BY THE COMPTROLLER GENERAL

Report To The Congress

OF THE UNITED STATES

Greater Energy Efficiency Can Be Achieved Through Land Use Management

When planning new growth and redevelopment, communities can significantly reduce energy consumption by incorporating energy-efficient land use concepts such as site and building design, locational planning, and higher density development.

Decisionmakers, however, are reluctant to use these concepts because of major barriers such as the cost of implementing the concepts and resistance to higher density development.

The Federal Government can play a role in promoting energy-efficient land use by providing guidance through its policies, supporting research and comprehensive planning, and providing needed financial incentives.

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COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON D.C. 20548

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To the President of the Senate and the
Speaker of the House of Representatives

This report explores selected concepts, progress, and problems related to energy-efficient land use management. We undertook this study because those responsible for considering energy-efficient land use concepts in the decisionmaking process face numerous barriers and constraints which limit the acceptance and implementation of these concepts.

In this respect, the Federal Government is in an influential position to encourage greater use of these concepts and in the past has had programs designed for this purpose. However, the Government's focus is changing and emphasis is being placed on decreasing the number of Federal programs. In view of the current and future decisions that must be made when examining and evaluating budget priorities, the information presented in this report can be useful.

We requested, but did not receive, comments on this report from the Department of Energy, the Department of Housing and Urban Development, the Department of Transportation, the Department of the Treasury, the Internal Revenue Service, and the Environmental Protection Agency.

We are sending copies of this report to the Director, Office of Management and Budget; the Secretary of Energy; the Secretary of Housing and Urban Development; the Secretary of the Treasury; the Commissioner of Internal Revenue; the Secretary of Transportation; the Administrator, Environmental Protection Agency; the Chairman, Senate Finance Committee; the Chairman, House Ways and Means Committee; and to the chairmen of energy-related congressional commmittees.

Charles A. Bowsher

Comptroller General
of the United States

D I G E S T

Today's energy situation is prompting a growing interest in planning, designing, and building communities that are energy-efficient. Energy-efficient land use management includes minimizing the amount of energy needed to heat and cool buildings and reducing energy intensive infrastructure construction (highways and sewer and water lines) and automobile travel. Energy savings can be realized through the siting and designing of buildings and neighborhoods, locating activities in close proximity to population centers, and building more multifamily dwellings. (See ch. 2.)

Local officials, builders and developers, financial institutions, and the public decide how land is used in the community. Many of these decisionmakers believe that energy can be saved through better land use. However, they are reluctant to accept and use energy-efficient land use concepts such as site and building design, locational planning, and higher density development. The major barriers include the cost of implementing the concepts, the lack of hard data that clearly demonstrate the energy savings and costs, and a strong community resistance to higher densities. (See ch. 3.)

The Federal Government's role in stimulating interest and activity in energy-efficient land use is changing. At the time GAO began its work, the Federal role was one of initiating guidance through urban policy formulation, supporting research and development programs, and providing financial assistance for comprehensive planning. However, since the 1982 budget terminates or changes the focus of many of these efforts, a number of issues need to be resolved. (See ch. 4.)

SHOULD DOE SUPPORT ENERGY-EFFICIENT LAND USE PROGRAMS?

DOE's formal policies do not recognize land use as an element in achieving energy efficiency. However, DOE has several long-term research programs directed toward developing communities

that employ energy-efficient land use concepts. The work under these programs focused on the barriers faced by State and local officials, builders and developers, and financial institutions. Even though the programs appear to be in line with the administration's policy of funding long-term research, they were terminated in fiscal year 1982 because of budget cuts. GAO believes that the benefits in increased energy efficiency through use of these concepts are significant enough to warrant at least a minimal level of research by DOE to address the barriers that impede their acceptance. (See pp. 29 to 31.)

RECOMMENDATION

GAO recommends that the Secretary of Energy, when evaluating and analyzing funding priorities for long-term research and development programs for fiscal year 1983, determine what, if any, supporting efforts should be undertaken to address the feasibility, advantages, and barriers of applying energy-efficient land use concepts in communities. (See p. 31.)

SHOULD HUD EMPHASIZE THE IMPORTANCE OF AREAWIDE PLANNING?

HUD has recognized energy-efficient community development in its 1980 urban policies; however, because of the uncertainty over whether the new administration will support this policy, only limited action has been taken to implement it.

In addition, HUD has provided financial assistance to regional, State, and local governmental agencies for comprehensive planning purposes through its "701" grant program. This program has been repealed by the Omnibus Budget Reconciliation Act of 1981 and the "701" activities combined with HUD's Community Development Block Grant Program.

The combination of the "701" program with the block grant program results in the loss of direct funding to regional planning organizations for areawide planning. Therefore, unless States and local communities choose to purchase areawide planning services, regional planning organizations could be forced to curtail much of their planning efforts.

Through areawide planning, regional agencies have the potential to influence development patterns and energy demand by preparing land use plans that cut across local governmental boundaries and provide an overview of the placement of roads and sewers in a manner that would promote energy-efficient development. Therefore, GAO believes that HUD should consider whether an effort should be initiated to emphasize the importance of areawide planning in the land use decisionmaking process. (See pp. 31 to 34.)

RECOMMENDATION

In view of the importance of energy-efficient land use and the uncertainty of the priority that States and local communities will place on the concepts, GAO recommends that the Secretary of Housing and Urban Development determine the extent, if any, to which HUD needs to emphasize the importance of areawide planning to State and local governments in increasing energy efficiency through the land use decisionmaking process. (See p. 34.)

SHOULD TAX CREDITS BE USED TO ENCOURAGE ENERGY-EFFICIENT SITE AND BUILDING DESIGN CONCEPTS?

Federal income tax credits for investments in passive solar systems would be an excellent means of providing incentives for builders and developers to use energy-efficient site and building design concepts. A passive solar system's effectiveness depends on the use of energy-efficient site and building design techniques such as maximizing southern window exposure, using overhangs, and properly placing trees and vegetation.

Tax credits are currently available to homeowners for installing passive solar heating systems in their homes; however, the Internal Revenue Service's restrictive eligibility requirements have caused considerable confusion over what components of the system are eligible for the credit. New legislation has been introduced in the Congress to provide incentives directly to builders and developers for incorporating passive solar systems into their buildings. Unless this legislation is very specific

about the eligibility of components that serve a dual purpose--e.g., a structural part of a building that also serves as a component of the passive solar system--it could be subject to the same restrictive interpretation that was manifested in the previous credit to homeowners and would not provide the maximum incentive. (See pp. 34 to 35.)

RECOMMENDATION

GAO recommends that the Committee on Ways and Means, House of Representatives, and the Committee on Finance, U.S. Senate, if they wish to provide a maximum incentive, clarify the proposed legislation to provide that components which serve a dual purpose of being a structural and passive solar system component are eligible for the tax credit. (See p. 35 and app. III for suggested clarification to proposed legislation.)

SHOULD OTHER EXISTING MECHANISMS BE USED TO ENCOURAGE ENERGY-EFFICIENT LAND USE?

A number of other existing mechanisms and programs could be used to channel information on energy-efficient land use concepts to decisionmakers at the community level. These include (1) Executive Order 12185 and the Interagency Coordinating Council, (2) the secondary mortgage market, and (3) applicable Environmental Protection Agency and Department of Transportation programs. Several of these mechanisms have been used to promote energy conservation; however, in only a few instances have they been used to foster energy-efficient land use. (See pp. 36 to 39.)

RECOMMENDATIONS

GAO recommends that the Secretary of Energy, in consultation and cooperation with the Secretary of Housing and Urban Development, provide guidance and assistance to Federal agencies on how energy considerations can be included in programs that affect land use. (See p. 39.)

GAO also recommends that the Secretary of Energy work with the secondary mortgage market to help it develop criteria for use in assessing the impact of energy-efficient land use concepts. (See p. 39.)

AGENCY COMMENTS

GAO sent a draft of this report to the Department of Energy, the Department of Housing and Urban Development, the Department of Transportation, the Department of the Treasury, the Internal Revenue Service, and the Environmental Protection Agency, requesting comments. However, no comments were received.

Contents

ABBREVIATIONS

APA	American Planning Association
CCEMP	Comprehensive Community Energy Management Program
CDBG	Community Development Block Grant
COG	Council of Government
DOE	Department of Energy
DOT	Department of Transportation
EPA	Environmental Protection Agency
FHA	Federal Housing Administration
FHLMC	Federal Home Loan Mortgage Corporation
FNMA	Federal National Mortgage Association
GAO	General Accounting Office
GNMA	Government National Mortgage Association
HUD	Department of Housing and Urban Development
IRS	Internal Revenue Service
SAND	Site and Neighborhood Design
VA	Veterans Administration
VHFA	Vermont Housing Finance Agency

CHAPTER 1

INTRODUCTION

Land use management has traditionally been a complex and controversial issue. Despite this complexity, the Nation's energy situation is prompting a growing interest in planning, designing, and building communities that are energy efficient. This report explores the issue of energy-efficient land use management by identifying and presenting a comprehensive discussion of selected concepts, progress, and problems in applying the concepts to achieve more efficient use of energy resources.

Both the Department of Energy (DOE) and the Department of Housing and Urban Development (HUD) have missions and responsibilities which relate directly to energy-efficient land use. DOE, under its energy conservation mission, is charged with stimulating and promoting conservation through policies and programs which seek a direct, immediate reduction in energy demand as well as increased efficiency in energy consumption. DOE is attempting to carry out this mission using such tools as financial incentives and assistance; research, development, and demonstration programs; educational materials; and standards and regulations.

HUD, on the other hand, plays a leading role in community planning and development and is funding a wide range of community, neighborhood, and urban development activities. Some of its activities include urban renewal, neighborhood development, and model cities programs. In an effort to move toward better use of physical and human resources in America's towns, cities, and metropolitan areas, HUD supports a full range of Federal, State, and local community programs. HUD's responsibility for setting urban policy encompasses planning activities which greatly influence State and local land use decisions.

OBJECTIVES, SCOPE, AND METHODOLOGY

The overall objective of this review was to explore the various possibilities and obstacles to energy-efficient land use. In line with this objective, we

--explored the potential for realizing energy savings through more efficient land use;

--identified the decisionmakers who play major roles in achieving energy savings through land use;

--identified the barriers that discourage decisionmakers from considering energy in land use decisions;

--analyzed the actions taken to encourage energy-efficient land use; and

--identified existing programs, mechanisms, and incentives that could be used to encourage the consideration of energy in land use decisions.

We limited the scope of this review to the community growth and development aspects of land use. By community growth and development, we mean those aspects of land use that relate to local government entities and to growth and redevelopment in metropolitan areas. It includes decisions concerning the location of various types of growth, such as commercial, residential, industrial, and recreational development; construction of infrastructure (roads and sewers); and the overall design of development projects, subdivisions, and buildings. We did not examine some of the broader issues concerning energy and land use, such as national transportation networks and extracting energy resources from the land. Thus, for the purpose of this report, we are defining energy-efficient land use to include:

1. The siting and designing of buildings and neighborhoods relative to natural terrain, landscape, and climate.

2. The location of new buildings, industrial centers, commercial enterprises, local transportation networks, sewers, and recreation facilities as they relate to population centers.

3. The density of communities and the construction of multifamily dwellings.

To avoid confusion about the overlap between energy-efficient land use and energy conservation, we excluded the retrofit of existing buildings and household energy conservation devices from our scope because they do not directly relate to the land use aspects of energy conservation.

An in-depth discussion of the scope, methodology, and approaches used in developing the report is presented below according to the information and analysis included in chapters 2 to 4.

Chapter 2 addresses the potential for achieving energy savings through land use and describes some of the basic concepts and theories on why and how energy savings can be achieved. This information was developed and extracted from various studies identified through a literature search, contacts with Federal, State, regional, and local government entities, representatives of professional associations, builders and developers, and energy conservation and land use experts from academic institutions. We identified approximately 90 studies and documents that addressed energy-efficient land use from which we selected and reviewed 20 which specifically address the energy savings potential. A synopsis of these studies appears in appendix I.

It should be recognized that several of the studies stressing the density aspects of energy conscious land use have been criticized. Although the critics agree that energy savings can be realized, they take exception to some of the assumptions made and question the amount of energy savings. To deal with the pros and cons of the subject, we solicited views from individuals knowledgeable in energy-efficient land use concepts.

The third chapter discusses the barriers faced by State and local government entities, builders and developers, financial institutions, and the public in implementing energy-efficient land development. It also points out the actions that have been taken to promote the concepts on a limited basis. To gain insights into these issues, we interviewed State, county, and local government officials, developers, builders, realtors, professional associations, and representatives of financial institutions in three diverse geographic locations: New England (Massachusetts and Vermont), the Midwest (Michigan and Missouri), and the Pacific Northwest (Washington and Oregon). These areas were chosen to get a diverse geographic mix and to obtain views from States and communities that faced different energy situations. We interviewed State officials in each State, and one Regional Council of Government in Massachusetts, Michigan, Missouri, and Washington, and three county governments in the vicinity of a large metropolitan area for Michigan, Missouri, and Washington. We interviewed representatives of 8 government entities in the Boston metropolitan area, 13 in the Detroit area, 17 in the St. Louis area, and 11 in the Seattle metropolitan area. The government entities we contacted are listed in appendix II.

We also interviewed builders and developers, financial institutions, and realtors in each of the four States. To gain a national perspective, we interviewed officials representing the Urban Land Institute, the American Planning Association, the National League of Cities, the American Institute of Architects, the American Land Development Association, the National Association of Realtors, and the National Association of Home Builders.

We selected large metropolitan areas for our interviews because they are centers of population and are areas where new growth and redevelopment are likely to occur. In selecting county and local government entities, we selected a predominence of communities which have potential for growth and development. Statistical sampling techniques were not used in this selection because we felt that interviewing communities that have growth potential was most important.

Builders and developers and local government officials were interviewed to determine what, if any, actions they are taking to conserve energy through land use management. We also wanted to obtain their views concerning the need for, and type of, incentives that could be provided to encourage more consideration of energy conservation in land use decisions.

We also interviewed officials from the States of Oregon and Vermont, and the city of Portland, Oregon, because they have been cited as being very progressive in adopting energy conscious land use concepts. This work was done to provide some perspective and examples of States and communities which are taking action to implement energy conscious land use measures.

The fourth chapter identifies and discusses current Federal actions that can promote and encourage energy-conscious land use management. Much of our effort was directed at DOE because of its energy conservation mission and HUD because of its direct involvement in land use from a community development perspective. Our work at DOE concentrated on several programs that have goals and objectives directly related to energy and land use--the Site and Neighborhood Design Program, the Comprehensive Community Energy Management Program, and the Comprehensive Master Planning Program in Atlantic City, New Jersey. At HUD, we obtained information on the National Urban Policy of 1980, the Council on Development Choices for the 80s, the Comprehensive Planning Assistance program, the Community Development Block Grant program, and the Urban Development Action Grant program.

In addition, we obtained limited information on programs in the Department of Transportation and the Environmental Protection Agency that appeared to have energy-efficient land use implications. We also contacted the following Federal secondary mortgage entities to determine what they are doing to encourage energy-efficient land use in the housing and mortgage markets:

--The Veterans Administration.

--The Federal Home Loan Mortgage Corporation.

--The Federal National Mortgage Association.

--The Government National Mortgage Association.

--The Federal Housing Administration.

The fourth chapter also contains our conclusions and recommendations concerning actions that can be taken to encourage more widespread consideration of energy in land use decisions.

A draft of this report was sent to the Department of Energy, the Department of Housing and Urban Development, the Department of Transportation, the Department of the Treasury, the Internal Revenue Service, and the Environmental Protection Agency, requesting comments. However, no comments were received.

CHAPTER 2

ENERGY CONSUMPTION CAN BE REDUCED THROUGH APPLICATION OF ENERGY-EFFICIENT LAND USE CONCEPTS

When planning new growth and redevelopment, communities can significantly reduce energy consumption by incorporating energy-efficient land use concepts such as site and building design, locational planning, and higher density development. The general theory of energy-efficient land use planning is that serious thought should be given to minimizing the amount of energy needed to heat and cool buildings and to reducing energy intensive infrastructure construction and automobile travel. The energy savings can be realized through the proper siting and designing of buildings and neighborhoods, locating activities in close proximity to population centers, and building more multifamily dwellings.

Studies by DOE and other organizations, such as the Urban Land Institute and the American Society of Landscape Architects Foundation, and limited applications of the concepts show that energy savings of 15 to 30 percent can be achieved by siting and designing buildings and neighborhoods to take advantage of natural environmental heating and cooling. Site and building design is a concept that can be used in a subdivision, neighborhood, or individual building and is a likely starting point for those interested in implementing energy-conscious land use techniques. The concept generally involves the designing of small communities, neighborhoods, and buildings that harmoniously co-exist with natural terrain, landscaping, and climatic conditions. It includes measures such as designing street layouts to facilitate maximum southern exposure for buildings, orientating windows toward the sun, and using landscaping and natural terrain features to block or redirect winds and breezes to increase the heating or cooling efficiency of buildings.

Energy-efficient locational planning is another concept that can be used to reduce as much as 44 percent of a community's demand for energy. This concept, which can be applied to small neighborhoods or large regional areas, primarily deals with reducing energy-intensive automobile travel by locating activities such as industrial centers, shopping, and recreational facilities close to centers of population. Compact communities encourage less energy-intensive travel, such as walking and bicycling, and reduce the frequency and average trip lengths when automobiles are used. Locational planning also involves decisions concerning energy-intensive construction of roads and sewers. By locating new development in areas already serviced by roads and sewers (infrastructure), urban sprawl is discouraged and costs, both energy and financial, associated with such construction can often be averted.

HOW SITE AND BUILDING DESIGN CONCEPTS CAN SAVE ENERGY

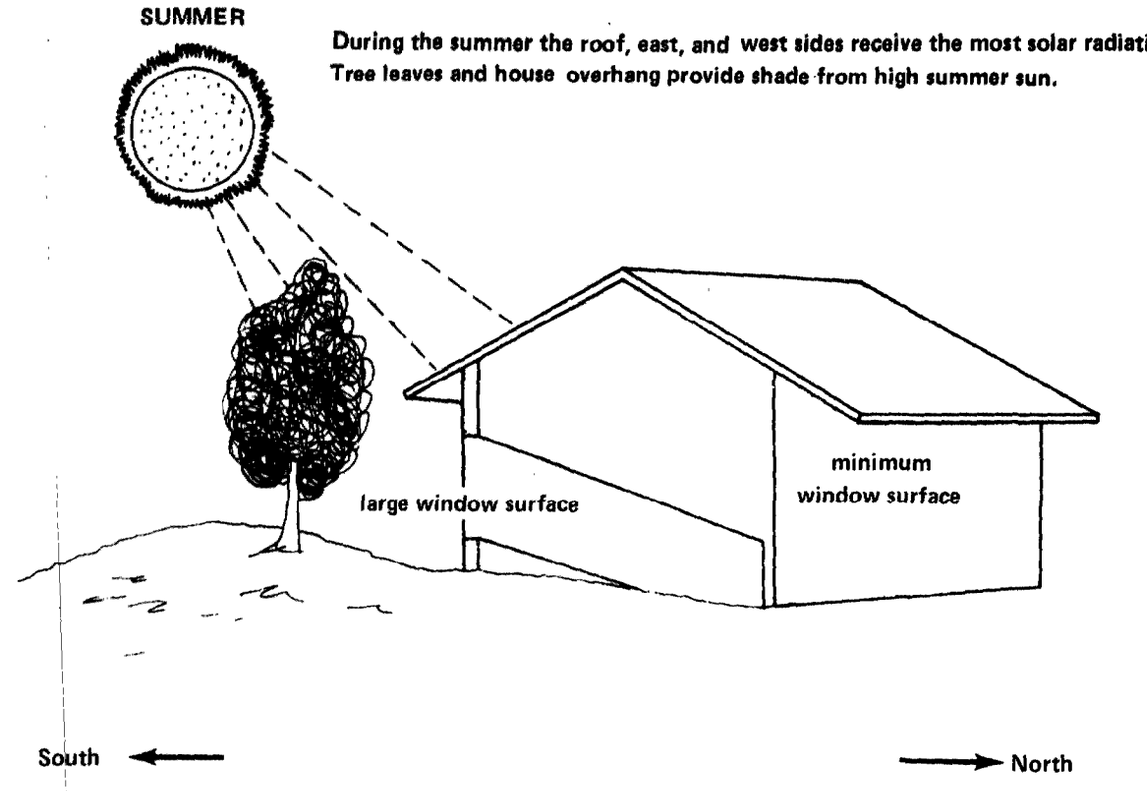
The application of site and building design concepts can result in urban growth and development that is both energy-efficient and aesthetically pleasing. The concepts involve the siting, designing, and orientating of neighborhoods and buildings to take advantage of natural land forms, wind direction, vegetation, and landscaping to reduce the amount of energy needed to heat and cool buildings. The following narrative and illustrations describe some of the basic site and neighborhood design concepts that can be used in planning for new or redeveloped communities.

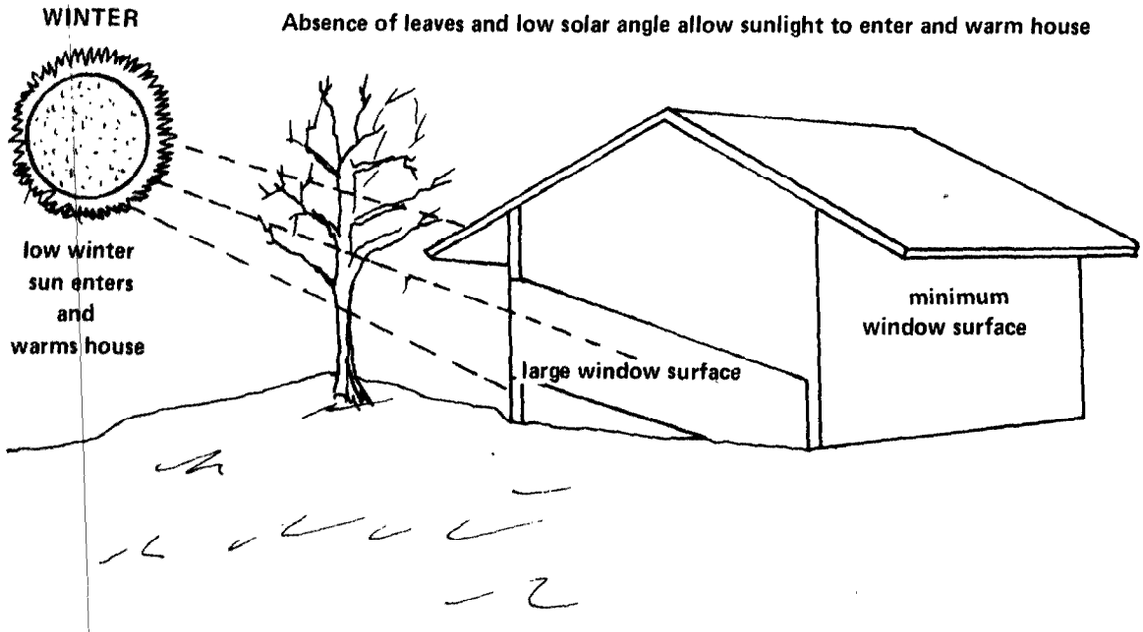
Orientating buildings to maximize or minimize solar heat

One of the simplest site design concepts is to orientate and design buildings to take advantage of the sun's position in the sky at different times of the year. Figure 1 illustrates this concept.

FIGURE 1

SUMMER AND WINTER SOLAR ANGLES





SOURCE: DUNCAN ERLEY, DAVID MOSENA, AND EFRAIM GIL, ENERGY EFFICIENT LAND USE, AMERICAN PLANNING ASSOCIATION, MAY 1979

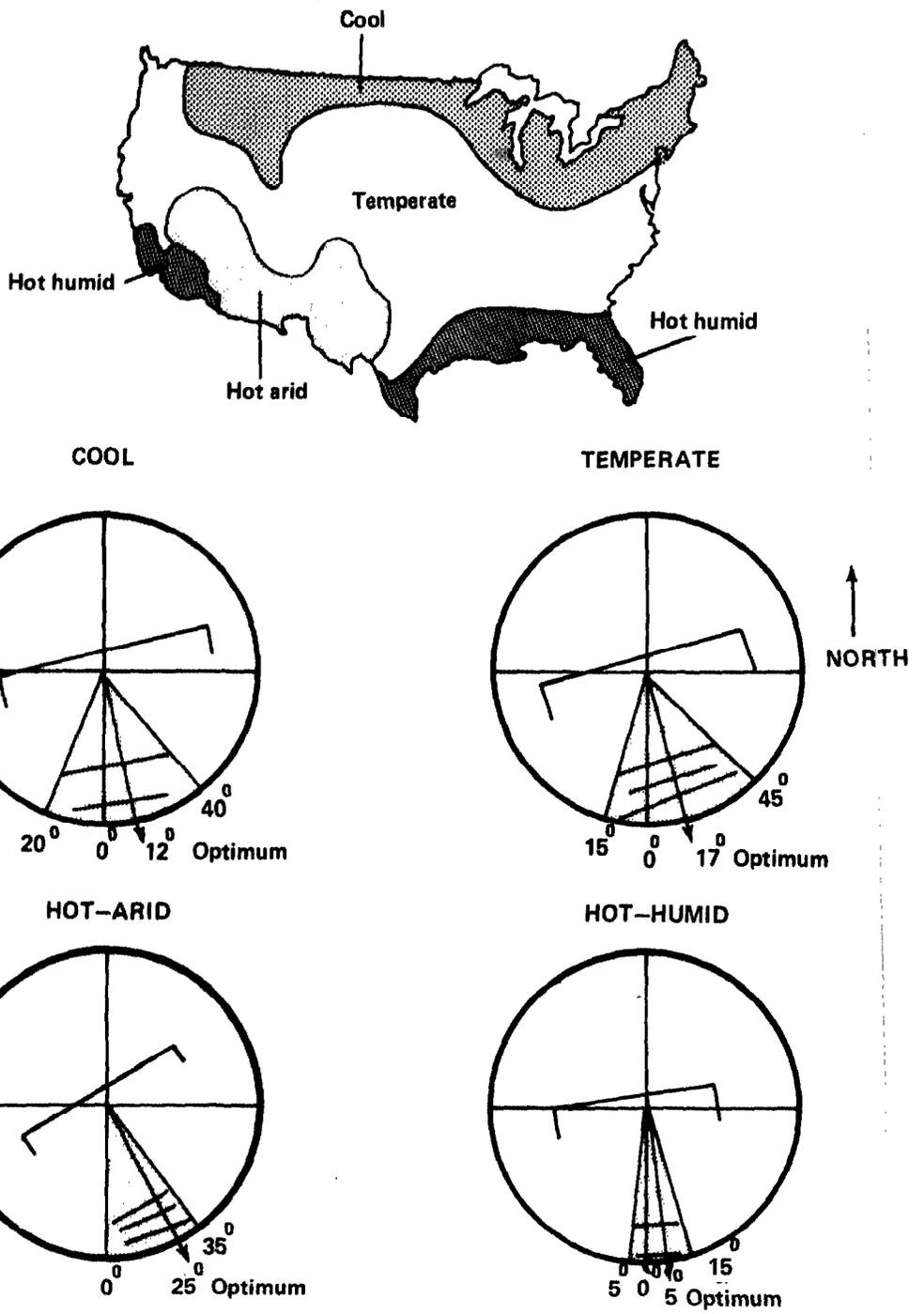
As illustrated in the diagram, the sun is lower in the sky and moves across the southern horizon during the winter months. Thus, by orientating the building toward the south and maximizing window surface on the south side, maximum solar heat can be gained to heat the building during the winter. Also, note that the sunlight passes through the leafless branches of the deciduous tree and because of the sun's low winter angle, the sunlight passes under the building's overhang. The winter energy efficiency of the building can be further enhanced by reducing window exposure on the windward west and north sides and situating the most frequently used rooms on the south side.

The orientation and design of the building are also conducive to cooling during the summer. As shown in the diagram, the sun is much higher in the sky during the summer, and the roof's east and west sides receive most of the solar heat. The heat is further diminished by the overhang that extends beyond the roof, and the leafy deciduous tree shades the building from the sun.

Energy-efficient building orientation and design will vary in different areas of the country. Figure 2 shows the desirable orientation for the four regional climatic zones of the country. The shaded areas represent the ranges for energy-efficient building orientation for the four regional climatic zones; the arrow represents the optimum energy efficiency siting. In each region, active living areas should be situated on the south side to take full advantage of the winter sun.

FIGURE 2

DESIRABLE BUILDING ORIENTATION FOR REGIONAL CLIMATIC ZONES



Active living areas are oriented to south to take full advantage of the winter sun

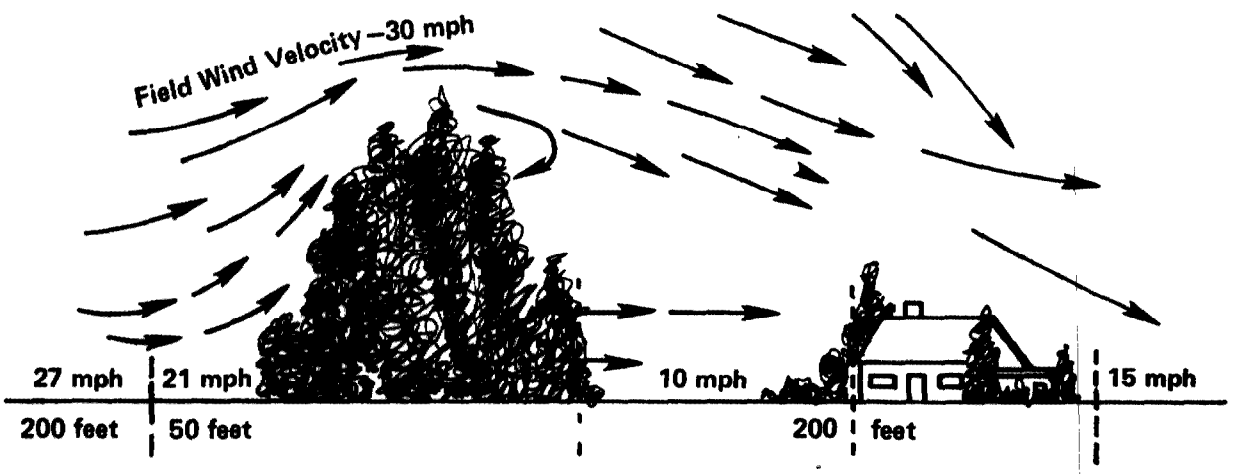
SOURCE. DUNCAN ERLEY, DAVID MOSENA, AND EFRAIM GIL, ENERGY EFFICIENT LAND USE, AMERICAN PLANNING ASSOCIATION, MAY 1979

Blocking and diverting winds
for heating and cooling

Fuel savings as high as 30 percent can be achieved with good wind protection on three sides of a building. 1/ Figure 3 shows how coniferous evergreens can be strategically placed to protect buildings from cold winter winds. The diagram shows how a stand of trees can divert and slow winds to reduce the heat loss of the building.

FIGURE 3

USE OF WINDSCREENS TO DIVERT COLD NORTH AND NORTHWEST WINDS



SOURCE: AMERICAN SOCIETY OF LANDSCAPE ARCHITECTS FOUNDATION, LANDSCAPE PLANNING FOR ENERGY CONSERVATION, ENVIRONMENTAL DESIGN PRESS, 1977

1/American Society of Landscape Architects Foundation, Landscape Planning for Energy Conservation, Environmental Design Press, 1977, p. 54.

Trees and vegetation can also be orientated to help cool buildings by diverting breezes. Proper placement of vegetation can divert cooling winds to go through rather than around buildings and, by narrowing vegetation rows, wind current can be intensified to get a greater cooling effect.

Since mature trees and vegetation provide the wind channels, it is wise to consider how existing vegetation on a lot can be used before the building is sited and oriented.

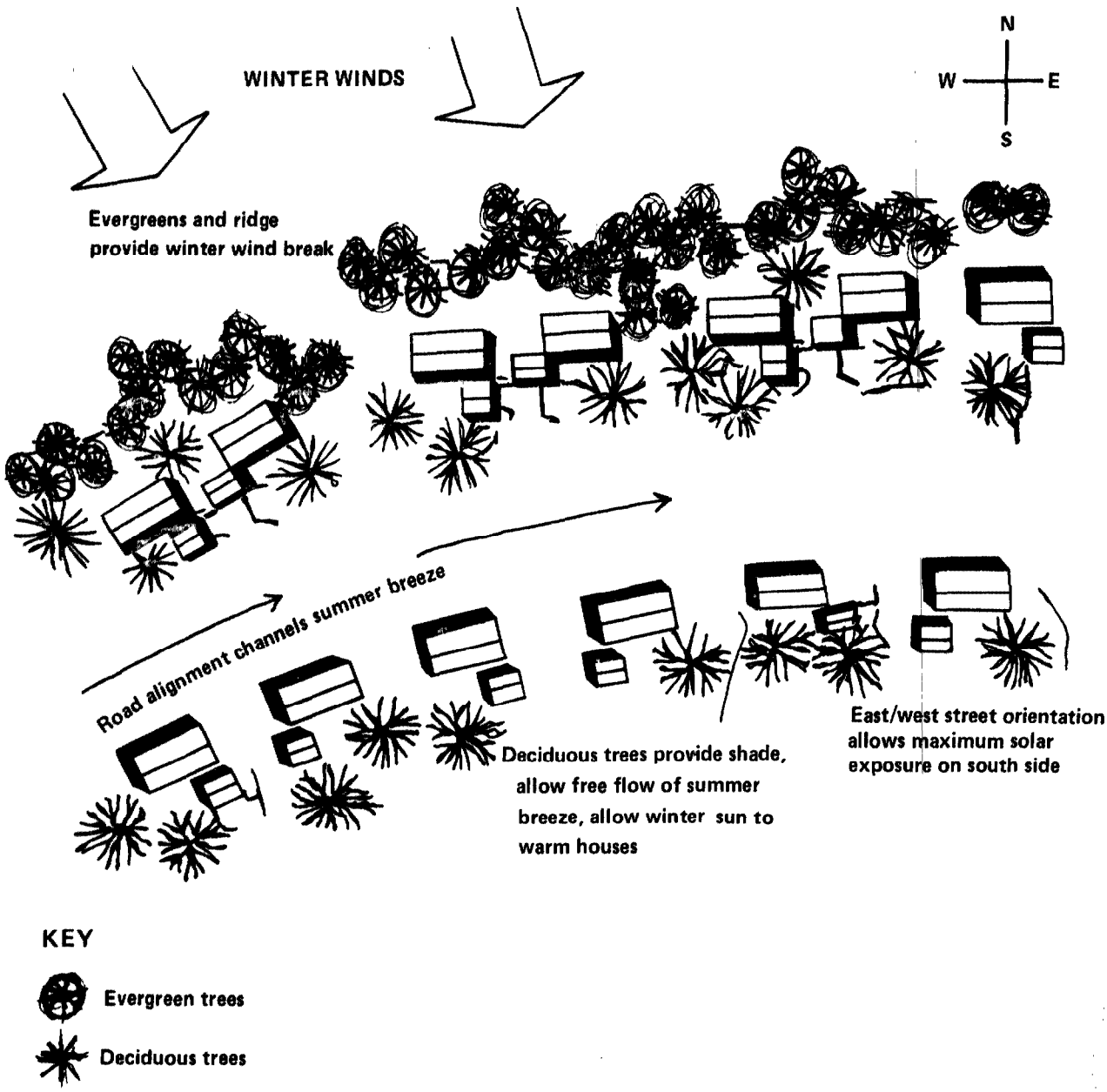
Employing energy-efficient site design for entire communities

The illustrations presented above feature site design concepts for individual buildings. These and similar concepts can also be incorporated into the design of entire communities. DOE case studies estimate that energy savings of 30 percent can be achieved in communities through the use of site design concepts. The studies indicate that these savings can be realized without increasing development costs.

Figure 4 below shows energy-conscious site design in a neighborhood consisting of single-family dwellings. One of the key features in this subdivision design is east/west street orientation which allows consistent southern exposure for the homes without destroying the continuity of the neighborhood. During the winter, the greatest amount of solar heat is collected through windows on the south walls. Another energy-saving technique included in this illustration is the use of evergreens and ridges on the north side of the subdivision to provide winter wind breaks. Also, deciduous trees permit the winter sun to enter windows on the south side to warm homes. During the summer, these trees provide shade and allow free flow of breezes around homes. Additionally, proper road alignment can channel summer breezes to help moderate hot temperatures.

FIGURE 4

ENERGY CONSCIOUS SITE DESIGN FOR A COMMUNITY



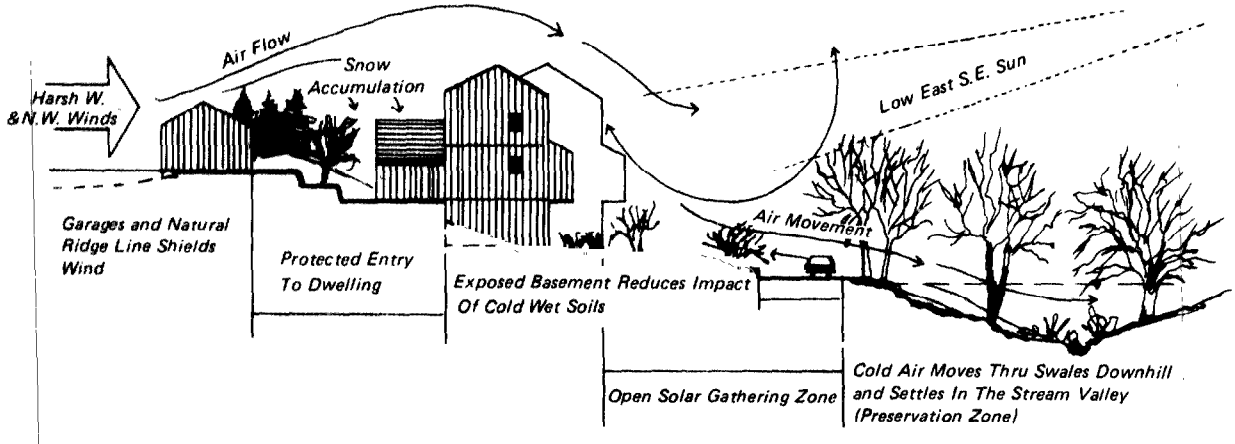
Source: National Association of Homebuilders.

Another way to achieve energy-efficient site design in a community is to use the existing contour of the land as shown in Figure 5 below. Newport West, a low-density cluster townhouse development, is located on a 60-acre site in a semirural area of Ann Arbor, Michigan. The woodland image of the site has been preserved by locating nearly all of the housing units on the open, sun-exposed slopes.

The illustration shows how a small exposed hilltop on the west edge of the site can modify the harsh prevailing west and northwest winds. The force of the cold winter winds is diminished by garages and a long double row of mature 80-foot Norway Spruce which was preserved on the ridge line. The excellent drainage of the site also ensures that cold, wet basements will not be a problem. The natural slope also permits construction of housing units with exposed basements facing the warm morning sun. The natural setting of the Newport West site allows 75 percent of the housing units to take advantage of solar-orientated slopes. Proper window orientation and the use of deciduous trees permits the low winter sun to warm the clustered buildings during the winter.

FIGURE 5

NEWPORT WEST: USING THE CONTOUR OF THE LAND FOR ENERGY CONSERVATION



SOURCE: AMERICAN SOCIETY OF LANDSCAPE ARCHITECTS FOUNDATION, LANDSCAPE PLANNING FOR ENERGY CONSERVATION, ENVIRONMENTAL DESIGN PRESS, 1977

HOW PLANNING THE LOCATION OF NEW GROWTH AND DEVELOPMENT CONCEPTS CAN REDUCE ENERGY CONSUMPTION IN COMMUNITIES

Proper locational planning of new growth and development can result in communities that are more energy efficient. Locational planning concepts generally relate to regions or metropolitan areas; however, they can also be applied to neighborhoods and small communities. Energy savings of up to 44 percent can be achieved by building compact communities that interrelate various activities with population centers. 1/

One study 2/ points out that compact communities and the interrelationship of activities can reduce transportation energy consumption by bringing people closer to activities, and that multifamily attached dwellings can be heated and cooled more efficiently than single-family detached dwellings. It also concludes that much of todays's energy-inefficient land use is attributable to urban sprawl and the haphazard construction of infrastructure. Building vast road and sewer networks on the outskirts of metropolitan areas encourages people to move farther from their destinations.

Studies estimating energy savings through the application of these concepts are generally based on models and hypothetical scenarios. Accordingly, some of the assumptions and conclusions made in several studies have been criticized. 3/ Although the critics agree that energy savings can be achieved through higher densities, they dispute the amount of savings attributed to some of the measures being advocated.

It should be recognized, however, that energy-efficient locational planning does not necessarily require high densities. Communities can be planned and designed to feature low-density, detached, single-family housing or mixed-use attached housing which is energy efficient and aesthetically pleasing. By strategically planning activity centers in and around residential areas, trip lengths can be reduced and less energy-intensive transportation can be made practical.

The basis for projecting energy savings by applying the concepts of energy-efficient locational planning and high-density development are discussed below.

1/Real Estate Research Corporation, The Costs of Sprawl, U.S. Government Printing Office, April 1974.

2/Urban Systems Research and Engineering, Inc., The Growth Shapers, Council on Environmental Quality, May 1976, pp 5 ff.

3/Alan Altshuler, AIP Journal, April 1977, p. 207.

Transportation energy savings attributable to compact development and higher densities

Transportation energy consumption can be reduced by developing land in clusters and activity centers. Such development can bring people closer to their places of employment, shopping, health care, and recreational activities. This close proximity of people and their destinations can reduce energy-intensive automobile travel by making less energy-intensive forms of travel, such as walking, bicycling, and riding buses and subways, more practical and convenient. It also reduces the length and frequency of trips when automobiles are used. One study concluded that a land use alternative characterized by energy conscious locational planning and higher population densities would be 31 percent more energy efficient than a low-density sprawl alternative. 1/

Figure 6 shows Columbia, Maryland, a planned community located between Washington, D.C., and Baltimore, Maryland. Columbia's design is based on a concept of grouping neighborhoods around village centers which in turn are linked by a community bus system, roadways, and 28 miles of paths for biking, walking, and jogging. Eight villages are clustered around a downtown urban core, and each individual village focuses on secondary schools and centers that contain shopping and recreational facilities. The downtown contains office buildings, colleges, a hospital, a 110-store shopping mall, and major cultural and entertainment centers.

The community design is energy efficient from a transportation standpoint because most of the community's residents are within walking distance of schools, shops, services, and recreation. Sixty-three percent of all students walk or bike to school. The community also operates a non-profit bus service that carried over 350,000 riders in 1978. This is considered a very high ridership rate relative to comparably sized communities.

Automobiles are still used in the community; however, the city's layout and mix of employment, recreational, and commercial areas lowers gasoline consumption considerably. Annual savings attributed to reduced distances between residences and commercial and community facilities were estimated to be $810,000, or an estimated 30 fewer miles of driving per month to activity centers for each of the 15,000 households.

1/James F. Roberts, Energy, Land Use, and Growth Policy, Implications for Metropolitan Washington, Metropolitan Washington Council of Governments, August 1975.

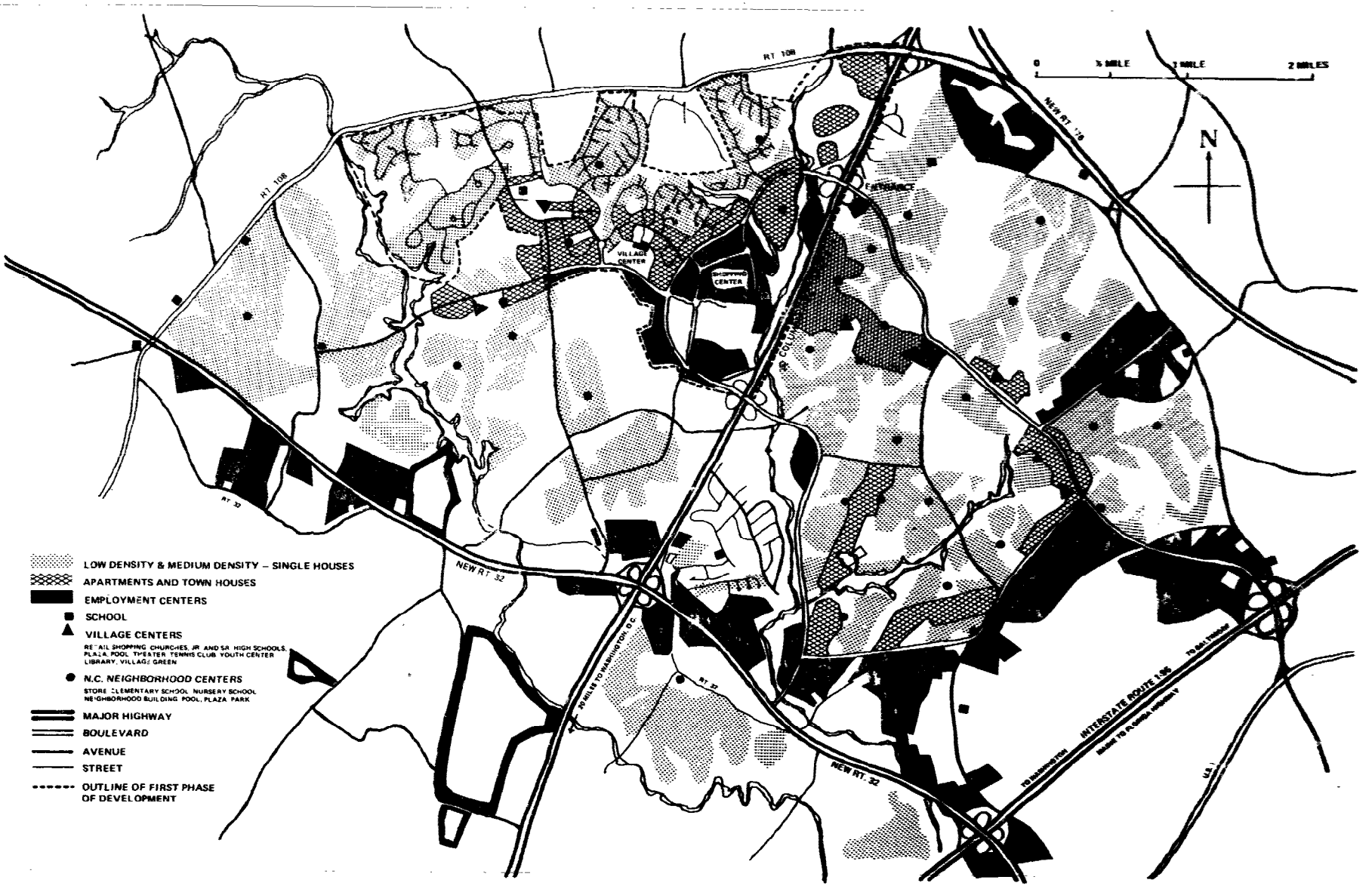


FIGURE 6
THE PLANNED COMMUNITY OF COLUMBIA, MD.

SOURCE: Columbia and the New Cities, by Gurney Breckenfeld. New York: Ives Washburn, 1971.

Heating and cooling energy savings attributable to compact development and higher densities

Attached housing is generally more energy efficient to heat and cool because there is less exterior wall surface per square foot of living space. One study shows that the thermal efficiency of small multifamily units is about 30 percent better on a square foot basis than that of single-family detached units. 1/ In cases where people are willing to accept less living space in an attached dwelling, the savings can be greater. There is a point of diminishing returns, however. In buildings over 10 stories tall, the energy efficiency of individual units tends to be outweighed by the energy requirements for operating elevators and maintaining other common services. 2/

High population densities also make community-wide energy systems, such as cogeneration and district heating, 3/ more feasible and cost effective. Generally, cogeneration and district heating are too expensive and impractical in low-density areas because the distribution networks are too spread out and require excessive material and labor costs. Substantially more people can be served in high-density areas with multifamily housing because the distribution network does not have to be as extensive.

Planning road and sewer projects to minimize energy consumption

The construction of roads and sewers is expensive and energy intensive, and since new development tends to follow these service networks, they contribute to urban sprawl. Thus, proponents of energy-efficient land use believe that new development should be planned, whenever possible, in areas that are already serviced by roads and sewers.

Highway systems built since the 1950s have improved transportation efficiency. However, they have also provided people with

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1/George E. Peterson and Dale J. Keyes, Urban Development Patterns, the Urban Land Institute, December 1980 (draft), p. 84.

2/Robert M. Byrne, Libby Hawland, Background Information Prepared for the Council on Development Choices for the 80s, Urban Land Institute, March 1980, p. 60.

3/A cogeneration plant simultaneously produces electricity and heat energy. District heating is the distribution of heat from a central source to consumers in surrounding areas.

increased opportunities to move farther from the central cities, causing sprawl-type development. This is considered very energy inefficient because it increases dependence on energy intensive automobile travel.

Increased concern for the environment has fostered extensive new sewer construction and has prompted many communities to intentionally attract more new development in order to pay for the sewers through user charges and connection fees. Further, sewer systems are often built with excess capacity to serve future population projections that may never develop. High Federal subsidies (up to 75 percent or more) also encourage the construction of large sewers with vast amounts of excess capacity for growth. These subsidies entice large projects that lead to the sudden development of huge land areas and tend to further promote low-density development. Thus, when planning new communities or redeveloped areas, it is important that the energy implications of road and sewer projects be considered.

Planned low-density development can also result in energy savings

A simulation study examining the energy impacts of future growth options in Trenton, New Jersey, shows that planned low-density residential areas can also realize significant energy savings ranging from 20 to 35 percent. 1/ One of the options considered relates to low-density urban spatial arrangements such as greater home-to-work proximity. The option which relates directly to development patterns assumes that people will keep their preference for low-density living but will select living areas closer to work. Also, employers are assumed to cluster into a few large employment centers throughout the metropolitan area. Low-density residential complexes around these centers greatly reduce the amount of travel to and from work. The estimated energy savings are 20 percent by 1985 and 35 percent by 2000 over a more typical sprawling pattern.

The National Association of Home Builders offers several suggestions for achieving energy efficiency in low-density housing in its publication, "Planning for Housing." One concept is the replacement of conventional subdivision development like that shown in Figure 7A with an energy-efficient cluster arrangement as shown in Figure 7B.

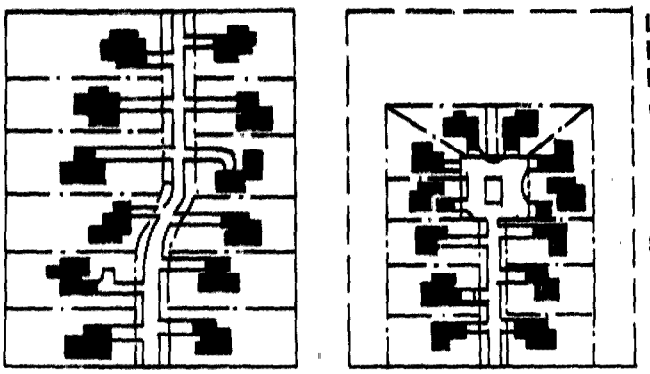
1/Duncan Erley, David Mosena, and Efram Gil, Energy Efficient Land Use, American Planning Association, May 1979.

FIGURE 7A

CONVENTIONAL

FIGURE 7B

CLUSTER DEVELOPMENT



Instead of all land being subdivided into individually owned lots, some undeveloped land is preserved as open space for community use

Structures are arranged in closely related groups around cul-de-sacs, courts or short loop streets

SUBDIVISION DEVELOPMENT

SOURCE: NATIONAL ASSOCIATION OF HOME BUILDERS, PLANNING FOR HOUSING, 1980

In the conventional development, the land was subdivided into individually owned lots and all dwellings faced long linear through streets. In contrast, in the energy-efficient arrangement, dwellings were arranged in closely related groups around cul-de-sacs or courts and some undeveloped land was preserved as open space for community use. The open land may be used for recreational activities, thus reducing automobile travel to more distant sites.

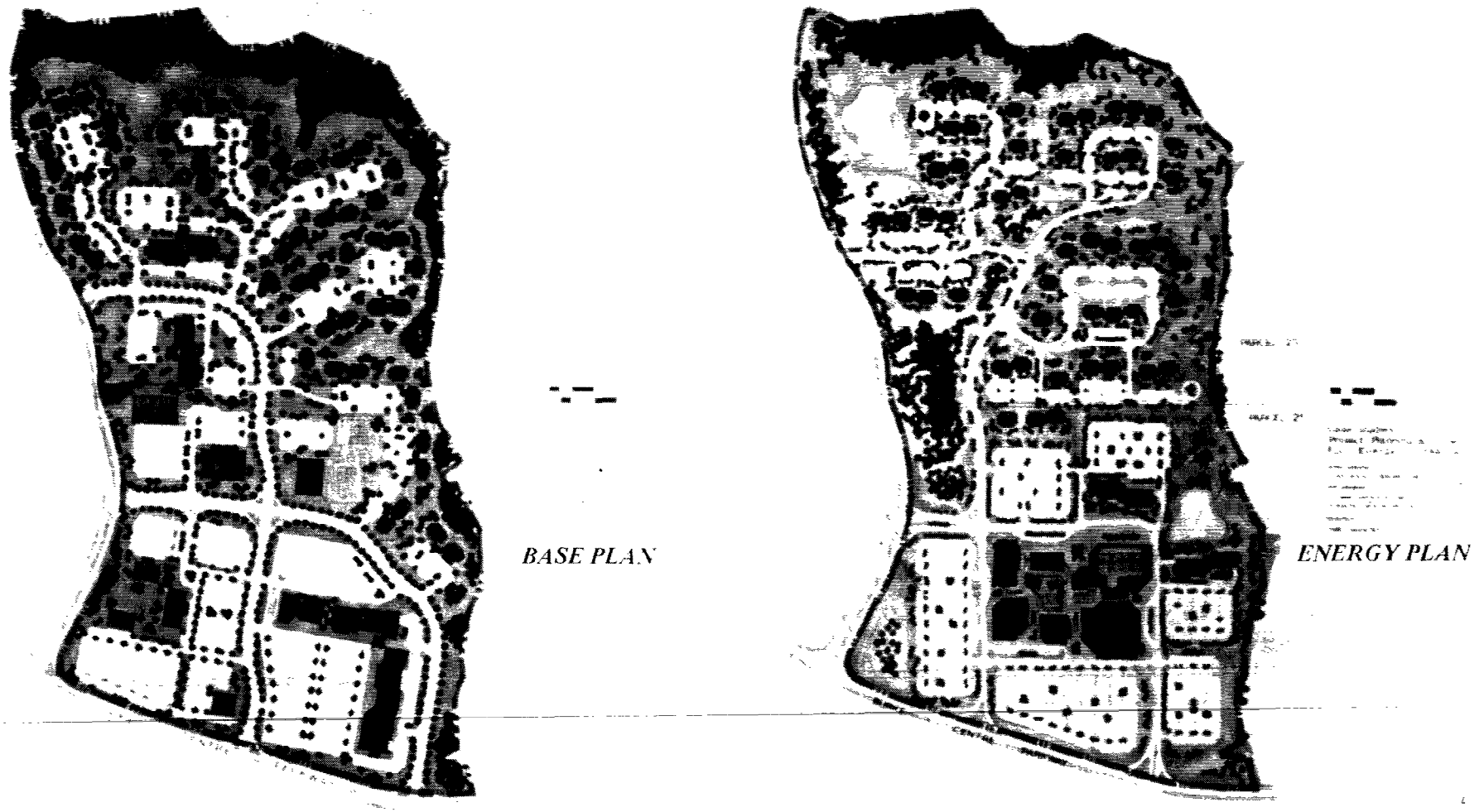
EMPLOYING SITE AND BUILDING DESIGN, LOCATION, AND HIGH-DENSITY CONCEPTS IN A PLANNED COMMUNITY

Communities can be planned that employ all or most of the concepts previously discussed in this chapter. Figure 8 contrasts a conventional community design with an energy-efficient design for Burke Center--a community being planned in Burke, Virginia, under DOE's Site and Neighborhood Design program. The Burke Center energy plan employs the same principles as those shown in figure 7, but on a community level.

The conventional plan is not as energy-efficient because, among other things, it fails to orientate buildings to take advantage of the natural environment, no attempt is made to cut down on trip lengths and encourage walking, and a substantial number of single-use dwellings resulted in excessive outside wall surfaces. In contrast, the energy plan sites buildings to take advantage of winter solar heat gain and natural vegetation, clusters activities close to each other, and calls for more multi-use and multifamily dwellings. Note the use of clustering, east/west street orientation, bike paths and the general compact layout of the energy plan.

FIGURE 8

Comparison of an Energy-Efficient Plan to a Conventional Plan for Burke Center, Virginia



Source: The Department of Energy

CONCLUSIONS

This chapter identifies and discusses the various concepts and ideas applicable to carrying out energy-conscious land use management. This information was essentially extracted from studies that specifically addressed the energy savings potential and pertinent issues of energy-efficient land use. Based on our analysis of the studies and interviews with various authors and experts, we believe considerable potential to achieve energy savings exists by applying energy-efficient land use concepts. Although we recognize the savings are only estimates and the studies do have limitations, there appears to be little doubt that energy savings can be achieved. The studies indicate that energy savings of up to 60 percent can be realized when planning new growth and development in communities.

The energy savings potential exists in both the site and building design and the locational planning and density aspects of land use. However, site and building design concepts are likely to gain acceptance faster than locational planning and high-density concepts because the energy savings in site and building design are easier to estimate and quantify and can be done on a small scale (e.g., individual houses and small neighborhoods). Implementation of site and building design concepts also requires the coordination and cooperation of fewer land use decisionmakers and would likely meet less public resistance.

Willing communities may be able to achieve even greater energy savings by applying energy-efficient locational planning for a region or metropolitan area. Since this type of planning would generally spread across local government boundaries, it would be more difficult to accomplish because it would require higher level government involvement and cooperation at the regional Council of Government, county, or State levels. It would also require close scrutiny over the energy impact of road and sewer projects.

Energy-efficient land use concepts involving higher densities may meet strong resistance. However, as the price of energy increases and more people become unable to afford single-family dwellings, the location and high-density aspects of energy-efficient land use could become more attractive.

Given the energy savings potential of these concepts, why then are communities and other land use decisionmakers not moving to adopt the concepts and reap the benefits? The progress to date and the barriers that various land use decisionmakers face are discussed in the following chapter.

CHAPTER 3

COMMUNITIES, BUILDERS AND DEVELOPERS, FINANCIAL INSTITUTIONS, AND CONSUMERS ARE RELUCTANT TO ADOPT ENERGY-EFFICIENT LAND USE CONCEPTS

Decisions on the way land is used in a community are made by local officials, builders and developers, financial institutions, and the public. Many of these decisionmakers believe there is potential to save energy through land use, however, they are reluctant to accept and use energy-efficient land use concepts such as site and building design, locational planning, and high-density development. The major barriers include the cost of implementing the concepts, the lack of hard data that clearly demonstrate the energy savings and costs, and a strong community resistance to higher densities.

Regional and State governments are two other entities which have the potential for influencing local land use decisions. Because regional governments are involved in areawide planning that cuts across local boundaries, they are in a unique position of looking at land use issues from a broad metropolitan area perspective. State governments, on the other hand, can influence land use decisions through various means such as the leverage they hold in providing and distributing State and Federal funds. Both of these entities have a similar barrier; the role they play is mostly advisory, and they need funding assistance to support energy-efficient land use efforts.

BARRIERS EXPERIENCED BY LOCAL COMMUNITY OFFICIALS

Local government officials are important to implementing energy-efficient land use concepts because they have direct authority over land development in the community. This authority is exercised through zoning regulations and ordinances that control the type of development (e.g., commercial v. residential) and set specifications for new construction (e.g., set back requirements and building codes). The barriers that discourage local government officials from considering energy in their land use decisions are related to two distinct roles. In their role as administrators, local government officials identified the following major barriers:

--Lack of hard data that demonstrate what the community can do to save energy through land use and the costs associated with these measures.

--Lack of funds to carry out local energy-efficient land use planning and implementation efforts.

--Lack of incentives because of no direct and immediate payback to the municipal government for considering energy in land use decisions. The cost savings would be realized by the general populace, not the governmental unit.

In their role as public servants, they generally see themselves as representatives of the community, and to date their public has opposed energy-saving land use measures, such as high-density, for fear of neighborhood deterioration. For example, in Seattle, an 8-to-10 acre site was proposed for a high-density housing project. However, the neighbors protested and the city of Seattle disapproved the project. In another case, a proposal was made to build low-cost multifamily housing for the elderly at an in-city site. The city approved the project, but the neighbors fought the project in court. The court found for the opponents, indicating that Seattle had a formal policy of promoting single-family residences and could not zone contrary to that policy.

BARRIERS EXPERIENCED BY BUILDERS AND DEVELOPERS

Builders and developers play a very important role in determining where development takes place, how tracts of land are laid out, and the type of structures that are to be built. In making these decisions, their primary motivation is profit. Thus, they attempt to build in the more marketable areas of the community and build structures that will be acceptable to their buyers. Our discussions with building associations and individual builders and developers in three diverse areas of the country disclosed that the major barriers they face are public acceptance and sensitivity to cost.

In discussing public acceptance, several builders pointed out that they would be receptive to building multifamily housing because it is cheaper to build and fewer people can afford single-family housing. However, the resistance to this type of development comes from people who already own single-family dwellings. These people purchased homes when the prices were more reasonable and have now become the decisionmakers in their communities. In order to protect their investment, they oppose multifamily development in their neighborhoods.

Builders and developers also raised several examples of their sensitivity to the cost of constructing energy-efficient buildings. They pointed out that energy-efficient site and building design is less appealing to them if it means fewer building lots on a tract of land. For example, by designing a subdivision with maximum east/west street orientation, developers may not be able to subdivide their lots to get a maximum return on their investment. Also, many

developers and builders referred to the delicate financial condition of the industry. Housing is expensive enough for most consumers without energy extras, and developers and builders are afraid of pricing themselves out of the market.

A study by the Urban Land Institute 1/ supports the opinions expressed by the builders and developers we interviewed. The study identifies the most significant barriers to be (1) the lack of credible and usable information, (2) uncertainty over the return on investments, (3) risks of non-acceptance by the public, and (4) local regulations that prevent implementation of the concepts.

BARRIERS EXPERIENCED BY FINANCIAL INSTITUTIONS

Financial institutions have the monetary resources that most developers, builders, and the public rely on to underwrite any new development, construction, or purchase, respectively. Primary lenders such as banks and savings and loan associations lend money to developers and builders and also supply mortgage money to consumers to buy these properties. Other entities such as the Veterans Administration (VA) and the Federal Housing Administration (FHA) influence the mortgage market by offering loan guarantees to primary lenders. Organizations such as the Federal Home Loan Mortgage Corporation (FHLMC) and the Federal National Mortgage Association (FNMA) also can stimulate more mortgage loan activity by providing a secondary mortgage market in which primary lenders can sell their existing loan holdings and use the proceeds to make new loans.

Representatives of the financial institutions we interviewed expressed concern about the lack of public acceptance of energy-efficient land use measures and consequently the stability of their investments. Although their experiences have been in the area of the more well-known energy conservation measures such as insulation, solar heat, etc., the positions they take in regard to energy conservation are also applicable to energy-efficient land use concepts such as site design. The major concern expressed by representatives of financial institutions is that energy-saving features generally add to the cost of a home in a time when many people cannot afford a home. Nevertheless, several of them felt that banks would be willing to invest in a more innovative energy-saving structure provided they could be assured of recovering their investment in the event of a default on the loan. They also pointed out that not enough good information is available on the energy savings that can be derived from various energy-saving measures. So, while one consumer may take

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1/Donald E. Priest, Libby Howland, and Robert M. Byrne, "Energy Conservation Through Large-Scale Development: Prospects and Problems," Washington, D.C., December 1979, pp. 10, 15, 17, 18, and 20 to 21.

the risk of investing in energy-saving features of a home, if that consumer subsequently defaults on the loan, the financial institution may not be able to get anyone else to pay for the "energy extras."

BARRIERS EXPERIENCED BY THE PUBLIC

Most importantly, the public exerts its voting power over local officials, and exerts power in the market over builders and developers, and financial institutions. Local officials can be voted out of office if their land use actions do not correspond with the wishes of the community. Developers and builders must have a ready market for their developments and/or individual structures to stay in business. And financial institutions, through their appraisers, try to be certain that the public perceives a real value in a project, at least commensurate with the institution's investment.

Many consumers are (1) financially unable to spend additional funds needed to include energy-efficient site and building design concepts in their homes, (2) uninformed about the energy-saving advantages and costs, and (3) very skeptical about high-density development and multifamily housing. Comments made by several real estate representatives put the public's attitude in perspective. The two following comments are illustrative:

--Housing is very expensive and buyers are scraping just to get into a house. Factors of most concern to prospective buyers are cost, location, financial arrangements and the number of bedrooms, rather than energy-saving features such as site design.

--The lack of information, and methods for measuring impact are the principal reasons why individuals do not consider energy-efficient land use concepts in their decisions.

BARRIERS EXPERIENCED BY REGIONAL AND STATE GOVERNMENTS

In support of the local community role mentioned above, regional and State governments have the potential to affect the extent and direction of the local land use planning process. Since they often lack funds to carry out such efforts, most regional and State governments have not been too involved in energy-efficient land use planning and decisionmaking.

Although most States have relinquished direct authority over local land use decisions, States can still play important roles because they (1) provide State aid funds to local communities, (2) serve as collection and dissemination points for information, and (3) often act as a conduit for distributing Federal funds. Furthermore, States can pass and implement legislation to achieve energy conservation through land use measures.

Regional or areawide planning agencies, commonly called Councils of Government (COGs), attempt to coordinate planning and development decisions of local communities. In this regard, many COGs prepare regional land use plans that are intended to balance the needs of the region against the desires of the local communities. These regional plans generally take the form of broad policy guidelines that address factors such as sewers, transportation systems, and the location of growth and development. The planning focuses on urban design that guides development in more desirable urban patterns. Many of these planning efforts have received financial support from the Federal Government, particularly HUD's "701" Comprehensive Planning Assistance Program, which is discussed in more detail in chapter 4.

In relation to the areawide plans, COGs can influence land use decisions through the federally mandated A-95 review process. This process requires applicants for Federal loans or grants involving planning or construction of public works projects to submit their applications to an areawide planning organization. This organization reviews the proposed project for its consistency and fulfillment with areawide planning objectives and policies and then submits comments to the responsible Federal agency. Although the Federal agency considers the areawide agency review to be strictly advisory, this process, along with the coordinating and planning functions performed by these entities, offers opportunities to influence local land use decisions.

The States and COGs have similar barriers in regard to energy-efficient land use. With home rule still being predominant, most States do not have real authority over land use decisions made at the community level. Similarly, most COGs function in a strictly advisory capacity and therefore do not have the power to actually make land use decisions.

State and regional governments are also experiencing budget problems and belt tightening. Without some type of outside funding support, State and regional governments are not likely to get involved in programs that involve energy-efficient land use. The proposed elimination of HUD's "701" Program, as discussed in chapter 4, will significantly curtail the COGs' areawide planning activities.

ENERGY-EFFICIENT LAND USE HAS OCCURRED ON A LIMITED BASIS AND UNDER SPECIAL CIRCUMSTANCES

Land use has not been totally ignored as a way to conserve energy, and there are positive examples of States, communities, and builders and developers which have taken action in this area. For example, in response to the 1973-74 oil embargo and a severe regional drought, Oregon enacted a land use bill which requires local governments to develop comprehensive plans in conformity with statewide goals approved by the Land Conservation and Development Commission. One of the Commission's goals, which relates directly to energy-efficient land use, states:

"Land and uses on the land shall be managed or controlled so as to maximize the conservation of all forms of energy, based on economic principles."

The city of Portland, in response to this goal, established a comprehensive policy that has received nationwide publicity. Responding to self-initiated goals such as (1) reducing trip length and need to travel, (2) promoting medium- and high-density use near transit lines, and (3) promoting attached and close-in housing, Portland is considering

--downsizing certain areas for increased density,

--decreasing the number of parking spaces available to encourage mass transit, and

--allowing new construction concepts such as common wall construction and cluster housing.

Vermont is also taking progressive land use energy conservation actions. Soaring energy costs plus a relatively low per capita income have made energy conservation very important to Vermont. Consequently, Vermont has taken a number of actions, including (1) legislation requiring that housing projects of 10 or more units, and commercial and industrial development of over 10 acres incorporate energy-efficient technologies; (2) a resolution urging communities to exempt alternative energy sources from property taxation; and (3) consideration of energy costs in the Vermont Housing Finance Agency (VHFA) eligibility formulas for purchasing mortgages. VHFA is also setting limits in its eligibility criteria on the distance that new single- and multi-family dwelling development can be located from existing settlements, and it is excluding builders which construct developments outside the distance limit from VHFA programs.

Individual builders and developers have adopted energy-conscious site design techniques on their own initiative in their development and new construction, and some financial institutions are actively supporting energy-conscious land use. For example, a builder in the Midwest has had a good degree of success building approximately 25 custom houses that use energy-efficient site design and passive solar techniques. According to the builder, the lower initial cost and virtually maintenance-free operation of passive solar is becoming more attractive to the buyer.

CONCLUSIONS

Local community officials, builders and developers, financial institutions, the public, and, to some extent, State and regional governments determine how communities use their land. We believe the major barrier to adopting energy-efficient land use concepts is public acceptance. This lack of public acceptance relates to the public's concern over the added cost of implementing the

concepts, a lack of hard data that clearly demonstrate the advantages and costs, and a strong community skepticism about the effects of high-density development.

The barriers to the acceptance and use of energy-efficient land use concepts are formidable, and we recognize that the market place is an important factor for bringing about change. In this respect, as the price of energy increases and more people become unable to afford single-family dwellings, the use of energy-efficient, high-density dwellings could become more receptive. However, as discussed in the following chapter, certain actions can be taken to make these market forces work better.

CHAPTER 4

THE FEDERAL ROLE IN ENCOURAGING ENERGY-EFFICIENT LAND USE

The Federal Government's role in stimulating interest and activity in energy-efficient land use is changing. At the time we began our work, the Federal role was one of initiating guidance through urban policy formulation, supporting research and development programs, and providing financial assistance for comprehensive planning. Both the Departments of Energy and Housing and Urban Development have been involved with plans and programs to carry out this role. DOE programs were designed to foster the acceptance of energy-efficient land use and address many of the barriers that inhibit use of the concepts. The HUD programs provided financial assistance for comprehensive land use planning and policy direction for energy-efficient development.

In addition to plans and programs of DOE and HUD, we also identified other programs and mechanisms, such as a Federal income tax credit, an executive order, and the secondary mortgage market, which could provide other means by which the Federal Government could encourage the use of energy-efficient land use concepts. Since many of these plans and programs are either undergoing change or being terminated as evidenced by the 1982 budget decisions, a number of issues must be resolved with respect to the Federal Government's role in encouraging energy-efficient land use management.

SHOULD DOE SUPPORT ENERGY-EFFICIENT LAND USE PROGRAMS?

Although DOE has not recognized land use as a means of achieving energy efficiency in its formal policies, it has funded several long-term research programs directed toward developing communities that employ energy-efficient land use concepts. The programs focused on the barriers faced by State and local officials, builders and developers, and financial institutions, such as the lack of hard data on cost and energy savings. Even though they appear to be in line with the administration's policy of funding long-term research that will not be addressed by the private sector, they were terminated in fiscal year 1982 because of budget cuts. These programs include the Site and Neighborhood Design (SAND), the Comprehensive Community Energy Management Program (CCEMP), and the Redevelopment Master Plan of Atlantic City.

SAND was planned as a 12-year, $23.6-million program that was scheduled for completion in 1990. Work was to be accomplished in three phases. Phase I was to provide models of successful approaches and techniques for developing an energy-efficient plan.

Phase II was designed to develop model regulatory procedures which would be more responsive to energy-saving measures and concepts. Phase III was to demonstrate that energy-efficient development can be built and marketed to minimize the use of scarce fuels. Phase I, which is complete, has generated information on the concepts and institutional barriers discussed in chapters 2 and 3. It showed that reductions of 20 to 60 percent in annual on-site energy consumption are achievable and that builders and developers can be persuaded to plan and develop energy-efficient communities. It also provided new information on energy savings which considers unique characteristics such as different climates and energy resources.

CCEMP, planned as a $22-million research and development program, started in 1978 and was scheduled for completion in 1987. Seventeen communities have received funds to prepare comprehensive energy management plans. Communities were given wide latitude on the type of energy-conserving measures they can include, and some of them have incorporated energy-efficient land use concepts in their plans. For example, the Toledo Metropolitan Council of Governments plan contains provisions to discourage urban sprawl and to promote energy-efficient site and building design, mixed-use development, and multifamily dwellings. One objective of the program was to prepare a guidebook that could be used by other communities interested in preparing comprehensive community energy management plans. This guide would address some of the barriers faced by local land use decisionmakers such as the need for (1) educational materials that explain the concepts and (2) methodologies and tools for preparing comprehensive community energy management plans.

The Energy Integrating Master Plan for the city of Atlantic City, New Jersey, was a $200,000 effort to demonstrate energy-efficient master planning for a redeveloped urban community. The program's objective was to provide a case study that could be used by other urban communities in planning the redevelopment of an area, and for DOE to ultimately form policies and take action to overcome institutional barriers to energy-efficient planning in an urban community undergoing redevelopment. The Master Plan was completed and published in 1978, and adopted by the Atlantic City Planning Board in 1979. Atlantic City is currently implementing the building envelope part of the plan, which includes site and building design features such as south facing glass, shading of walls and windows, and overhangs. DOE also considers the Atlantic City Project successful because it demonstrates that a practical energy plan can be devised for a redevelopment community.

The research programs discussed above were focusing on energy-efficient land use concepts such as site and building design, locational planning, and multifamily housing. Furthermore, much of the work was directed at alleviating the barriers

which the local decisionmakers face in implementing energy efficient land use concepts such as (1) the lack of credible and visable information, (2) uncertainty over the return on investments, (3) risk of nonacceptance by the public, and (4) local regulations that prevent implementation of the concepts.

Under the administration's fiscal year 1982 budget, these community systems programs have been terminated. The administration has taken the position that financial support for research, development, and demonstration programs should be limited to long-term research that is too risky to be undertaken by private concerns. Based on the nature of these programs, and discussions with community officials, researchers, and a DOE official, we believe these programs are long-term research efforts which will not be pursued by the private sector. Builders, developers, and financial institutions hesitate to take market risks associated with the cost and sale of experimental concepts unless hard data on energy and cost savings are available to show that it will be financially beneficial. Local community officials likewise are not in a position to experiment with concepts that have not been adequately demonstrated and have long-range benefits since they must give priority to projects that are of immediate concern to their communities.

Conclusion

DOE is in a position to stimulate interest and activity in energy-efficient land use. This could be accomplished by including it as an element in DOE's policies and/or supporting research and development programs designed to reduce uncertainty about implementing energy-efficient land use concepts. We believe that the benefits in increased energy efficiency through use of these concepts are significant enough to warrant at least a minimal level of research to address the barriers that impede its acceptance.

Recommendation

We recommend that the Secretary of Energy, when evaluating and analyzing funding priorities for long-term research and development programs for fiscal year 1983, determine what, if any, supporting efforts should be undertaken to address the feasibility, advantages, and barriers of applying energy-efficient land use concepts in communities.

SHOULD HUD EMPHASIZE THE IMPORTANCE OF AREAWIDE PLANNING?

HUD has recognized energy-efficient community development in its 1980 urban policies; however, because of the uncertainty over whether the administration will support this policy, only

limited action has been taken to implement it. In addition, HUD has been providing financial assistance to regional, State, and local governmental agencies for comprehensive planning purposes through its "701" grant program. This program has been repealed by the Omnibus Budget Reconciliation Act of 1981, and although the program activities have been made eligible for funding under HUD's Community Development Block Grant (CDBG) program, they are not required. Therefore, regional planning agencies could be forced to curtail the preparation of land use plans that cut across local governmental boundaries due to a lack of funds. We believe that a need exists for HUD to determine whether it should emphasize to States and local communities the importance of comprehensive areawide planning as a means of encouraging energy efficiency in the land use decisionmaking process.

Regional planning agencies have been organized in many metropolitan areas, and one of their primary functions is to coordinate planning and development decisions. These agencies have the potential to influence energy-efficient land use through (1) areawide planning, (2) A-95 review authority under Federal programs, and (3) public information and local government assistance programs. Regional planning agencies are concerned with a comprehensive approach to examine the total effect of a proposal on the region. The A-95 review process provides regional agencies with the authority to review and comment on whether a Federal project is consistent with areawide comprehensive planning as discussed in chapter 3. They are often able to develop and disseminate information and provide communities with technical assistance for local planning when it is not feasible for local governments to do so.

HUD's Comprehensive Planning Assistance Program (commonly referred to as the "701" program) was initiated in 1954. The program provided financial support to State, regional, and local governments for upgrading their planning and management capabilities. Grant recipients were required to prepare plans that would conserve existing communities by promoting orderly and efficient growth and development. Because the program provided money for land use planning on a regional level and considered factors such as the location of roads and sewers, it had the potential for encouraging communities to consider energy in their land use decisions. In this regard, HUD had previously made rule changes to provide guidance to grant recipients concerning energy-efficient planning concepts. One rule change suggests that grantees consider patterns of existing and future land use and relate to energy conservation factors such as transportation and population mobility. As of September 30, 1980, about $948 million had been expended for planning assistance through the "701" program, and approximately $19 million 1/ was appropriated for fiscal year 1981.

1/Adjusted for 1981 rescission of about $15 million.

The administration's proposed 1982 budget eliminates the "701" planning assistance program because the administration believes that the program has accomplished its primary objective of developing sub-national planning capabilities and that general planning assistance, apart from implementation, is ineffective. Also, the administration believes that, to the extent States and localities benefiting from the program find it worthwhile and of a high priority, they can provide funding or use block grants or general revenue sharing funds for this purpose. The Congress, in the Omnibus Budget Reconciliation Act of 1981 (P.L. 97-35), repealed the "701" Comprehensive Planning Assistance Program and combined the "701" activities with HUD's Community Development Block Grant Program.

The combination of the "701" program with the block grant program results in the loss of direct funding to regional planning organizations for areawide planning. Therefore, unless States and local communities choose to purchase areawide planning services, regional planning organizations could be forced to curtail much of their planning efforts. Under the "701" program, the metropolitan and nonmetropolitan regional planning organizations received about $17 million of the $19 million authorized for fiscal year 1981.

The American Planning Association (APA) has indicated support of actions that would encourage areawide planning activities. In its opinion, much still needs to be done regarding community development planning, and APA has proposed that a portion of every block grant should be allocated for planning, management, and periodic evaluation of the supported programs.

Conclusion

HUD's action to recognize energy-efficient community development in its formal policies is an important step in demonstrating the Federal Government's commitment to this goal. In addition to policy commitment, we believe HUD needs to emphasize the importance that areawide planning could have in influencing energy-efficient land development. Although the Omnibus Act contains no provision to provide direct funding to regional planning agencies, the act allows States and local governments to use their CDBG moneys to fund areawide planning. However, CDBG recipients may elect to curtail or possibly eliminate their planning activities.

The existing structure of regional planning agencies provides a means for examining energy-efficient land use issues in a comprehensive and coordinated manner. For example, through areawide plans, regional agencies have the potential to influence development patterns and energy demand by the energy-efficient location of roads and sewer systems, which are major contributers to growth, as discussed in chapter 2. Although regional planning agencies have other functions, we believe that their areawide planning

function provides an opportunity to encourage energy-efficient land use patterns. Therefore, in our opinion, HUD should consider whether an effort should be initiated to emphasize the importance of areawide planning in the land use decisionmaking process.

Recommendation

In view of the importance of energy-efficient land use and the uncertain priority that States and local communities will place on the concepts, we recommend that the Secretary of Housing and Urban Development determine the extent, if any, to which it needs to emphasize the importance of areawide planning to State and local governments in increasing energy efficiency through the land use decisionmaking process.

SHOULD TAX CREDITS BE USED TO ENCOURAGE ENERGY-EFFICIENT SITE AND BUILDING DESIGN CONCEPTS?

Federal income tax credits for investments in passive solar systems would be an excellent means of providing financial incentives for builders and developers to use energy-efficient site and building design concepts. Tax credits are currently available to homeowners for installing passive solar heating systems in their homes; however, the Internal Revenue Service's (IRS's) restrictive eligibility requirements have caused considerable confusion over what components of the system are eligible for the credit. New legislation has been introduced in the Congress to provide tax credits directly to builders and developers for incorporating passive solar systems into their buildings. Unless this legislation is very specific about the eligibility of components that serve a dual purpose--a structural part of the building and a component of the passive solar system--it could be subject to the same restrictive interpretation that was put on the previous credit to homeowners and would not provide the maximum incentive.

A passive solar system's effectiveness in reducing energy consumption depends on the use of energy-efficient site and building design techniques such as maximizing southern window exposure, overhangs, and proper placement of trees and vegetation. Thus, tax credits for passive solar could also provide incentives for builders and developers to adopt some of the site and building design concepts discussed in chapter 2.

The Energy Tax Act of 1978 (P.L. 95-618, Nov. 19, 1978), as amended, provides a tax credit to homeowners for renewable energy source expenditures. In accordance with provisions of the act, IRS Instruction 903 states that a taxpayer may receive a 40-percent credit on the first $10,000 cost of a passive solar

system. To qualify, the system must include (1) a solar collection area, (2) an absorber, (3) a storage mass, (4) a heat distribution method, and (5) a heat regulation device. The IRS instruction further states that materials that serve a significant structural function or are structural components of a house, and labor costs of installing such materials and components, do not qualify for the credit. This restriction causes considerable confusion over which features of a passive solar system serve a significant structural function or are not structural components of a house. For example, a trombe wall (a south facing wall composed of a mass wall and other glazing) serves as an absorber and a storage mass. However, according to the IRS instruction, because the trombe wall serves as a significant structural component, only costs associated with outer (non-window) glazing, shading, venting, and heating distributors qualify. When questioned about the type of component that would be eligible, IRS taxpayer service personnel were unable to provide definitive guidance concerning the eligibility of passive solar equipment. They said that since the law is vague, the issue would probably not be better defined until a case is decided in court.

Several bills (e.g., H.R. 1960, H.R. 1963, and S. 498) have been introduced in the 97th Congress that would amend the Internal Revenue Code to provide tax credits to home builders for constructing residences that incorporate certain passive solar features. According to the bills, the amount of the credit, up to a maximum of $2,000, would be based on solar construction credit tables which consider factors such as the amount of insulation in floors, walls, and ceilings, and the number of panes of glass. Based on this criterion, residences can be placed in one of eight categories, ranging from one having no insulation to one having the maximum amount.

The bills define passive solar the same way it is defined in IRS Instruction 903. Although the language in the bills does not indicate that components that serve a significant structural component of the dwelling unit would be excluded from the tax credit, they do not make it clear that components serving a dual purpose of being a structural and passive solar component are eligible for the tax credit. Thus, this new legislation could be subject to restrictions similar to those placed on the previous passive solar credit and cause further confusion and uncertainty to potential users.

Recommendation

We recommend that the Committee on Ways and Means, House of Representatives, and the Committee on Finance, U.S. Senate, if they wish to provide a maximum incentive, clarify the proposed legislation to provide that components which serve a dual purpose of being a structural and passive solar system component are eligible for the tax credit. (See app. III for suggested clarification to proposed legislation.)

SHOULD OTHER EXISTING MECHANISMS BE USED TO ENCOURAGE ENERGY-EFFICIENT LAND USE?

There are a number of other existing mechanisms and programs that can be used to channel information on energy efficient land use concepts to decisionmakers at the community level. These include (1) Executive Order 12185 and the Interagency Coordinating Council, (2) the secondary mortgage market, and (3) applicable Environmental Protection Agency (EPA) and Department of Transportation (DOT) sewer and transportation system programs. Several of these mechanisms have been used to promote energy conservation; however, in only a few instances have they been used to foster energy-efficient land use.

Executive Order 12185 and the Interagency Coordinating Council

Executive Order 12185 requires Federal agencies to develop, and put into effect, rules aimed at getting recipients of Federal financial assistance programs to conserve petroleum and natural gas. Although the order does not specifically mention energy conservation through land use, financial assistance programs which have community land use implications can be an excellent vehicle for getting Federal agencies, areawide planning organizations, States, and local governments to consider energy in their land use decisions.

Because it is Governmentwide in scope, Executive Order 12185 is being implemented through the President's Interagency Coordinating Council. The Council is composed of key program managers from each domestic agency in the executive branch and is charged with working with executive agencies to involve all levels of Government and the private sector into a partnership to strengthen and conserve American communities.

In response to the executive order, a number of Federal agencies have made changes to some of their financial assistance programs. For example, the Farmers Home Administration has made several changes in its financial assistance programs to increase incentives for conserving petroleum and natural gas. One change requires builders and developers, in their planning and site development work, to demonstrate how energy considerations influence selection and development of the site. This analysis is to include the energy required for site preparation, installing utilities, and vehicle transportation of the occupants.

We believe that Executive Order 12185 is an excellent mechanism to promote energy-efficient land use at all levels of government. And since DOE and HUD are active members of the

Interagency Council, they could use this means to pool their resources and provide guidance to other agencies concerning the potential for conserving energy through Federal assistance programs which have an impact on land use.

Secondary mortgage market

Secondary mortgage market entities could provide more incentives to builders, developers, and the public for investing in energy-efficient site and building design concepts if the market entities were more aware and able to measure the energy saving aspects of the concepts. Organizations such as VA, FHA, FHLMC, and FHMA influence decisions of primary lenders because they provide a secondary market which either secures a mortgage or allows the primary lender to liquidate existing loans and use the proceeds for new ones.

We found that secondary mortgage market entities are making it easier for applicants to qualify for a loan if the building they intend to buy is energy efficient. This is done through mortgage eligibility criteria, which allow the buyers of an energy-efficient building to have a higher debt-to-income ratio. In assessing the buildings' energy efficiency, the primary lenders consider some of the more well-known energy saving measures such as the amount of insulation and the type of storm windows and doors. However, as mentioned in chapter 3, the primary lenders are not familiar with energy-saving site and building design concepts, and their appraisers are generally not versed in measuring energy savings attributable to the concepts.

Secondary mortgage market officials acknowledged that accounting for energy costs is difficult due to factors such as individual living habits and climatic conditions. Nevertheless, they said they are willing to work toward more energy-efficient housing because they recognize the growing importance of energy costs in the mortgagee's ability to afford a home. A DOE official said DOE has plans for working with the secondary mortgage markets to help them better define the impact of energy costs on mortgage eligibility formulas. We support DOE's plan to help secondary mortgage markets provide guidance to primary lenders on assessing the energy costs of a building. We also believe that energy-efficient site and building design should be a major element in this education effort.

Environmental Protection Agency programs

EPA is in a good position to influence urban development patterns because it provides Federal subsidies of 75 percent or more for the construction of sewer systems. The concept of locational planning is important to energy-efficient land use because it involves decisions being made on the location of

energy-intensive infrastructure systems such as roads and sewers. Because new growth tends to follow these infrastructure networks, haphazard construction of these systems encourages energy-inefficient urban sprawl.

Under an EPA policy to discourage the conversion of farmland to urban development, it has taken steps to preclude new sewer construction in rural areas. In some instances, however, EPA has provided funds for new sewage treatment systems that were not needed. In a May 1980 report, 1/ we cited several small community facility plans that did not adequately justify Federal funding for new sewage treatment systems. The communities were concerned about the potential growth associated with the sewer development projects and the dramatic change these projects can cause in a community. In these instances, the sewer lines covered large areas of undeveloped land which could lead to rapid growth and urban sprawl in the area.

In our view, the EPA sewage development projects offer significant opportunities to encourage energy-efficient land use development. We believe that DOE and HUD, through mechanisms such as Executive Order 12185 and the Interagency Coordinating Council, should work with EPA to see that the concepts of energy-efficient land use are given more consideration in its planning and program activities.

Department of Transportation programs

The location and direction of transportation systems also have a profound impact on where new growth and development take place. DOT was created to develop national transportation policies and programs for safe, fast, efficient, and convenient transportation that is compatible with other national objectives, including the efficient use and conservation of natural resources. DOT's control over the planning process for major highways and transportation systems, together with its control over the financial resources needed to construct the facilities, provides it with an excellent potential for influencing urban land use patterns and development.

DOT has taken several positive actions. It has established joint planning regulations for the Federal Highway Administration and Urban Mass Transit Administration to ensure that urban areas receiving Federal funds have transportation plans and programs which are consistent with urban development plans. In response to Executive Order 12185, DOT issued regulations designed to ensure

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1/"EPA Should Help Small Communities Cope with Federal Pollution Control Requirements," CED-80-92, May 30, 1980.

that the energy impacts of public transportation projects proposed for Federal assistance be identified and considered in local system planning and in project design. Applicants were advised that particular attention would be given to the energy used in construction versus the direct energy savings over the life of the project. Also DOT, through an interagency agreement with DOE, established a research program to provide urban areas with technical and procedural guidance on how energy considerations can be incorporated into the local transportation planning process. The objectives of the program are to demonstrate and test innovative management techniques for incorporating energy conservation into the transportation-planning process and to use the results to develop and transmit guidance to local planning agencies.

Joint planning regulations and interagency programs of this type have the potential of achieving energy savings through transportation planning at the local level. They also provide a means of giving positive direction to States, areawide planning agencies, and local governments to consider the energy implications of their land use decisions.

RECOMMENDATIONS

We recommend that the Secretary of Energy, in consultation and cooperation with the Secretary of Housing and Urban Development, provide guidance and assistance to Federal agencies on how energy considerations can be included in programs that affect land use. This guidance can be given through existing mechanisms such as Executive Order 12185 and the Interagency Coordinating Council.

We also recommend that the Secretary of Energy work with the secondary mortgage market to help it develop criteria for primary lenders to use in assessing the energy cost impact of energy-efficient land use concepts and explore additional means of providing incentives for using these concepts.

APPENDIX I

SYNOPSIS OF STUDIES ON ENERGY-EFFICIENT LAND USE CONCEPTS

A. STUDIES USING SITE AND DESIGN CONCEPTS FOR COMMUNITIES, NEIGHBORHOODS, AND BUILDINGS

1. American Society of Landscape Architects Foundation, Landscape Planning for Energy Conservation, Environmental Design Press, 1977. Examines the effects of vegetation and landforms on the use of energy in buildings. Vegetation may absorb 90 percent of light falling upon it, reduce wind speeds to less than 10 percent of that in the open, or increase them, reduce daytime temperatures by as much as 15 degrees Fahrenheit, and in certain situations, raise nighttime temperatures. Deciduous trees are good temperature control devices since they cool in summer and yet allow the sun to pass through during the winter. A dense evergreen windbreak protecting a house with a 70-degree constant temperature, can result in a 22.9-percent fuel savings. Plants and grassy covers reduce temperatures by scattering light and solar radiation. On sunny summer days, these surfaces are about 10 to 14 degrees cooler than temperatures of exposed soil.

2. Duncan Erley, David Mosena, and Efraim Gil, Energy Efficient Land Use, American Planning Association, May 1979. Discusses and illustrates energy-saving concepts of site selection, topography, vegetation, and landscaping. A study of winter temperatures in unheated apartments in Davis, California, showed that on several days, south-facing apartments had temperatures 24 degrees above those of northeast and west-facing apartments. The study also discusses housing types and density. Clustered housing results in more compact development and thus less travel, and common wall units require less heating and cooling energy. Authors also critique conclusions of several studies on energy/land use savings.

3. Ontario Ministry of Housing, Residential Site Design and Energy Conservation, April 1980. Report shows that a traditional low-density subdivision could save 15 to 20 percent of the energy needed for space heating by selecting housing with better energy efficiency, orienting the buildings to receive most sun and least wind effect, arranging landscaping as a shelter, and increasing major southerly windows.

4. Robert M. Byrne and Libby Howland, Background Information Summary, The Urban Land Institute, March, 1980. Report shows how passive solar techniques including proper orientation, shading, and material choice can reduce a structure's energy load by 25 to 50 percent. The report also states that up

to 60 percent energy savings can be expected from a combination of energy-conscious site design and provisions of relatively sophisticated individual and community systems. Site design alone can save up to 30 percent savings without increases in development costs.

5. Libby Howland and Jane Silverman, Focus on Energy Conservation: A Second Project List, The Urban Land Institute, 1980. The report discusses solar housing in Boulder, Colorado, which designers estimate can achieve a 20-percent energy saving as a result of site planning and energy conservation. The project list also cites Reston, Virginia, as a community which has achieved significant energy savings as a result of sensitive site planning which includes cluster development, extensive use of natural vegetation, and mixed land use.

6. Land Design/Research, Inc., Planning for Housing, Development Alternatives for Better Environments, National Association of Home Builders, 1980. Report shows how several fundamental concepts of mixed land use, compact development and better use of existing landscape resources are basic to the development of attractive energy-efficient residential neighborhoods.

7. Land Design/Research, Inc., Cost Effective Site Planning, National Association of Home Builders, 1976. Book provides basic guidelines for energy conservation through proper site selection and planning. Twenty-five site plans with varying densities are presented. Cluster and conventional plans can be compared in terms of site costs and land utilization.

8. Duncan Erley and David Mosena, Energy-Conserving Development Regulations: Current Practice, American Planning Association, Argonne National Laboratory, May 1980. The study discusses the use of development practices to conserve energy. A comparative analysis of single-family detached and single-family attached (townhouses) dwellings showed that the latter are more energy efficient based on space-heating energy use. The most significant difference occurs between the one-story detached unit and the two-story attached unit with two common walls—annual heating costs were 40 percent less for the attached unit. A two-story attached dwelling with one common wall (end unit) uses 20 percent less energy than a one-story detached unit.

9. David Crandall, Maximizing Energy Conservation Through Site Planning and Design, Environmental Design & Research, December 1979. This study explains options available to the designer/planner for achieving energy-conscious land use planning. Energy saving concepts include site selection, building orientation, and roadway layout.

10. Duncan Erley and Martin Jaffe, Site Planning for Solar Access, American Planning Association, U.S. Department of Housing and Urban Development, May 1980. Explains basics of site selection

of a conventional and a planned unit development. This includes an analysis of specific design strategies to protect solar access, and solar access and the use of vegetation.

B. STUDIES ON ENERGY-CONSCIOUS LOCATIONAL PLANNING AND HIGH-DENSITY DEVELOPMENT

1. Real Estate Research Corporation, The Costs of Sprawl, U.S. Government Printing Office, April 1974. According to this study, the greatest cost advantages occur when higher density planned developments are contrasted with low-density sprawl. Generally, sprawl is the most expensive form of residential development in terms of economic costs, environmental costs, natural resource consumption, etc. Energy consumption is reduced 44 percent in high-density planned communities as compared to low-density sprawl communities. The reduction reflects variations in residential power consumption by housing type and decrease in automobile use in high-density planned areas.

2. Brookhaven National Laboratory/State University of New York, Land Use and Energy Utilization, National Technical Information Service, June 1977. This study explores the quantitative relationships between alternative land use patterns and their resultant energy and fuel demands as well as the impacts of these demands on the regional and national energy supply. Present planning practices and design philosophies used in the preparation of area land use plans in a region such as Long Island, New York, suggest that total incremental energy consumption can be reduced by 15 to 25 percent by altered future growth patterns. In comparing an urban sprawl scenario characterized by corridors, clusters, and centers, the study concludes that 52 percent less transportation energy would be consumed in the corridor/cluster scenario.

3. James S. Roberts, Energy, Land Use, and Growth Policy: for Metropolitan Washington, Metropolitan Washington Council of Governments, August 1975. A comparison was made of energy consumption in six alternative land use patterns. The least energy-consuming alternative, characterized by energy-conscious locational planning and high density, was 31 percent more efficient than the most consumptive sprawl alternative.

4. Dale L. Keyes and George E. Peterson, Metropolitan Development and Energy Consumption, The Urban Land Institute, March 1977. The heating efficiency in low-rise and small high-use multifamily units is about 30 percent greater than single-family detached dwellings. Approximately 20 percent of projected national energy consumption per year (0.2 quadrillion Btu's) could be saved by 1985 from a large but possibly reasonable shift toward multifamily dwellings. These savings could reach

0.5 quadrillion Btu's by the year 2000. Also, by accommodating new growth in an energy-efficient manner, a 15-percent saving may be possible in transportation consumption. Authors also critique other land use/energy conservation studies.

5. Dale L. Keyes, Energy and Land Use: An Instrument of U.S. Conservation Policy? Energy Policy, September 1976. The author describes studies of energy usage in metropolitan areas of the USA, simulation studies of alternative building types, and the potential for energy conservation. Rearranging the urban housing pattern into more compact high-rise patterns could lead to significant savings in domestic and transportation energy consumption.

6. Robert M. Byrne and Libby Howland, Background Information Summary, The Urban Land Institute, March 1980. Small multifamily attached structures hold significant energy efficiency advantages over single-family detached homes, because of the thermal insulation provided by common walls, reduced exterior exposure, and typically smaller sizes of multifamily housing. Households in structures with five or more units use about 60 percent less energy for space conditioning than those in single-family detached homes. For units of the same size, the difference is about 25 percent.

7. Libby Howland and Jane Silverman, Focus on Energy Conservation: A Second Project List, The Urban Land Institute, 1980. Energy-conscious locational planning is well exhibited in Reston, Virginia—a new town about 18 miles west of Washington, D.C. Residential, employment, commercial, educational, and recreational facilities are integrated within the community for the purpose of reducing distance, time, and energy consumption. This mixed land use reduces dependence on the automobile, and enables facilities to be used efficiently during daytime and evening hours. The integration of functions at Reston is enhanced by cluster development or residences which are accessible to major activity centers, such as schools, shopping, and jobs. Thirty-five miles of major walkways enable residents to walk, jog, or bicycle to destinations within the new community.

8. Dale L. Keyes and George E. Peterson, Urban Development Patterns, The Urban Institute, April 1980.

   Energy Use in Housing

   The thermal efficiency of units in low-rise and small high-rise multifamily units (perhaps up to 10 stories in height) is about 30 percent greater on a square foot basis than single-family detached units. Per-unit energy savings in multifamily dwellings are as large as 60 percent, but are due in good part to the smaller size of the units.

   Approximately 20 percent of the projected national energy consumption per year (0.2 quadrillion Btu's) could

be saved in a decade from a large but possibly reasonable shift in housing construction toward multifamily units. These savings could reach 0.5 quadrillion Btu's by 2000, and eventually 0.9 quads.

Energy Use in Transportation

The average amount of gasoline consumed per capita in metropolitan areas increases as: (a) total population increases, (b) the proportion of the population living in high-density areas (at least 10,000 persons per square mile) decreases, and (c) as the proportion of jobs located in the central business district increases. Alternatively, general measures of population clustering and density tend to produce gasoline fuel economics.

Simulation studies of travel behavior and empirical analysis of gasoline sales suggest that savings in transportation energy use of approximately 20 percent might be possible by accommodating new growth in an energy-efficient manner at the metropolitan scale, using what may be acceptable levels of land use controls and incentives.

These savings would produce an annual energy saving of about 0.47 percent (or 0.47 quadrillion Btu's per year) in a decade, and eventually as much as 2.2 quads.

9. Dale L. Keyes, Reducing Travel and Fuel Use Through Urban Planning, Energy and Environmental Analysis, December 1979. Over 25 percent of all energy consumed in the United States is used to transport goods and people, and of this total, one-third is devoted to travel within urban areas. Almost 3 million barrels of oil are consumed each day to convey urban residents to work, to school, to shopping centers, recreation areas, and home again. We travel frequently, cover long distances, and choose the automobile as our primary mode.

Where housing densities are high, destination points are clustered, allowing for a degree of substitution of walking, transit, and other modes for automobile trips. Moreover, high-population densities typically produce congested streets and limited parking conditions, further reducing automobile travel.

Assuming that a nationwide decrease of 10 to 15 percent in energy consumed per person for urban travel is feasible from changes in urban development patterns alone, national energy consumption would decrease by 0.8 to 1.2 percent per year once the changes have been realized. If this could be accomplished by the end of the century, by which time national consumption should approximate 110 to 120 quadrillion Btu's per year (U.S. Department of Energy, 1979), then the annual savings would equal 1 quad or more per year.

10. Alan Altshuler, The Urban Transportation System, MIT Press, 1971, Ch. 10, and AIP Journal, April 1977.

According to the author, the energy savings attributed in The Costs of Sprawl need qualifications as follows.

a. To date, results of prototype analysis have not been calibrated against the experience of real communities.

b. The authors assumed different space standards for the several types of dwelling units. At the extremes, they assumed that single-family households would require 1,600 square feet, whereas households occupying high-rise apartments would require only 900 square feet—a 34-percent differential.

c. The energy savings attributed to high density appear to be grossly overstated.

(1) The report examines only three aspects of total urban energy consumption, and these elements account for only one-fifth of urban energy consumption.

(2) The report shows a 41-percent saving in heating and cooling costs due to high density. The 34-percent differential in average dwelling unit size, however, accounts for five-sixths of this savings.

(3) The report shows a 49-percent energy reduction for travel from a low-density planned environment. The only saving would be for travel within the neighborhood—not all travel. Using a reasonable estimate of 20 percent for intra neighborhood travel, the savings shrink by 80 percent.

(4) The report shows that high density would facilitate the substitution of mass transit for some automobile travel. The auto travel reduction is apparently reflected in the fuel consumption estimate, but no offsetting estimate is made of mass transit fuel consumption. If one holds dwelling size constraint and allows only 20 percent of the claimed auto saving (but still levies no charge for mass transit energy usage), the energy demand differential between the high-density planned community and the low-density sprawl community shrinks from 44 percent to 14 percent. Comparing a high-density planned community with a low-density planned community, the differential falls to 6 percent.

The author points out that despite these qualifications, The Cost of Sprawl merits the close attention of all who are concerned professionally with the analysis of urban form. The essential method represents an important step forward in the appraisal of alternative urban forms, and most of its detailed analyses are extremely well done.

APPENDIX II

A LISTING OF STATES AND LOCALITIES VISITED

WASHINGTON

State Department of Energy
State Planning Department
Pierce County Planning Department
Snohomish County Planning Department
King County Planning Department
Puget Sound Council of Governments
City of Bellevue
City of Everett
City of Seattle Planning Department
City of Seattle Energy Office
City of Redmond
City of Tacoma
City of Renton
City of Edmonds
City of Puyallup
City of Gid Harbor
City of Arlington

OREGON

State Energy Office
City of Portland Planning Department
City of Portland Energy Office

MICHIGAN

Michigan Energy Administration
Southeast Michigan Council of Governments
Wayne County Planning Department
Oakland County Planning Department
Monroe County Planning Department
Lathrup Village
City of Southfield
City of Berkley
City of South Lyon
Grosselle Township
Independence Township
City of Farmington Hills
City of Pontiac
City of Livonia
City of Clawson
Village of Dundee
City of Monroe
City of Troy

APPENDIX II

MISSOURI

State of Missouri Energy Division
East-West Gateway Coordinating Council
St. Louis County
St. Charles County
Jefferson County
Ballwin
Blackjack
Bridgeton
Ellisville
Eureka
Fenton
Florissant
Hazelwood
Kirkwood
Manchester
St. Ann
O'Fallon
St. Charles
St. Peters
Wentzville
Arnold
Festus

MASSACHUSETTS

Massachusetts Executive Office of Energy Resources
Metropolitan Area Planning Council
Action
Arlington
Beverly
Braintree
Carlisle
Lexington
Medway
Sudbury

VERMONT

State Energy Office
State Planning Office
Environmental Policy Board
Vermont Housing Finance Authority
Agency of Development and Community Affairs
Addison County Regional Planning and Development Commission
Chittanden County Regional Planning Commission

SUGGESTED CLARIFICATION TO
PROPOSED LEGISLATION

The definition of "passive solar energy system" could be clarified by inserting the following language at subsection (c)(3) of the new section 44F proposed by section 1(a) of S.498, H.R. 1960, and H.R. 1963;

"(3) PASSIVE SOLAR ENERGY SYSTEM.--The term 'passive solar energy system' means a system--

"(A) which contains--

"(i) a solar collection area,

"(ii) an absorber,

"(iii) a storage mass,

"(iv) a heat distribution method, and

"(v) heat regulation devices,

regardless of whether one of these components serves a structural purpose of the residential unit, and

"(B) which is installed in a new residential unit after _____ and before _____.

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