officials.

As noted earlier, different types of dwelling units have different energy requirements. Single-family detached dwellings, because they have more exposed surface area and greater thermal conduction and air infiltration, consume significantly more energy for heating and cooling than townhouses or apartments. Based on typical building construction in eleven metropolitan areas, Hittman Associates, Inc. calculated the following relative values for dwelling unit heating and cooling energy requirements (single-family detached equals 100):[11]

	Heating	Cooling
Single-family detached	100	100
Townhouse	53	95
Low-rise apartment	43	108
High-rise apartment	39	109

Since almost two-thirds of the nation's existing stock of year-round dwelling units is in single-family detached buildings, significant energy savings should be possible if the proportion of households living in other types of dwelling units can be increased. For example, in comparing prototypical thousand-dwelling unit neighborhoods, the Real Estate Research Corporation found that gas and electricity requirements would be about 25 percent less in a neighborhood composed of equal numbers of single-family, townhouse, garden apartment, and high-rise apartments than in a neighborhood composed solely of single-family detached units.[12] Although the task of inducing significant numbers of households to change their housing preferences might appear to be Herculean, increasing construction and financing costs, in combination with demographic trends toward smaller families, may over time lead to greater acceptance of higher density residences.

In addition to changing the mix of housing types, there are a number of other ways to save energy through neighborhood design. One is to provide for neighborhood commercial land uses. For example, in Portland, Oregon, it has been estimated that by resurrecting the neighborhood grocery store of bygone days, the number of automobile shopping trips can be reduced by 15 percent, and the average length of shopping trips can be reduced by 25 percent.[13] In Davis, California, a community that is nationally known for its attention to energy-conserving neighborhood and community planning, it has been estimated that by reducing the required width of residential streets and increasing street landscaping, outside temperatures can be reduced by 10 degrees Fahrenheit in the summer, which will produce a 50 percent reduction in the amount of electricity required for air conditioning.[14] Air conditioning loads can also be reduced by orienting subdivision lots to maximize window exposures on the south and east sides, preserving deciduous landscaping which screens south-facing windows, and orienting units to take advantage of cooling summer breezes. Additional energy can be saved in the neighborhood through the provision of bicycling and walking paths—estimated to produce a 2 percent reduction in shopping, recreation, and school vehicular trips in Portland, Oregon—and by the optimum placement of street lighting.[15] Finally, neighborhoods can be designed to preserve "access to the sun" (solar access) so that optimum use can be made of solar energy systems.[16]

Resistance to Change

Although significant energy savings through neighborhood design seem to be possible, their realization will be extremely difficult. Major decisions about neighborhood design are made by builder/developers, local governments, and the housing consumers who influence both developer and governmental decisions. A recent national market survey of prospective home purchasers found that 97 percent would first attempt to purchase a single-family detached home rather than a townhouse or condominium apartment. The same survey revealed that new home buyers were extremely wary of solar heating and solar water heating. Only 8 percent would purchase solar heating (36 percent would consider it), and 7 percent reported they would purchase solar hot water heating (38 percent would consider it), if they were offered as options by builders.[17]

Given the lack of any clear market signals, builders and developers are naturally hesitant about venturing into energy-conserving development projects. This hesitancy is reinforced by the risks and potential financial costs associated with securing permits from local government for a development plan which requires variances from existing zoning and subdivision regulations. Although some communities, such as Davis, California, have formulated energy-conserving land development plans and regulations, as Harrington has observed, local governments have little incentive to promote energy conservation, since the benefits (extra energy resources) of local sacrifices in preferred lifestyles and development practices will accrue to the nation and not to the locality.[18]

Energy Conservation and Urban Form

At the community and metropolitan scale of development, urban form becomes an important aspect of the

planner's perspective on energy conservation. Urban form refers to the overall spatial configuration or structure of an urban area. Aspects of urban form that are related to energy conservation include the overall scale and density of the community, overall spatial arrangement of development, and the configuration of individual land uses. By manipulating these various aspects of urban form, it has been estimated that community energy consumption can be reduced by 3 to 10 percent by the year 2000.[19] Short-term estimates indicate that national energy consumption can be reduced by about 3 percent by 1985 through the adoption of energy-efficient patterns of urban development.[20] However, because the required changes in urban form imply even greater changes in lifestyle than required by energy-efficient buildings and neighborhood design, achievement of the potential savings is extremely problematic.

Urban Density and Energy Efficiency

Some studies have indicated that the size of an urban area is related to energy consumption. For example, data collected for the U.S. Department of Transportation's Nationwide Personal Transportation Study indicate that household travel for work- and nonwork-related trips reaches a peak in cities in the 5,000–25,000 population range and then tapers off steadily as city size increases. Other research suggests that medium-size urban centers of 25,000–100,000 population offer energy-conserving advantages over smaller and larger centers, but these conclusions are tentative and highly qualified.[21]

The evidence with regard to overall urban density and energy conservation is more firmly established. Energy savings in buildings through higher density development were discussed above. Savings in transportation energy requirements also occur. Shopping and employment areas should tend to be located closer to residential areas, with consequent reduction in travel; high density development makes it possible to use more energy-efficient modes of transportation.[22] In addition, higher density development may result in savings in energy required for utility systems, since shorter transmission lines are required to serve a given population and economies of scale may be achieved in larger, more efficient production plants.[23]

Spatial Planning and Land Use

A number of studies have examined the energy implications of alternative spatial arrangements of urban development. They indicate that a number of aspects of spatial structure must be considered, including the shape of the urban area (whether it is a concentric ring around one center, polynucleated with a number of centers, or linear), the extent to which it is compact or sprawling, and the degree of population and employment concentration. Although the studies tend to agree that the sprawl pattern of development is the least energy-efficient, there is little agreement about the most efficient pattern, in part because of differing study objectives and methods. For example, one study concluded that a "dense center" pattern of development was most efficient, while another found that polynucleated urban structures hold more promise for energy conservation than other spatial arrangements.[24]

Neighborhood grocery stores could significantly reduce shopping trips by car.

Another aspect of urban form that has implications for energy conservation is the configuration of individual land uses. Although research results are far from conclusive, it is generally believed that energy can be saved by mixing and integrating residential, commercial, industrial, and other land uses. In this case, savings stem from (1) sharing energy-consuming mechanical and electrical services, as well as other facilities, such as parking lots; (2) operating economies that can be achieved through centralization; and (3) reducing distances needed to travel from one land use to another, such as from home to work, shopping, and leisure activities.

It has also been suggested that better integration of land uses can make possible more efficient coordination of energy resources in urban areas. Integrated community energy systems can be developed which coordinate various energy services, such as electricity, cooling, heating, hot water, solid and liquid waste treatment, and others in such a way that the energy that is now wasted in producing one service is used as fuel for other services. For example, by locating electric generating stations within communities to make use of waste heat, system efficiencies as high as 85 percent can be achieved—far above the 35 percent efficiency typical of current electrical generating plants.[25]

A variety of policies have been proposed in order to achieve the energy savings that are possible in community development. They include (1) better coordination of urban growth and the provision of electrical services to achieve the savings potential of integrated systems; (2) location of community facilities and employment areas near residential areas and location of higher density housing near activity centers in order to reduce transportation energy consumption; (3) promotion of cluster development with walking paths and mixed-use development projects to achieve transportation and operating economies; (4) curtailment of sprawl development patterns through coordinated utility extension policies and other means; and (5) greater commitment to public modes of transportation. Although major technical and institutional obstacles must be overcome before integrated community energy systems are adopted, other policies for achieving energy conservation through community development are very familiar to those who have followed the evolution of urban planning over the past three decades. Similar policies have been proposed in order to achieve more cost-effective and environmentally sound communities. Delays in their adoption are due primarily to political factors, rather than legal or technical considerations.[26]

Cluster development with walking paths and mixed-use development projects could save energy.

Conclusion

This brief article has highlighted a number of opportunities for conserving energy in the course of urban development and redevelopment. A host of others, related primarily to energy consumption for urban transportation, could be mentioned. While researchers pursue additional ways to save energy in urban areas, it is essential that those already discovered be adopted more rapidly by the individuals and firms who play key roles in urban development processes and by communities. Educational efforts focused on home owners, professional architects and planners, developers, builders, and the building trades are well under way, and a number of energy conservation manuals have been produced. The potential effectiveness of these and other methods of promoting the adoption of energy conserving urban development practices and policies, however, is not well understood. Social science research can make a major contribution to the correction of this deficiency. By indicating the key factors related to individual and community adoption of energy-efficient policies and practices and suggesting policies to influence the factors in desired directions, the vision of energy-efficient communities may be brought one step closer to the realization.

Notes

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16. *See* Martin Jaffe, "Protecting Solar Access," *Environmental Comment* (1978): 12–14.

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