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PLANNER'S GUIDE TO COMMUNITY ENERGY CONSERVATION

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PLANNER'S GUIDE TO COMMUNITY ENERGY CONSERVATION

BY

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Abstract

This research paper examines the community planner's role in responding to this country's energy problem. The paper is based on the principle that because final use of energy is ubiquitous, relative to production of energy, that a solution to this problem can be best approached from the grass roots level. As a result, the paper focuses on reduction of energy use rather than other energy considerations. The paper establishes the correlation between physical growth and energy consumption, thereby placing the planner in a key role for energy planning due to his traditional function as manager of physical growth and physical resources. This paper suggests an approach to local energy planning by making it a part of the community master plan. It then proceeds to present facts, tools and implementation resources and mechanisms that can be used by the planner to achieve a more energy efficient community.

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CHAPTER I

THE NEED FOR COMMUNITY ENERGY PLANNING

Introduction

Beginning with the OPEC oil embargo of 1974 the idea that energy supplies are finite became acknowledged by a large number of Americans. This oil embargo precipitated a concern on the part of many individuals regarding the situation of ourselves and of our country with regard to our energy posture and energy availability. Cheap and available energy provided Americans with a high standard of living and helped to make the United States the most powerful nation in the world. By comparison to today it seems there was very little regard for or acknowledgement of the importance of energy in the pre embargo era.

A rise in the price of energy is felt in many ways, as this resource is an input to everything we come into contact with in our everyday lives. Energy is a component to manufacturing and production, maintenance and construction, and transportation. It is an input to the house we wake up in the morning, to the breakfast we eat, and to the transportation we take to work. When considering such a pervasive resource it would seem that everyone could and should have a role in solving the energy problem. In a sense everyone created it. Everyone is subject to the implications of it.

Various policies and strategies relative to our energy situation have been posited by government officials, members of Congress, and other informed and responsible groups and individuals, including AIP. These have been reflected in programs and statements[1] that have been promulgated and, in the case of programs, some are being implemented. Policies and strategies center around three broad needs or concerns which in sum, define our energy problem. These are: (1) the need to reduce our dependence on foreign/imported oil so as to remove this country from its precarious position regarding access to energy and its implications for national security, balance of trade, and foreign policy; (2) the need to maintain industrial and economic growth so as to continue to support the standard of living which Americans now enjoy relative to other countries and to ameliorate the effects of high energy costs on the socially disadvantaged; (3) the need to protect and preserve our environment in the face of continued demand for resource extraction, the construction of energy facilities, and the adoption of alternative energy resources. The strategies which have been developed in response to these needs fall under the categories of : (1) petroleum reserve and fuel allocation,[2] (2) increased domestic energy production primarily through the use of coal,[3] nuclear, and renewable energy resources, (3) energy conservation.

Congress has responded to these needs by employing the above strategies in six seperate pieces of energy legislation since 1974.[4] The most significant piece of energy legislation to date is the five part National Energy Act which was passed by Congress and signed into law by the President on

November 9, 1978. Inclusive of this energy package are: The National Energy Conservation Policy Act, which provides programs for attaining energy reductions in all end/use sectors;[5] The Energy Tax Act, which provides incentives and disincentives designed to result in reductions in energy use and a shift from conventional petroleum fuels;[6] The Powerplant and Industrial Fuel Use Act, which is intended to force utilities and industries to switch from the use of oil and natural gas to the use of other indigenous fuels, particularly coal; The Public Utilities Regulatory Policies Act, which seeks to ensure that retail rate structures of utilities encourage conservation of energy, efficient use of facilities and resources, and equitable charges to consumers; and The Natural Gas Policy Act, which contains provisions for the phase out of price controls on this fuel type and sets forth fuel allocation guidelines.[7] Acts passed prior to the National Energy Act laid much of the foundation upon which this five part energy package was ultimately built. Of particular importance in this regard and of particular pertinence to this paper is the Energy Policy and Conservation Act of 1975 which attempts to establish a basis for a comprehensive and concerted conservation ethic in this country.[8]

PROBLEM DEFINITION

The purpose of this paper is to provide the community planner with a guide to local energy planning. The need for energy planning at the local level is beginning to be recognized. The American Institute of Planners points to this need in Planning Policies '77, the AIP annual statement of policy. In highlighting pertinent sections of this statement the AIP states that:

1. "Comprehensive energy planning should take place at all levels of government. An energy element should be incorporated into regional, state and local comprehensive planning documents. This can aid in the formulation of policies concerning land use and physical development that are responsibe to the need for better management of our energy resources."

AIP further states that:

2. "States and local governments should develop plans patterned after the National Energy Plan. The states and multijurisdictional substate organizations should provide technical assistance to local planning agencies, as necessary."

Several local communities have begun to undertake a comprehensive conservation energy planning effort. The most notable examples are Sacramento California and Yamhill County Oregon. Sacramento is trying to undertake a program which will effect the entire region around the state capital.[10] The Sacramento plan seeks to reduce energy consumption by thirty percent while increasing jobs and polulation in the region. Yamhill County has developed a document entitled, "Relationships of Energy to Land Use", which guides the County's planning initiatives to ensure that energy is properly considered.[11] Other local communities have also undertaken less comprehensive energy planning efforts.[12] These communities include Davis California, which is known for its innovative use of building codes and subdivision regulations; Hobbs New Mexico, which has employed the use of a management plan to mobilize and organize its human resources and Seattle, which has implemented several programs through its municipal utility, Seattle City Light.[13] The communities that have undertaken the development and implementation of piecemeal plans vastly outnumber those which have undertaken partial plans. In view of this the goal of the AIP for comprehensive energy planning at the local level is probably a long way off and the practicality of undertaking a comprehensive energy planning effort on a local basis is most often very dubious.

The constraints to undertaking energy planning on the local level are probably most largely attributed to a lack of resources rather than a lack of interest on the part of the planner.[14] Some other constraints include a lack of preparedness on the part of the planning profession to deal with the energy situation, a lack of understanding of the planner's role relative to the energy problem,[15] a lack of adequate information to formulate an approach to community energy planning, lack of manpower, and lack of money.[16] Another constraint is the question as to whether energy is an appropriate responsibility for the community to take on and commit resources to.[17]

Most planners and most community officials probably would have difficulty committing themselves to this cause and in defending it as a community responsibility. This is particularly difficult when comparing it to other vital community services which must be planned for and maintained and which are more traditional in nature such as education, public works, fire and police, and administration of the government. In a recently printed article one community planner defends undertaking energy planning with the following statements:

"Conservation would create as many or more jobs as would be produced by constructing new thermal facilities to generate an equivalent amount of energy, and the jobs produced would be of particular benefit to unskilled labor.

It is six times less expensive to produce energy through conservation than through building new power plants.

Saving a portion of our dwindling fossil fuels for such non-energy purposes as lubricants and medicines will afford greater security for future generations."[18]

There are other convincing reasons for undertaking local energy planning programs including the reduction of environmental residuals, [19]reducing municipal budgets, improving housing stock, assisting the socially disadvantaged in the community, as as a show of support for undustry and business in the community. These concerns, coupled with the three areas of national concern outlined previously, provide many reasons for undertaking local energy planning which are consistent and compatable with community goals, other community programs, and provisions of the community master plan.

This paper will focus on energy conservation and is based on the principle that the final use aspect of the energy picture is most suited to the community planner. There are significant reasons for arriving at this principle. The reasons are scale, scope and jurisdiction. Scale, scope, and jurisdiction are reasons for not addressing areas outside the realm of conservation in this paper. They are also reasons for addressing conservation.

In explanation, power production (for the most part) and petroleum reserve, the "other" strategies mentioned in the introduction, are large scale undertakings if they are to be developed in an economical manner. The scale required to make these facilities economically sound and reasonable put them beyond the capacity of local government needs in most cases. Related to the question of scale is scope. Energy supply and production necessarily have regional implications. Energy is a commodity which is isolated in supply and ubiquitous in demand. Oil is the most extreme example of this with the United States having to go outside the country for fifty percent of its petroleum supply.[20] This is also true with regard to our elecricity supply where large scale production and pooling of power has been determined to be the most efficient, economical, and reliable way to produce power.[21] This thinking is illustrated by the fact that General Electric Company currently has orders for twenty nuclear generating units rated at 1360 Mega Watts, each capable of providing the electric needs of over a million people (approximately the population of Rhode Island).[22]

When considering energy conservation the scale and scope of undertaking programs to implement these strategies are appropriate to the capabilities of local government. Because energy consumption is ubiquitous and is a function of each final user the scale of programs only have to be extensive enough to meet the needs of the typical end user in a given end use sector. Their scope need only be as wide as a given end use sector which is contained within the geographical area of the community. To clarify, this explanation is provided. In implementing a conservation program in the residential end use sector for example a program which can address the needs of each housing type in a cost effective manner can be successful in the remaining houses in the universe. Additionally, the scope of such a program can be limited by defining the universe geographically as a sub unit of the community and spill overs outside of the target area can be limited. Careful definitions of end use sectors and accurate assessment of needs will result in the most valid plans and effective programs. This requires the application of energy planning tools and understanding of energy considerations which are addressed in later chapters.

Jurisdiction is the final reason mentioned for arriving at the principle which is behind the decision to center upon conservation in this paper. Mostly due to the regional scope of energy production/supply and petroleum reserve as well as the macro economics and national security implications of these strategies, regulatory authority and implementation resources lie at the state and federal levels of government. The National Energy Act provisions, which were briefly described previously, is typical of previous legislation which has placed program resources and jurisdiction, in virtually all instances, in the hands of federal and state government.

Up to now this placement of programs in the state and federal levels of government is also true of energy conservation. Our most widely known and significant programs are delivered by state and federal government. These programs include tax credits,[23] utility conservation programs, home retro fit loans, school and hospital energy conservation programs, loan guarantees, thermal efficiency standards for new construction, contigency gas tax, 55 mph speed limit and mandatory automobile efficiency standards. Eight other conservation programs have been developed in all fifty states of this country to make them eligible for federal monies for implementation. These programs were provided for by the Energy Production and Conservation Act of 1975, and its amendments,[24] and requires states to; adopt thermal efficiency standards for all new construction,[25] establish and promulgate lighting efficiency standards for new and existing public buildings, establish energy efficient procurement procedures in state and local government, establish programs which promote the use of public transit, enact a law which allows traffic to make a right turn at a red light, establish programs to create public awareness of the savings which are likely to result from undertaking specific measures and information on how to go about undertaking those measures, establish procedures for ensuring that effective coordination exists among local, state, and federal conservation programs within a state, and establish programs for encouraging and carrying out energy audits in at least one of twelve building types and in at least one political subdivision in the state. Another program which should not be left unmentioned is the low income weatherization assistance program which is run by regional agencies (sub state) and are in force in all fifty states.

The short track record of some of these programs reveal that they have not been as effective in practice as they appear they should be in concept.[26] Several of these are types of programs which lend themselves to implementation at the local level and include public awareness programs, code establishment and enforcement programs, and programs aimed at the building sector. The intent of this writing is not to say that these programs have been a wasted effort but to suggest that they have laid a useful framework from which to follow through to more effective implementation through a local approach in conjunction with the introduction of other programs.

A final reason for focusing on energy conservation as opposed to the other possible areas is that this subject matter is pertinent to all communities. Although the local planner is expected to have a role in things such as resources extraction, facility siting, and dealing with the impacts of energy related projects on the community,[27] these problems confront a minority of local planners. Additionally, the planing profession is equipped to deal with these considerations with existing tools which are traditional to his trade.

PURPOSE AND INTENT

As previously stated, the purpose of this paper is to provide the community planner with a guide to local energy planing. This document contains facts, strategies, and considerations to assist the community planner in developing a local energy plan and program. It is intended that this document be employed to eliminate some of the problems and constraints that confront the planner and the planning profession and provide ideas and information that can be employed to solve energy problems from the local level of government.

The following four chapters address the multitude of considerations for the development and implementation of a comprehensive community energy plan. Chapter two of this document establishes the basis for local energy planning by identifying an approach which draws upon the traditional authorities, tools, and implementation mechanism of the community and the community planner. It illustrates how a local energy plan and program can and must be rooted within these traditional areas for an endeavor to be a success. Chapters three and four present data, data collection tools, and planning considerations to assist the planner in understanding the energy profile of the community and to apply in the formulation of policies goals, objectives, and plans. Chapter three addresses energy for production, construction, and buildings in this regard. Chapter four addresses energy and land use. Finally, Chapter five presents resources and mechanisms for implementation and demonstrates how information presented in the previous chapters can be applied towards implementation.

In closing this chapter, although the information presented in this document should ideally be applied in the development of a comprehensive energy plan, earlier discussion in this chapter concedes that most often constraints make this impossible. In view of these constraints, this document is development more as a guide than a recipe or formula and is well suited to application in the development of modified plans or most preferably integrated into the community master plan. The remainder of this ducument will bear this out to the reader.

CHAPTER 1

Footnotes

[1]There is an abundance of printed material of this type that has been prepared by many individuals and organizations. There are three particular writings in print that are of particular pertinence to this study. The are: American Institute of Planners, Planning Policies '77, (Washington, D.C., 1977), pp. 11,12; "New Orleans APA Workshops: How Do You Plan Local Energy", The Energy Planning Report, 3 (Oct. 6, 1978): pp. 6,7; Jeff Forker, "Viewpoint: Will the Real Energy Problem Please Stand Up", Energy Management, ed. Jeff Forker, (Fall 1978 10-13.

[2]Two acts are of particular significance with relation to petroleum reserve and fuel allocation. The Energy Policy and Conservation Act of 1975 provides for the establishment of a "Strategic Petroleum Reserve" by 12/78 which will contain a reserve of energy suitable to fill this countries energy needs for three months. The Fuel Allocation Act of 1974.

[3]The Energy Supply and Environmental Coordination Act calls for the conversion of petroleum burning industrial and power plants to coal. The Power Plant and Industrial Fuel Use Act of 1978 reiterates this and expands its scope.

[4]These acts are listed as follows:
The Fuel Allocation Act of 1974, The Energy Supply and Environmental Coordination Act of 1974, The Solar Heating and Cooling Demonstration Act of 1974, The Energy Policy and Conservation Act of 1975, The Energy Conservation and Production Act of 1976, and the five part National Energy Act.

[5]An end use sector is a well defined segment of the economy which consumes energy as a final product. An end use sector could be the buildings sector. Or it could be types of buildings; new, old, residential, commercial, public, and industrial. Or it could be uses within buildings; lighting, heating, appliances and air conditioning.

[6]This Act addresses the residential, business, and transportation end use sectors. Income tax credits are provided to homeowners who purchase energy conservation or solar energy equipment. Businesses are provided with a 10 percent investment tax credit for installing energy conservation equipment. The transportation tax is a tax on gas guzzler cars which imposes gradually higher taxes on less efficient cars.

[7]Several good summaries of the National Energy Act have been developed. The New England Regional Commission developed a lengthy summary with editorial note addressing the ef-

fects on New England, the U.S. Department of Energy has developed an uneditorialized summary, the National Governor's Association has developed a very succicnt editorialized summary. These summaries can be obtained by contacting the respective agencies: New England Regional Commission, 53 State Street, Boston MA: National Governor's Association, Hall of the States, 444 North Capitol St., Washington, D.C.

[8]Title III, Part C, section 361 of this act provides for the development of State Energy Conservation Plans with the goal of reducing energy consumption in the state by five percent. The Act authorizes 150 million dollars to make available to states for the development and implementation of plans that have been approved by the U.S. Department of Energy. The Energy Production and Conservation Act is also the first piece of legislation to address energy in a comprehensive manner by covering production, conservation, petroleum reserve, pricing, and planning and management data aquisition.

[9]American Institute of Planners, Planning Policies '77, (Washington, D.C.) pp. 11 12.

[10]Dennis Dickman and Lee Stephen Windheim, "Sacramento Can Do More With A Lot Less Energy", Planning, vol. 43 no. 11 (Dec. 1977) pp. 24,25.

[11]"Energy and Land Use Planning: One County's View", The Energy Planning Report, vol. II no. 12 (March 24, 1978) pp. 6-8.

[12]Robert Cassidy, "A Few Cities Aren't Waiting For The Next Energy Crisis", Planning, vol. 43 no. 11 (February 1977): pp. 24,25.

[13]Robin C. Calhoun andSam R. Sperry, "Seattle's Energy 1990 Program Conservation Today and for the Future", Technology for Energy Conservation, Information Transfer Inc. (Rockville Maryland), pp. 25-36.

[14]A number of articles in planning publications in recent years demonstrates the interest of the planner in local energy planning. See, Comer L. Taylor Jr., "Planning and Energy Conservation", Practicing Planner, vol. 8, no. 2, (June 1978), pp. 6-7.

[15]Edgar A. Imhoff, "Planners Can Improve Responsiveness to Surface Mining Reclamation Issues", Practicing Planner, vol. VI, no. 2, (Sept. 1974), pp. 20-22.

[16]For more discussion of these points see, Robert Cassidy, "A Few Cities Aren't Waiting For The Next Energy Crisis", Planning, vol. 43 no. 11 (Feb. 1977) pp. 24,25.

[17]In the Fall of 1978 the American Institute of Planners met in New Orleans for a three day workshop on "Community

Energy Planning-Defining Achievable Alternatives". During this workshop all of the issues mentioned in this paragraph were discussed. A summary of the highlights of this workshop can be found in, "New Orleans APA Workshops: How Do You Plan Local Energy". The Energy Planning Report, ed. David L. Howell, vol. II, no 12, (March 24 1978): pp. 6,7.

[18]Energy and Land Use Planning: One County's View", The Energy Planning Report, ed. David L. Howell, vol. II, no 12, (March 24 1978): pp 6,7.

[19]The Office of State And Local Programs, Office of Energy Conservation and Environment, Federal Energy Administration, "Final Assessment of the Environmental Impacts of the State Energy Conservation Program", April 1976.

[20]New England Federal Regional Council, Energy Resource Development Task Force, "New England Energy Situation and Alternatives for 1985", (August 1977): p. 12.

[21]New England Regional Commission, New England Power Pool: Description, Analysis, Implications, Energy Program Technical Report: 76-2 (March 1976): pp. 3-1 3-8.

[22]To further illustrate this point, only two states in New England generate all their own power. These two states, Massachusetts and Connecticut, produce a surplus which it makes available to other New England States through the New England Power Pool. Rhode Island is very dependent on this power pool, generating only about 10 percent of the power it consumes within the state. Also, the evolution of the size of generators in power production is discussed in, "Generation: From the Curtis Turbine to Combined-Cycle Configurations", Electric Forum vol. 4 no. 3, ed. D.E. Wilcock, pp. 6-10.

[23]See Appendix A for a brief description of the programs listed in this paragraph and the following paragraph.

[24]Title IV, Part B, section 432 makes a major amendment to the State Energy Conservation Plan program originally provided under the Energy Policy and Conservation Act of 1975.

[25]There are two provisions in seperate pieces of legislation which address thermal efficiency standards for new construction. A provision in the Energy Policy and Conservation Act of 1975 makes statewide adoption of an acceptable standard a prerequisite for funding of State Energy Conservation Plans under section 362 of that act. Title III of the Energy Conservation and Production Act of 1976 provides for the development of standards by HUD and once developed this or an equivalent standard will have to be adopted for an entity to be eligible for any HUD funds.

[26]States that have received funding under Title III of the

Energy Policy and Conservation Act of 1975 are required to make annual BTU assessments of progress of the state towards their energy conservation goal. The most recent assessments for calendar year 1978, show that most states are lagging behind.

[27]For more information on energy project impacts see, U.S. Department of Housing and Urban Development, Office of Community Planning and Development, Rapid Growth from Energy Projects: Ideas for State and Local Action, (March 1976).

West German City Planners Exper...
With a Community Set Up to Save En...

By Bill Paul

Staff Reporter of The Wall Street Journal

ERLANGEN, West Germany—When it's built, probably within the next two years, the new suburb of this southern German city will look like any other residential community.

But there will be an important difference. Part of the suburb will have been designed and built specifically to save energy—the first "energy-planned" community in the world. U.S. energy officials will be among the interested observers.

What is an energy-planned community? It's a community where home owners must abide by tough city ordinances on positioning of homes for maximum exposure to the sun. It's a community where homeowners must plant tall shrubbery to lessen the cooling effects of the wind and must heat their homes in officially prescribed ways, using nonoil energy sources.

In exchange for abiding by these and other rules, homeowners will save 20% or more on their annual home-heating bills. At least that's the estimate of researchers at Battelle Institute of Frankfurt, an economics and environmental research organization that designed the community.

A Sufficient Sample

Nothing in the Battelle plan represents new technology. Rather, Battelle took many simple energy-saving ideas, such as utilizing solar power, and incorporated them into a town plan that has the legal backing of the local authorities. Erlangen officials are betting that people won't mind conforming to a more stringent building code if it means a substantial energy saving.

To be sure, Erlangen officials aren't certain that people will want to live in the energy-saving development. Thus, despite financial assistance from Bonn, they are setting aside only a small part of the privately developed suburb for the project. About 1,000 people of the 15,000 eventually expected to live in the community will reside in the energy-saving section.

Still, officials in Bonn think that will be a sufficient sample to indicate whether energy saving can be carried out through town planning. (Houses in the test area probably won't go on sale to the public for several more months.)

Every Tree and Bush

The Erlangen project is part of a four-nation study on energy saving under the auspices of the International Energy Agency, a Paris-based intergovernmental body that promotes ways to reduce dependence on oil. Other countries taking part are the U.S., Greece and Italy. Greece and Italy are focusing on energy saving in rural areas, while the U.S., like Germany, is working on urban energy planning.

An official of the U.S. Department of Energy says the department hopes to turn the South Bronx area of New York City into another Erlangen, the only difference being that the strict energy-saving rules would be applied to offices and factories instead of homes.

But the South Bronx and other U.S. projects are farther off than the Erlangen project, which already has been planned down to the location of every tree and bush.

Among the features of the community is a system incorporating a variety of home-heating methods. Individual homes far away from the gas line will use heat pumps that can be driven either by solar power or by electricity. Battelle researchers say that if a homeowner installs solar panels on his roof, the heat pump will run on solar power most of the time, saving as much as 50% on the annual heating bill.

For homes nearer the gas line, gas alone will be used.

Waste water from a local power station will heat multifamily dwellings.

Battelle estimates that planting trees and bushes in the proper places throughout the community can cut the average homeowner's heating bill 5% a year by reducing the cooling effect of wind currents, especially in winter. Homeowners must plant the bushes; the city will plant the trees.

The Battelle plan also dictates the maximum height of homes and multifamily dwellings according to location. Battelle worked all this out on a machine called a heliograph, which simulates the position of the sun on the community in any month. By using the heliograph, the researchers were able to locate buildings so as to prevent one from casting a shadow on another.

Federal Express Corp. Passenger Service

outrace town's ability to plan for them

By LARRY BRUNELL
Journal-Bulletin Staff Writer

NORTH ATTLEBORO, Mass. — Town Department heads, who had to estimate next year's gasoline budget about five months ago, may find themselves asking the Finance Committee for more money before the end of fiscal 1980.

The cost of premium gasoline, which was 56.8 cents a gallon last November, when most budgets were being prepared, has now risen to 67.8 cents. Three weeks ago the cost of the premium gasoline, which is used in most of the town vehicles, was 61.1 cents.

Town vehicles using unleaded gasoline, which includes about 25 from eight town departments including 13 police cars, are being filled at a cost of about 64 cents a gallon. On March 27, the price of a gallon of unleaded gasoline was 60.54 cents. On March 21, 1978, the town paid 47.14 cents a gallon for unleaded gasoline.

"I just can't imagine that they (the department heads) would have put in for such drastic increases," Selectman John Drury said. "I would expect they'd put in for some, but I don't know if they put in for this much."

• • •

DRURY SAID HE EXPECTS that by this time next year, some officials may have to ask the Finance Committee for a reserve fund transfer to cover the steadily increasing cost of gasoline.

James McKeon, a member of the Board of Public Works and the former highway superintendent, also thinks that some town departments might not have allowed enough money to meet their gasoline needs.

"It's tough, you just can't figure it anymore," McKeon said. "You can say I'll figure on 80 cents a gallon and by the end of the year it's 85."

"We're going to try to start conserving as much gasoline as possible," he said "but you can't put all the trucks in the garage."

Police Chief John D. Coyle Jr., whose department is the largest consumer of gasoline, says he is concerned not only with the rising cost of gasoline but also the allocations.

A spokesman for the Texaco Co., the town's gasoline distributor, said he recently received the town's new monthly gasoline requests. He said the departments would receive 85 percent of these new figures.

• • •

HE SAID HE DID NOT KNOW how much gasoline the police department ordered last year but added that its new requirements average about 5,200 gallons a month.

He said prior to receiving the new gasoline require-

CHAPTER II

AN APPROACH TO LOCAL ENERGY PLANNING

Introduction

A local energy plan should have its beginnings in and derive its basis from functions, tools and authorities that are already within the repertoire of the planner. Much can be done to initiate the adoption of energy considerations on the local level because energy considerations permeate every community function. Phased and incremental adoption and introduction of energy considerations into master plans can test the community reaction to energy involvement and serve as a useful trial baloon to the adoption of more specific and meaningful energy planning.

Identification of those community functions which most lend themselves to intervention on the part of the planner should be the first step when considering an energy program. Having a broad understanding of how these functions relate to energy is part and parcel to this first step. These considerations set the tone for this chapter. This chapter seeks to set out the framework for approaching energy planning. It sets out this framework in a broad and comprehensive manner with an eye toward total integration into a community master plan. However it also attempts to establish a universally valid approach from which communities can pluck selected portions to establish an energy program on an incremental basis without loosing site of the comprehensive context from whence it came.

LOCAL ENERGY PLANNING AND THE MASTER PLAN

The comprehensive plan has been defined by the planning profession as, "an official public document adopted by a local government as a policy guide to decisions about the physical development of the community".[1] Further definition and explanation of the comprehensive plan depicts it as:

1. consisting of three technical elements; the private uses of land, community facilities, and circulation.
2. being comprehensive in scope, long range, general, focusing on physical development, relating physical design proposals to community goals and social and economic policies, primarily a policy instrument and and secondarily a technical instrument.
3. functioning to facilitate policy formulation and effectuation by legislative bodies and chief executives establish communication and coordination among government agencies, provide a forum for conveying advice from the government technicians to the policy formulators, educate the public about community issues and conditions, solicit public viewpoints, provide government agencies with a context into which each one can place its own plans and programs.
4. a process which requires continual review and appraisal and from which benefits flow rather than an end in itself. It depends upon carefully drafted programs, zoning ordinances, budgets, and capital investment programs for its implementation and the collection and review of technical data for its development.[2]

Recognizing the distinction between the plan, planning tools, and implementation is important to the planner and to the reader of this document. These are concepts which have historically been confused and used synonamously when in fact they are very distinct. These are three seperate concepts which together make up the planning process and are addressed in seperate chapters in this document. This chapter, Chapter II, addresses the plan. Chapter III and IV address the tools, Chapter V addresses implementation.

Energy components can be integrated into the comprehensive plan to meet specific energy goals and/or as a means of attaining related community goals. Establishing provisions for energy in the plan which are consistent with and contribute towards the attainment of other goals of the community may be the best way to assure that progress is made in ultimately effectuating policies and plans for energy. For example, this has become a recommended course of action within the 208 program.[4] 208 is a federal program aimed at reduction of water pollution and bringing water bodies and waterways up to fishable and swimmable levels by 1983. The success of the program is to a great extent dependent on performance at the local level. One 208 expert advocates that, "One way to almost assure local implementation of 208 is to show how it can accomplish some of the existing desires of the community".[5] This will help planners to build the coalition necessary to implement 208. The same can be said for energy, with master planning advocated as the best mechanism from which to begin the building of this coalition.

The traditional focus of comprehensive planning on private uses of land, community facilities, and circulation are clearly the appropriate areas for which to link energy planning. The level and type of energy consumption is clearly a function of the physical size and make up of the community. Like any other resource which is consumed in the community it has its social and economic implications. Whether the goals of the community are explicitly energy goals or not, the form-

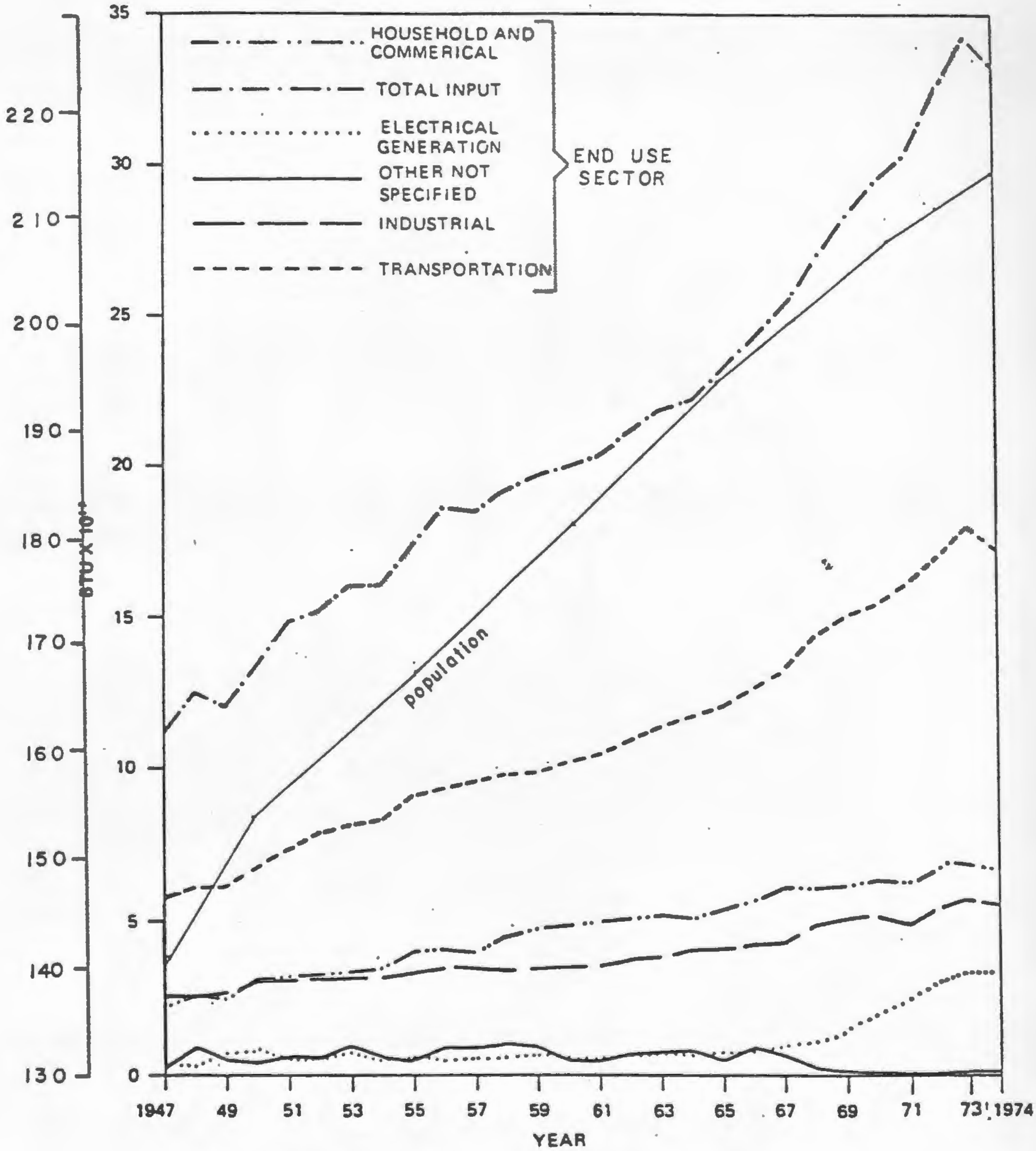
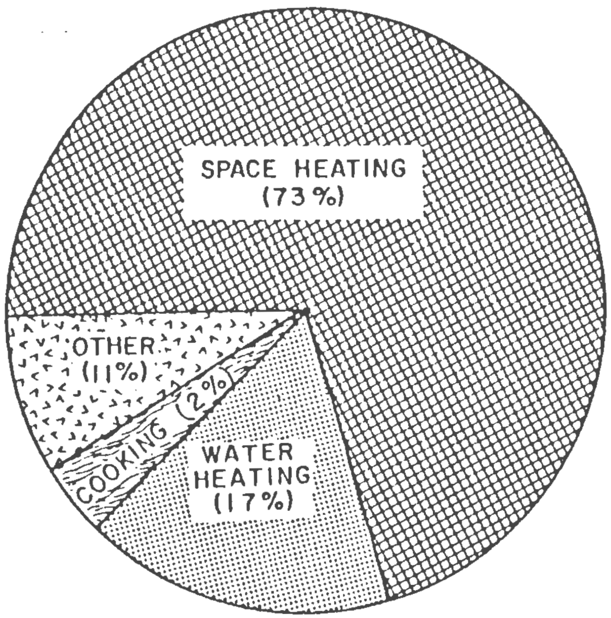


Figure II-1 Petroleum Consumption by Sector, 1947-1974
U.S. POPULATION, 1947-1974

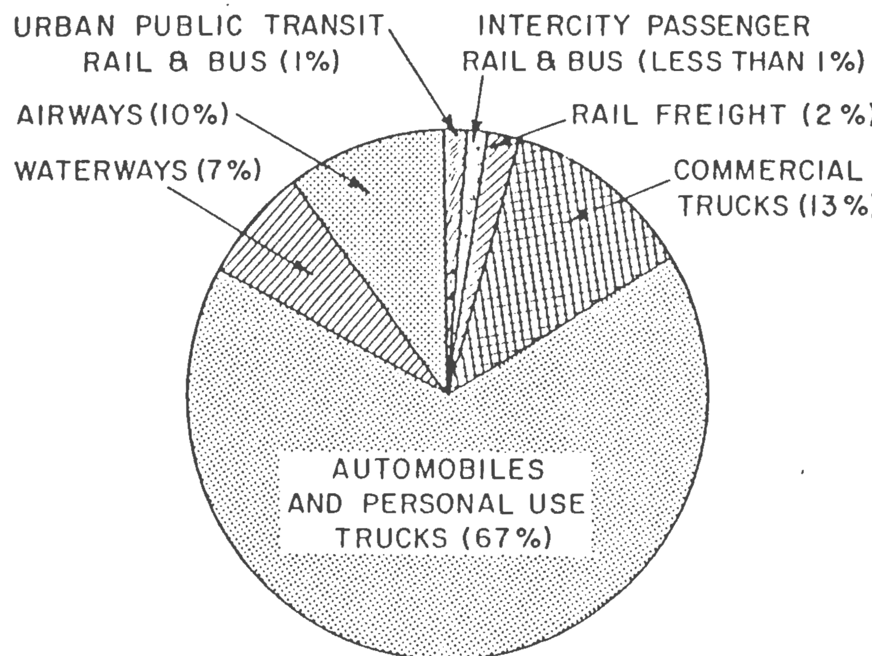
source: U.S. Department of Commerce, Bureau of the Census, Current Population Reports: Population Estimates and Projections, Series P-25, No. 704, Washington, D.C. Jan. 1977, Table D; U.S. Dept. of Interior, U.S. Energy through the Year 2000, Dec. 1972, tables 2, 6a, 6b.

SECTOR END-USE OF ENERGY - 1974

	New England	United States
Residential	25%	18%
Commercial	27%	14%
Industrial	13%	35%
Transportation	35%	32%
Agriculture	–	1%



Residential and commercial energy use in the Northeast, 1972.



Transportation energy consumption in the Northeast by mode, 1972.

Figure II-2 END USE SECTOR ENERGY CONSUMPTION ulation of energy policies and objectives can be done to enhance the probability of achieving these goals.

Figure II-1 is offered to illustrate how physical growth necessarily means an increase in energy consumption. The functions, or aspects, of the community which comprise its physical make up are presented subsequantly.

COMMUNITY FUNCTIONS

Identification of those functions of the community which most lend themselves to intervention on the part of the planner is important because it provides the planner with a perspective as to what extent he can influence the direction of the community's growth and, therefore, the way energy is used. By examining the community functions, establishing what individuals have a role,. and establishing its relationship to energy, the planner can better assess what his role should be and how particular community functions fit into the overall scheme of community energy planning. This will help the planner in a number of ways It will help him to establish a coalition of support, it will help him in making an early identification of barriers to implementation (political, financial, bureaucratic barriers), it will help identify areas where a vacuum in planning or responsibility exists which he may be able to influence, and it will provide him with a framework of ideas to consider for integration into the master plan.

Table II-1 presents the typical functions of the community and important characteristics of each function. This matrix is a tool which can be applied by the planner in doing preliminary analysis of any community. The community functions

Table II-1 COMMUNITY FUNCTIONS

FUNCTIONS	IMPLEMENTATION MECHANISMS	ACTORS	IMPLEMENTATION FUNDING SOURCES
	PRESENT LOOKING FUNCTIONS		
maintenance of housing stock	minimum housing code	housing inspector, housing authority, landlords	private, HUD, EDA, CSA, DOE, state and local revenues
maintenance of government buildings	budget, capital improvements program	department heads, building authority, chief exec.	local and state revenues, HUD, EDA
maintenance of economic base	taxation	chief exec., economic development department	private, EDA, HUD, state and local revenues
public transit and highway maintenance	budget, pricing, regulatory powers	public works dept., city engineer, transit auth.	HUD, EDA, DOT, UMTA, state and local revenues
maintenance of public utilities	budget, pricing, regulatory powers	public works dept., utility commission, chief ex.	utility revenues, taxes
waste disposal	budget, capital improvements program, pricing	public works dept.	fees, local and state revenues
	FUTURE LOOKING FUNCTIONS		
future use of vacant land	land use plan, zoning	planner, planning bd., cons, com., ind. dev. auth.	private, BOR, BLM, HUD, foundations
site design	subdivision regulations	planner, building insp., city eng., health dept.	local, private
new construction	building code	planner, bldg. insp., planning bd.	local, private, HUD, EDA
transportation and highways	land use plan, subdivision regulaions,	planner, city engineer, planning bd.	UMTA, FHWA, local and state revenues
municipal facilities	land use plan, capital improvements program	planner, dept. heads, chief exec.	local and state revenues, EDA, HUD

presented are physical aspects of the community. Altering these aspects of the community will affect long term changes in energy growth because it is the structural and developmental components of the community which most affect the manner in which growth in energy consumption takes place. The information presented in this matrix can be used as a guide to the planner or the matrix format can be used as a tool to apply to specific communities.

The functions which are identified are those functions over which the community/local government has traditionally had a role in shaping either through its explicit responsibilities and controls or due to less explicit influence such as the overall community values and attitudes. Shaping these values and attitudes is perhaps as important in guiding the direction of the community as planning itself, especially with regard to energy.[6] The controls and the responsibilities of the local government are exerted or tended to through many mechanisms such as building codes and maintenance agencies, such as the public works department. Values and attitudes of the community are expressed in many ways including the community master plan. A more detailed discussion of implementation mechanisms and resources available to the community will take place in Chapter V.

The community functions in table II-1 are considered under two headings. These are "present looking functions" and "future looking functions". Future looking functions encompass those physical aspects of the community that will ultimately exist and must be planned for but, in fact, do not exist at at present. Present looking functions are those aspects of the community which are existing, thus the role of the community/local government is to maintain these aspects of the community. Future looking community functions are greatly subject to community influences because they lend themselves to full conceptualization, whereas present looking functions lend themselves to limited conceptualization. This idea is important, particularly to the planner who is most often involved in future looking functions. The temporal nature of the community function is a large factor in determining the approach to implementation and the extent of results in any type of community program, including energy conservation.

These eleven functions encompas the end use sectors within which the greatest energy savings in the community are possible and which most lend themselves to implementation through resources and mechanisms which have traditionally been applied by the planner and the community to obtain community goals and objectives. Community energy conservaiton goals and objectives should be integrated within the overall goals and objectives of the community in order to be given proper and thorough consideration. Some means for integrating community energy management goals and objectives with other compatable goals and objectives of the community are addressed subsequently.

INTEGRATING ENERGY INTO THE MASTER PLAN

Prior to presenting approaches to integrating energy into the comprehensive plan it is necessary to establish a clear definition of the terms goal, policy and objective. These are terms which are loosely used in the planning profession. A lack of clear definition of these terms can make the task of plan development much more complex than it has to be. Although definitions of these terms do vary slightly from planner to planner and from plan to plan, the most workable definitions come from Morris Hill. Hill's definitions are as follows:

1. Goal - and end to which a planned course of action is directed.

2. Objective - denotes an attainable goal that has instrumental value in that it is believed to lead to another valued goal rather than having intrinsic value in itslef. Objectives are defined operationally so that either the existence or nonexistence of a desired state or the degree of achievement of this state can be established.

3. Policy - the specification in concrete details of ways and means for the attainment of planned objectives.[7]

Other terms which are frequently used by the planner in master planning and which could benefit by definition are as follows:

1. Ideal - a horizon allowing for infinite progression in its direction.[8]

2. Values - the system of preferences which governs action in society.[9]

To the planner, the relationship of the concepts depicted by these terms is fundamental. The concepts of ideal, goal, value, objective, and policy relate to one another on a continuum. This relationship has been dubbed by one planner as a system of interlocking circles and spirals depicting "planning in action".[10] The task of identifying and establishing the specific make up of these concepts, along with the implementation strategies appropriate to them, is the essence of planning. Figure II-3 is one way of depicting the relationship

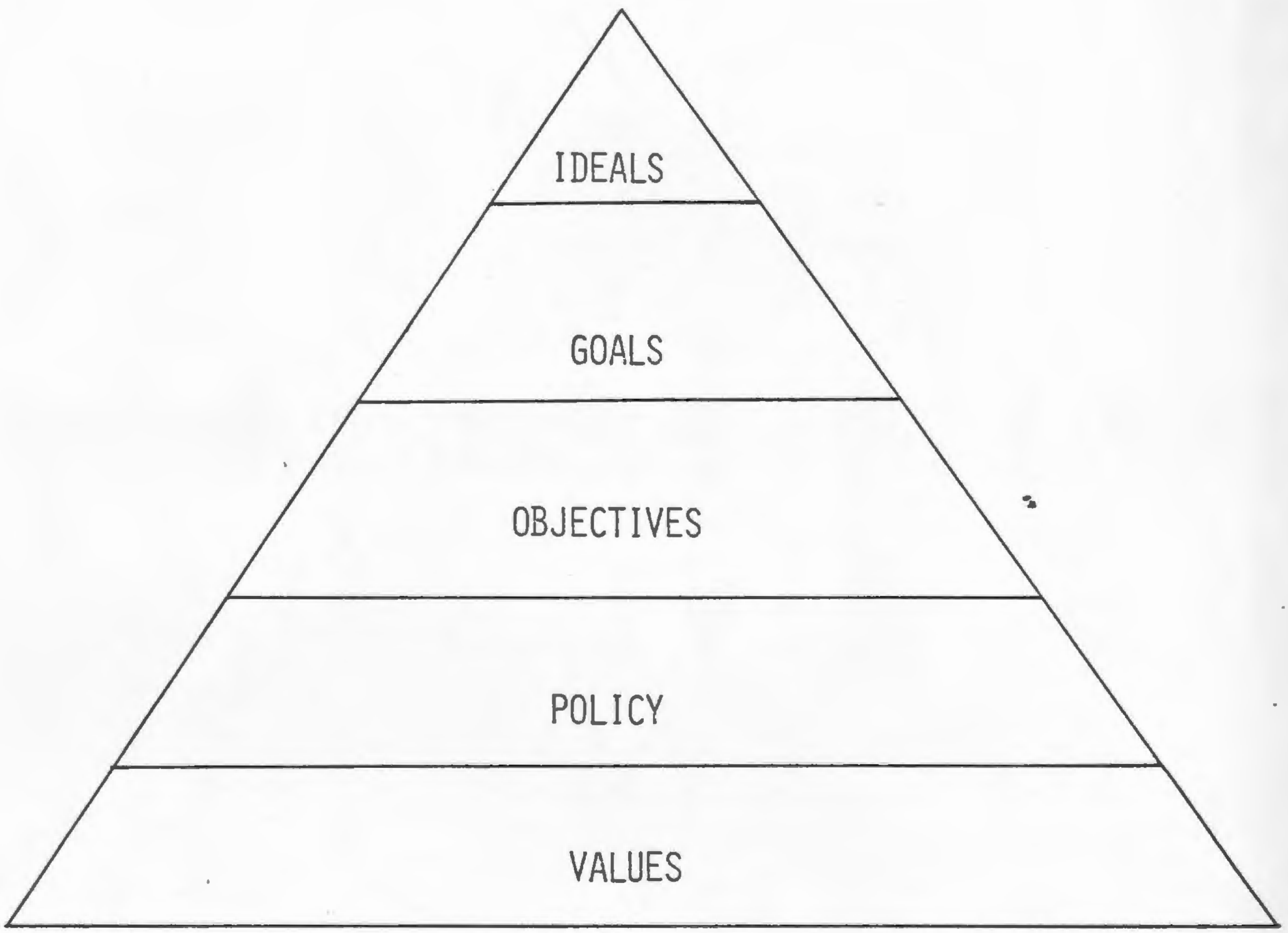


Figure II-3 One way of depicting the relationship between values,policy, objectives, goals, and ideals. Ideals are depicted as the pinnacle of the triangle, while its base is made up of the values of the community. Any change in the base will change the shape of the entire triangle.

of these concepts. The examination of an actual community master plan will help to specify the possible linkages between energy concerns and other concerns and components of the master plan. The document to be examined, forthwith, is a comprehensive plan for a suburban community which is fairly typical of New England. It is developed and presented in the traditional mode, with a focus on three major elements: land use, community facilities, and highways. The community has a population of 15,000 and is 15 square miles in size.

This community has established the following goals in its comprehensive community plan:

1. To encourage population growth providing such growth takes place in an orderly and efficient manner.

2. To provide a range of possible housing densities based on the availability of public utilities, physical conditions, community facilities and existing patterns of development.

3. To broaden the employment base by promoting gowth of established firms and location of new industries.

4. To promote and insure the use of physically sound and safe structures for human habitation.

5. To accomodate the expansion of business activities by providing viable primary shopping complexes and highway and service areas.

6. To provide an efficient and economical program of community facilities and services commensurate with population gowth, in accordance with accepted standards and in locations designed to best serve the needs of the community.

7. To provide an efficient uninterrupted flow of both through and local traffic throughout the Town.

8. To coordinate the development of the town with those of adjacent communities.

9. To enable the Town to qualify for State and Federal financial and technical assistance for planning,

public works, and other development programs.

10. To provide recreation areas for all age groups in each district of the Town, and to preserve and improve water courses and adjacent natural areas.[12]

Table II-2 presents a framework for analysis of the implications of the goals which have been established by the case community in its comprehensive plan. This analytical tool can be used to establish linkages between the goals of the master plan and its implications for other characteristics and resources of the community. Figure II-2 provides an assessment of the case community's goals based on their face value, that is, out of the context of the comprehensive plan. This first cut analysis enables the identification of only the obvious linkages which are explicitly expressed in the goal statement. Use of this matrix allows for the identification of the main thrust of individual goals and the cumulative impacts of the goals. Placing these goals within the context of statements of objectives and policies will enable more detailed and meanin analysis of each goal and more specific identification of the impacts. Without knowing these objectives and policies the goals remain somewhat nebulous and any further attempt to make judgements about their impacts would be erroneous.

This tool should be used during plan development to identify those characteristics of the community which are affected by master plan goals, determine the level of their energy implications, and generate alternatives for achieving the desired goals in an energy efficient manner and through the attainment of energy objectives. For example, table II-2 points to increasing accessibility as a desirable objective for the achiev-

Table II-2 IMPACTS OF CASE COMMUNITY'S GOALS

	ECONOMIC	PHYSICAL GROWTH AND MORE STRUCTURES	ACCESS AND PROXIMITY OF LAND USE	INTENSITY OF LAND USE	DIRECT ENERGY USE	INDIRECT ENERGY USE
1. Encourage orderly and efficient population growth.	related	strong	strong	indeterminate	strong	strong
2. Provide a range of housing densities considering utilities, community facilities and current land uses.	indeterminate	strong	strong	strong	potentially	potentially
3. Broaden employment base by promoting growth of present industry and location of new industries.	strong	strong	indeterminate	indeterminate	related	related
4. Promote and ensure the use of physically sound and safe housing.	indeterminate	strong	indeterminate	indeterminate	strong	strong
5. Accomodate the expansion of business activities by providing viable shopping areas and highway service areas.	strong	strong	strong	related	strong (transp.)	related
6. Provide efficient community facilities and services in good locations and which serve community needs.	weak	related	strong	related	strong (transp.)	related
7. Provide and efficient flow of through and local traffic.	weak	related	strong	related	strong (transp.)	related
8. Coordinate development with adjacent communities.	related	related	related	indeterminate	related	related
9. Enable the town to apply for TA funds for planning, public works, and development programs.	strong	strong	———	———	———	———
10. Provide recreation areas in all parts of the community and preserve natural resources.	weak	strong	strong	indeterminate	strong	related

ment of three of the ten goals listed. The strong correlation between energy consumption and accessibility is apparent from the matrix. Establishing a goal of reducing energy consumption in the transportation sector through promotion of mass transit and accomodation of alternative transportation modes would be very compatable with these goals. This goal would result in the same implications for accessibility as the other three goals, but for different purposes. In fact, this community could very well have improved the organization of its master plan by making accessibility the goal for the purposes of servicing commercial districts, accomodating through and local traffic, and achieving energy reductions in the transportation sector. Objectives could then more easily be established to achieve the goal which is common to these purposes. Other examples can be culled from this matrix.

The terms "direct energy use" and "indirect energy use" are explained in the next chapter. A knowledge of the facts of energy consumption, both generic facts and community specific facts, is very important in energy planning and in the effective application of the analytical tool provided by table II-2. Chapters III and IV will address these facts as well as tools for collecting community specific data.

CHAPTER II

Footnotes

[1]Alan Black, "The Comprehensive Plan". In Principles and Practices of Urban Planning, ch. 13; p. 349. Edited by William I. Goodman and Eric C. Freund. (Washington, D.C.: International City Managers Association, 1968).

[2]Ibid. pp. 349-371.

[3]Mel Scott, American City Planning, (Berekley: University of California's Press, 1971) pp. 242-248.

[4]Federal Water Pollution Control Act Amendments of 1972, Title II, Grants for Construction of Treatment Works, sec. 208, Areawide Waste Treatment Management.

[5]Ron Davis, "208 Report", Practicing Planner, vol. 6, no. 4 (Sept. 1976): 38-40.

[6]For a discussion of the planner's role in educating the public about energy and shaping the public's values and attiudes see, Comer L. Taylor Jr., "Planning and Energy Conservation", Practicing Planner, vol. 8, no. 2, (June 1978), pp. 6-7.

[7]Morris Hill, "Goals-Achievement Matrix", Journal of the American Institute of Planners, vol. 35, no. 1 (January 1968): 19-28.

[8]Ibid.

[9]"Comprehensive Community Energy Planning", draft prepared for the U.S. Dept. of Energy, Division of Building and Community Systems by Hittman Associates, 1978.

[10]Alfred J. Kahn, Theory and Practice of Social Planning, (New York: Russell Sage Foundation, 1969), 60-95: William Ferguson, "Model for the Interface of Social and Environmental Planning", (typewritten paper prepared for graduate school planning course), November, 1975.

[11]North Providence, Rhode Island, Comprehensive Community Plan, prepared by the Dept. of Community Affairs, Planning Division, 1968.

CHAPTER III

ENERGY USE IN BUILDING AND BUILDINGS

Introduction

The planner's ability to serve a useful function relative to community based energy planning is largely dependent upon two things. They are:

1. his ability to assemble meaningful and valid information,
2. his ability to apply this information to plan development and implementation.

Chapter III focuses on energy consumed in three areas. These areas are the manufacture of products, in construction, and in the operation of buildings. This chapter addresses structures as individual entities taken out of the context of the community as a whole. Because it addresses structures it will encompass the industrial, commercial, residential, and government buildings end use sectors. The information presented has meaning for both new and existing buildings as well as for physical maintenance of the community. Chapter IV takes more of a holistic approach by looking at energy in the context of the overall physical makeup of the community.

In recent years, much headway has been made in the monumental task of understanding how energy is used in the three aforementioned areas of Chapter III. However, most of this information lays idle in reports and is yet to be applied for practical purposes and in the solving of actual problems. This will be part of the job of Chapter III. Chapter III will present this data, demonstrate how it can be applied by the planner, and identify and discuss methodologies which were used in its collection. Much of the data presented in Chapter III is generic data. Sources of, and methods for, gathering and utilizing community specific data will be presented as well. However, because community energy data collection is such an enormous task the application of generic data to specific community circumstances may be the most feasible approach to energy planning research.

When assembling data the planner must understand the distinction between primary or original data and secondary data. Primary data is the data which the planner or researcher collects for himself. Secondary data is data which has already been compiled by other agencies or individuals. When deciding whether to undertake primary data collection or to rely on secondary data the planner/researcher must be cognizant of several considerations.

The collection of primary data is costly and time consuming. An accurate assessment of costs and time requirements for undertaking primary data collection must be made prior to undertaking the task. A decision must be made as to whether the planning process can accomodate these factors without disrupting its timeliness or creating a project cost imbalance. On the other hand collection of primary data may be required due to a complete data gap or due to serious questions of validity about existing data. Primary data collection can sometimes provide an educational function that may be useful to the community and the planner by exposing people to issues and aspects of their community that they have never had to think about. Providing for timely public release of the results of the data collection process can further focus public attention on the subject matter and issues of the study.

Secondary data has the advantage of being readily available and inexpensive to collect. However secondary data may be inaccurate because it is outdated or not accurately transferable from one situation to another. Also, the accuracy and bias of its collector must be a consideration. When utilizing secondary data some of the educational advantages, attributed to primary data collection, are lost.

Some combination of primary data and secondary data is usually the best approach in conducting planning research. Whatever the planner decides, he should always be careful to fully consider the implications and documenting his reasons for selecting a particular approach. During the data collection process the planner should also document methodologies, data sources, and assumptions which were made during the process of data collection and analysis.[1]

DEFINING TERMINOLOGY

Energy consumed can be defined under two categories. The terminology which applies to these categories is "indirect" or "embodied" energy consumption and "direct" energy consumption. The concepts which these terms encompass are fundamental to this chapter.

The term embodied energy refers to the quantity of energy input to production of a particular good or material. Embodied energy is comprised of energy consumed in the processing, assembling, packaging, and transportation of goods and materials. Every good produced has an investment of energy embodied in it although, as an end product, it may or may not consume energy in their operation. This type of energy consumption is termed direct energy consumption. Other end products, such as insulation, do not consume energy but are a factor in the level of energy consumed directly. Whereas indirect energy is a measure of energy consumed per production output, direct energy is a measure of specific energy input.

As has been previously stated, this chapter focuses on energy consumed in the manufacture of products, in construction, and in the operation of buildings. Manufacture of products implies the concept of embodied energy. Under the category of embodied energy this chapter will be addressing energy consumption in industry and for the production of building materials. Under the category of direct energy consumption this chapter will address energy consumed in construction and by buildings.

EMBODIED ENERGY

Embodied energy is commonly expressed in terms of energy intensity. Energy intensity is often expressed as the number of BTU's consumed per dollar of manufacturing or the percent of value manufacturing for energy. Energy intensity can be applied to individual products or to whole industry groups to produce a meaningful statistic for use in understanding the relative level of energy use in the manufacture of goods.

Table III-1 lists the energy intensity of selected end products. Table III-2 illustrates the energy intensity of New England industries by SIC. (A more complete list is included in Appendix C.)

Knowing the energy intensity, embodied energy, of products

Table III-1

ENERGY INTENSITY OF SELECTED PRODUCTS

(in thousands of Btus per $)

Product	Energy Intensity	Product	Energy Intensity
Medical, Health Services	110	Misc Business Services	25
Tires	85	Drugs	41
Chemicals	206	Public Bldg. Furniture	55
Apparel(from purchased material)	43	Fertilizer	197
Glass Products	92	Envelopes	68
Refrig. Machinery	58	Electric Lamps	39
Sanitary Paper	79	Radios and TVs	28
Plastics	86	Athletic Equipment	52
Canned Fruit	68	Bakery Products	43
Hand Tools	58	Pens and Pencils	48
Frozen Food, Vegetables	67	Musical Instruments	47
Ice Cream	56	Coffee	29
Poultry, eggs	68	Wood Househod Furni.	40
Metal Cutting Toosl	35	Electronic Components	44
Soft Drinks	54	Mattresses	52
Pickles	65	Sugar	107
Silverware	40	Hardware	65
Footware (except rubber)	35	Phono Records	49
Pottery Products	80	Watches, Clocks	38

Source: R.A. Herendeen and C.W. Bullard, "Energy Costs of Goods and Services", (University of Illinois), November 1974.

BTU CONTENT OF SELECTED FUELS			
Distillate	1 gallon	=	125,800
Residual	1 gallon	=	125,880
Natural Gas	1 cubic ft	=	1,025
Electricity	1 kwh	=	3,412

Table III-2
TOTAL PURCHASED ENERGY COSTS AS A
PERCENT OF VALUE ADDED

sic	manufacturing sector	U.S.	CT	ME	MA	NH	RI	VT
20	Food and Kindred Prdts	4.3	3.6	11.2	3.4	4.7	3.9	4.1
205	Bakery Products	1.9	3.0	--	2.8	--	--	--
22	Textile Mill Prdts	5.2	8.0	7.0	6.8	5.7	8.1	--
225	Knitting Mills	3.7	--	--	3.2	2.8	8.2	--
23	Apparel	1.1	1.7	1.0	1.2	0.9	1.5	--
24	Lumber and Wood Prdts	4.2	6.0	6.3	4.1	4.0	--	6.4
25	Furniture and Fixtures	1.8	1.9	2.8	2.7	2.9	--	5.2
26	Paper and Allied Prdts	10.0	13.3	21.8	12.7	17.5	10.3	10.4
27	Printing and Publishing	1.0	1.2	1.3	1.3	2.2	1.1	1.2
28	Chemicals	7.7	6.1	--	5.7	7.7	5.3	--
30.	Rubber and Plastics	3.6	6.1	5.8	6.3	4.0	3.6	5.8
31	Leather Goods	2.5	--	2.8	2.5	3.6	--	--
314	Footware (ex rubber)	1.1	--	1.4	1.1	1.2	--	--
32	Stone, Clay, Glass	10.7	6.4	17.9	5.8	9.1	17.2	4.8
33	Primary Metals	11.2	8.8	--	5.3	--	6.4	--
34	Fabricated Metals	2.3	3.0	5.5	3.5	2.3	3.6	--
35	Non Electrical Mach.	1.5	2.5	2.9	1.5	1.6	2.2	2.3
36	Electrical Equipment	1.6	1.8	1.3	2.1	1.4	2.0	--
37	Transportation Equipment	1.8	2.1	--	3.5	3.8	1.8	--
38	Scientific Instruments	1.2	1.8	--	1.5	1.4	2.6	--
391	Jewelry	1.4	--	--	1.1	--	--	--

source: Susan K Raskin, "The Manufacturing Industries' Energy Requirements in New England and the United States", Technical Report No. MIT-NEEMIS-77-008TR, (Boston: New England Regional Commission, 1977), Table 1.

and industries is important in two ways. First, it provides a presentation of data on energy consumed for the manufacture of construction materials used in the community. Second, it provides generic data on the energy consumed by the industries in the community.

Data on embodied energy of construction material gives the planner information he needs to assess the marginal costs and benefits of alternative construction projects in the community. It also gives the builder additional information when choosing amongst alternative materials and designs for construction projects. Information on embodied energy becomes increasingly important as the cost of energy rises. Future construction or capital improvements that are being considered in the community by building committees or in master plans would best serve the community through their cognizance of embodied energy in construction.

Data on embodied energy is also important when evaluating community based industries from an energy stand point. In lieu of energy information for specific plants in the community, embodied energy data for industry groups and products provides a good indication of the relative importance of energy to various firms in the community and to the industrial sector of the community as a whole. This generic information can be derived by state for industries from the U.S. Bureau of Census and Bureau of Mines.[2] This information can be used to target programs or further study. Industries which are energy intensive have a higher investment in energy and therefore can be expected to be more concerned about managing energy use in an effort to maintain their profitability and their stability in the community.

Information compiled by the Rhode Island Governor's Energy Office verifies the significance of energy intensity data as an indicator of the importance of energy management to industry groups.[3] In a survey of the nine most energy intensive industries in the state eighty percent of the firms responding indicated that coping with the cost of energy was important to the success of their business.

EMBODIED ENERGY AND INDUSTRY

Although embodied energy data is being touted as the fundamental information for analyzing industry and planning conservation programs for industry, the groundwork of establishing a detailed inventory of manufacturing firms in the community must be undertaken as the first step. There are several sources that the planner can turn to for this information. They are local or regional industrial development agencies, Chambers of Commerce, the local taxation office, and the state taxation department. In the state of Rhode Island the Department of Economic Development has established and maintained a directory of manufacturers.[4] This directory lists all manufacturing firms in the state by town and by SIC. Similar directories may be available in other states and regions.

Once the inventory is completed, the firms should be listed by two digit SIC. Energy intensity data, expressed in percent value added[5] can be obtained from, U.S. Bureau of Census, Annual Survey of Manufacturers. This information is available by area by SIC. This energy data should then be matched with the inventory by SIC to establish the relative energy intensity of each industry group. Table III-2 lists total U.S. and New England energy intensity data by industry group.[6] This U.S. data can be used to compare with area specific data to obtain a better perspective of the significance of the local data.

At this point the planner has to make a decision as to one of three options. They are: (1) begin program development based on the data obtained, (2) undertake primary data collection, (3) present embodied energy data to the chief executive governing body and recommend a direction and resources necessary to persue that direction. In most cases the planner will want to undertake option (3) at this stage in order to gain support and build a coalition for options (1) or (2). The decision as to whether to opt for (1) or (2) largely depends on how conclusive information collected during the first phase of energy research was (energy intensity information), how well targeted programs have to be in order to be effective, the financial resources available, and the support existant within the community. At this point the pros and cons of primary data collection should be carefully considered.

In many cases a decision should be made to persue the collection of primary data. A needs assessment survey of firms in the community can accomplish several things. First, it can help to accurately target informational needs. Secondly, it can help to reveal whether firms share common needs and concerns that can be addressed simultaneously in one program or help to bring firms together to solve their problems jointly. Third, it can provide the educational function of getting firms to think about the issues and problems that face them. Fourth, it can contribute towards developing a positive attitude on the part of the industrial community toward the local government which could conceivably serve as a factor in keeping firms in the community to remain as part of its economic base.

When undertaking a needs analysis or attitudinal survey it is important to have a good mail-out questionnaire. There are several characteristics that comprise a good questionnaire. A questionnaire should be as brief as possible, present questions clearly, put as little burden as possible on the respondent without leading him, should posess questions which have a specific purpose, should be careful to include all questions that need to be asked. Although this list is not exhaustive these are good guidelines that work in practice. Having some ideas about what types of programs potentially could be implemented prior to the development of a questionnaire is recommended where possible. In this way the need for specific programs can be tested. Use of return envelopes and postage will contribute towards a high response rate. Use of a cover letter which carefully explains the purpose of the survey, which promises disclosure of the results of the survey, which emphasizes that programs for the client group will result from it, and which stresses the importance of responding will also contribute towards a high return. Appendix C contains a needs assessment and program evaluation questionnaire which was utilized by the Rhode Island Governor's Energy Office in the development and evaluation of programs conducted in the state. Also included in Appendix C is the results of the questionnaire.[7]

There are a number of possibilities for energy programs which could be conducted for industry. There are also many organizations which are eager to assist in the development and sponsoring of energy programs for industry. These organizations include the State Energy Office, Chambers of Commerce, Small Business Administration-Senior Core of Retired Executives, energy utilities, professional societies (engineers in particular) and others. Possible programs include technical seminars, forums for plant engineers, information dissemination, and tax incentive programs.

ENERGY AND CONSTRUCTION

The traditional job of the planner is managing physical growth and the social, environmental and economic implications of that growth. The level of construction in the community represents that growth. How significant is construction in the overall energy scheme? Overall, the construction industry consumed about 6000 trillion BTU's, or about ten percent of the total U.S. energy requirement in 1967.[8] This represents energy embodied in material and energy consumed directly at the construction site. It also represents a significant amount of energy consumption. Energy used in construction, rather than energy used by buildings, is the topic of this section. Energy consumed by buildings is the topic of the next section. Much of the information presented in this section comes from a study done by the Center for Advanced Computation, University of Illinois at Urbana. Although the study was only recently completed in 1977, the base year used for the study was 1967. As a result most of the information presented in this section will be for that base year.[9]

This section points out the major areas in which energy is consumed in construction. By doing so, it is hoped that decisions made in the community and by the planner will better be able to account for the energy implications. The information should serve as a guide for decision making about construction in the community. The information presented can be used to formulate specific policies and regulations about methods and materials used for private and/or public construction in the community or could be applied during review procedures when considering new construction proposals.

Of all the energy used in construction less than twenty percent is consumed at the job site (direct energy). The remaining eighty percent is accounted for by embodied energy.[10] Figure III-1 illustrates that of all the energy for construction 57.4 percent is for building construction where 42.6 percent is for non-building construction. This figure also illustrates that 81.8 percent of all energy consumed for construction goes to new construction with 18.2 percent going to maintenance and repair. Figure III-2 presents this same information as a percentage of all energy consumption in the U.S. The most significant areas of energy consumption in construction are highways, new single family residential buildings, industrial buildings, and educational buildings as portrayed in Table III-3. Note also that new residential alterations and additions and highway maintenance account for significant energy consumption. Table III-4 lists the ten most energy intensive construction sectors,

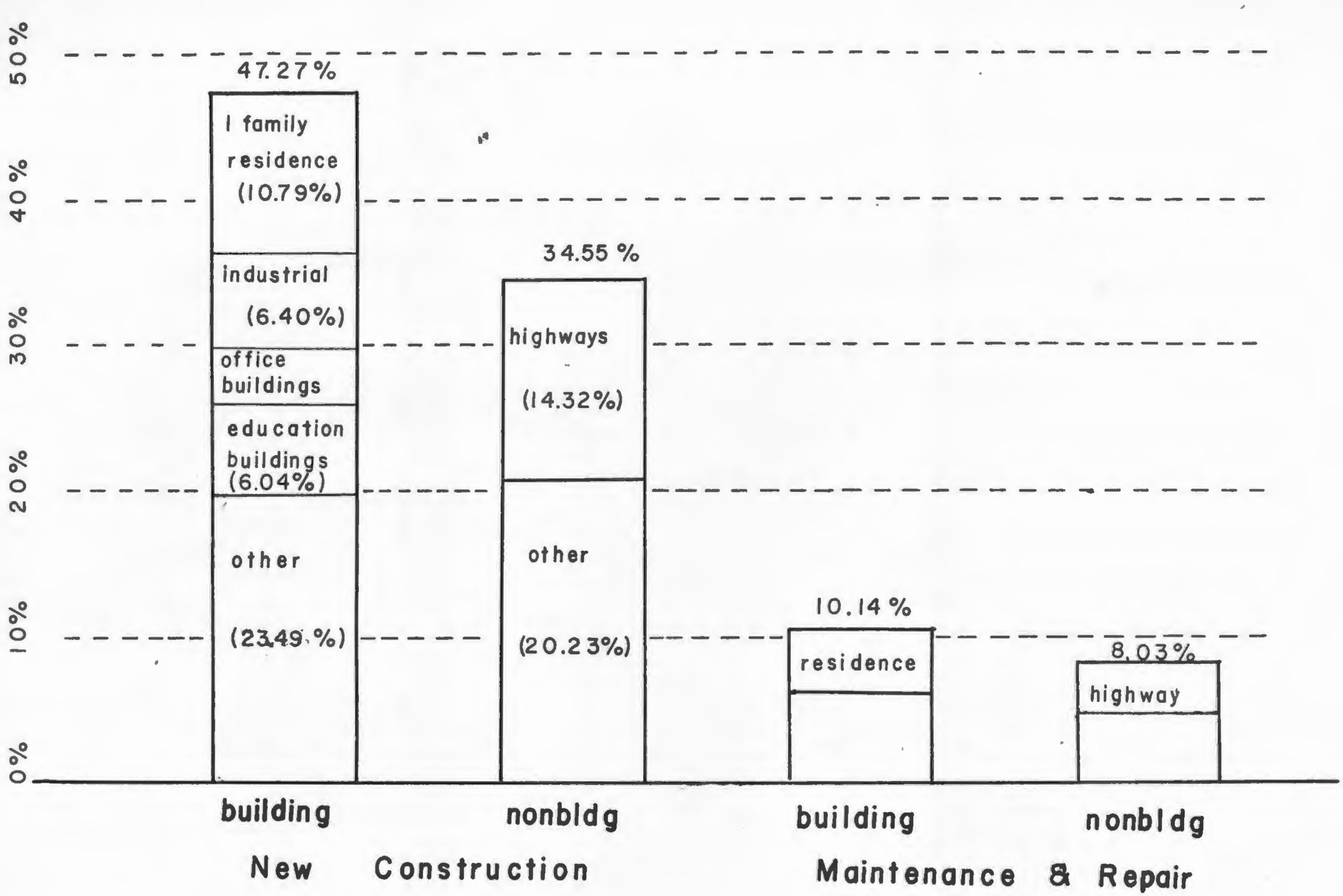


Figure III-1 % TOTAL CONSTRUCTION INDUSTRY ENERGY USE BY MAJOR SECTOR

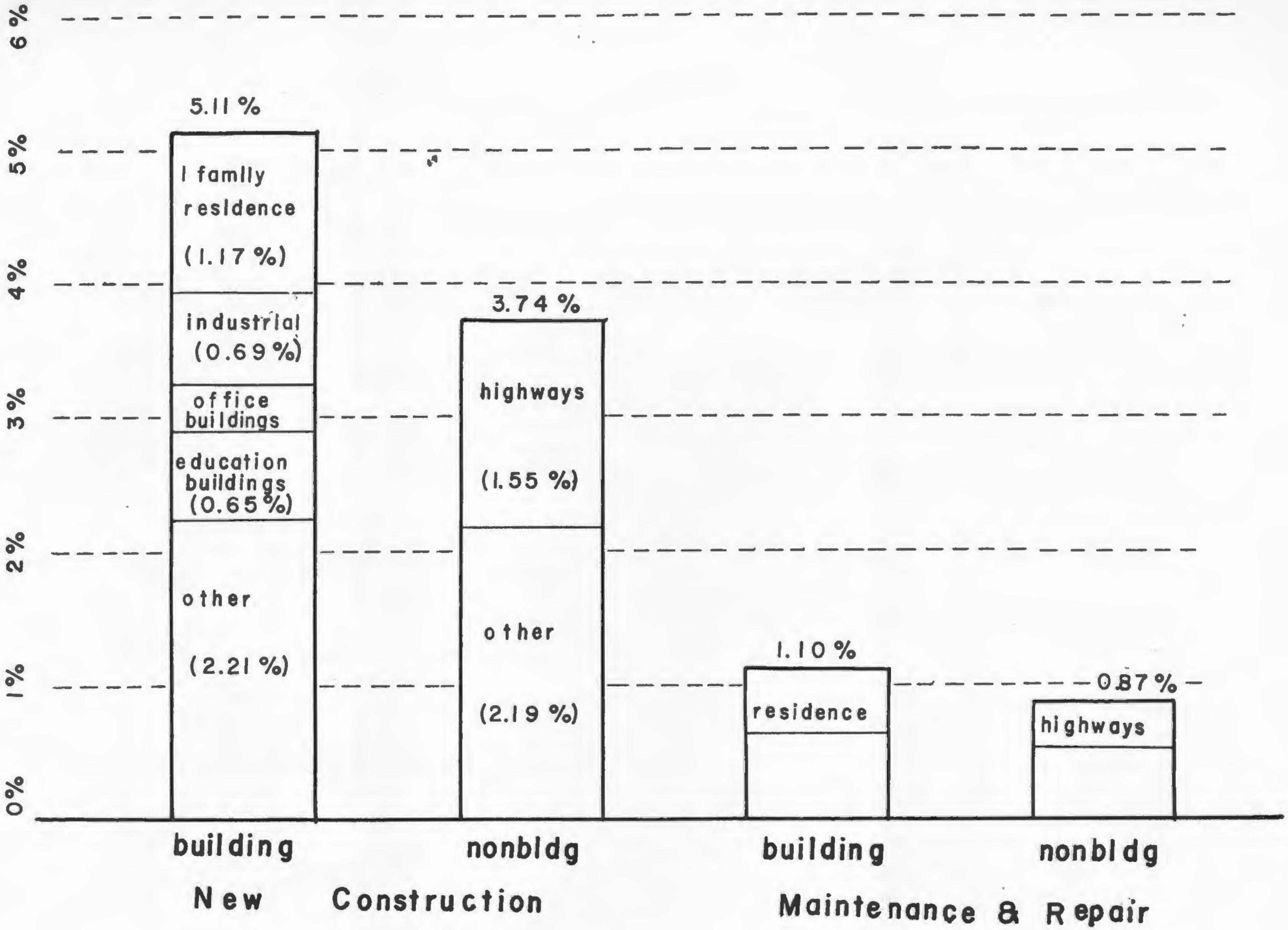


Figure III-2 CONSTRUCTION INDUSTRY AS % OF TOTAL U.S. ENERGY USE

Table III-3

TEN CONSTRUCTION SECTORS REQUIRING THE MOST TOTAL ENERGY TO FINAL DEMAND IN 1967.

SECTOR WITH INDEX	TOTAL ENERGY TO FINAL DEMAND (TRILLION BTU)	PERCENT DIRECT
New* Highways	1035.87	39.60
New Residential 1-Family	780.98	9.94
New Industrial Buildings	463.38	8.23
New Education Buildings	437.36	15.48
New Electric Utilities	303.94	12.69
New Residential Alterations & Additions	261.85	2.87
New Office Buildings	258.66	17.80
New Oil & Gas Wells	235.54	30.56
New Other Non-Farm Buildings	231.07	17.50
Maintenance**- Highways	220.00	43.57
All Construction Sectors	6301.94***	19.52

*Stands for "New Construction."

**Stands for "Maintenance & Repair Construction."

***Represented 9.42% of total U.S. energy requirement in 1967.

source: Hannon, Segal, Stein, Serber, Energy Use for Building Construction, (Urbana - Champaign, Ill.: Energy Research Group, Center for Advanced Computation, University of Illinois, February 1977) p. 11.

Table III-4

TABLE 3. TEN MOST ENERGY INTENSIVE CONSTRUCTION SECTORS IN 1967

SECTOR WITH INDEX	TOTAL PRIMARY ENERGY INTENSITY (Btu/$)
43. New* Petroleum Pipelines	147,197
42. New Gas Utilities	140,038
47. New Highways	123,745
63. Maintenance**- Petroleum Pipelines	117,158
50. New Oil & Gas Wells	116,895
70. Maintenance - Oil & Gas Wells	109,103
58. Maintenance - Farm Service	96,288
68. Maintenance - Conservation & Development	92,963
51. New Oil & Gas Exploration	92,941
54. New Other Non-Building	89,466
AVERAGES:	
All New Construction (32 sectors)	74,122
All Maintenance Construction (17 sectors)	56,182

* Stands for "New Construction."

**Stands for "Maintenance and Repair Construction."

source: Hannon, Segal, Stein, Serber, Energy Use for Building Construction, (Urbana-Champaign, Ill.: Energy Research Group, Center for Advanced Computation, University of Illinois, Feb. 1977) p. 10.

note that new highway construction ranks third. These sectors are of particular significance to the community in that they are the most familiar and predominant aspects of its physical growth. A more detailed understanding of their energy composition reveals alternatives for obtaining energy reductions.

Table III-5 presents the percentage energy embodiment attributed to the various components of construction sectors mentioned above. (note that direct energy is also included in Table III-5) This table reveals predominant energy components in each construction sector. Direct energy and stone and clay are predominant in the one family home sector while educational buildings and industrial buildings focus on a heavy energy embodiment for fabricated metals. Energy for highway construction is heavily oriented toward direct energy consumption.

Analyzing this information in light of what we know about the energy intensity of materials from Table III-6 provides a better understanding of the energy implications of information presented in Table III-5. It also provides a basis of information from which to derive alternatives for design and construction material selection in each building sector. Table III-6 illustrates that from the perspective of embodied energy it would be desirable to avoid the use of fabricated metals in construction. Within the stone/clay products category, the use of concrete blocks is the most desirable alternative when possible. Within wood products, plywood is a reasonable alternative. Glass products present a wide range of energy intensities, with specialty glass products (for use as structural components to buildings etc.) being very intensively consumptive

Table III-5

PER CENT ENERGY EMBODIMENT FOR COMPONENTS TO CONSTRUCTION SECTORS

material	one family buildings	industry buildings	education buildings	new highways	water supply
wood	16.4	1.3	2.5	0.7	1.4
paint/ asphalt	3.1	3.9	4.7	13.8	0.2
stone/ clay	23.4	25.8	21.9	23.2	15.7
fabricated metals	10.6	29.7	19.0	7.6	14.4
transprotation	3.4	2.4	2.1	2.8	1.6
trade	7.5	3.4	4.3	1.9	2.8
professional services	2.2	1.4	2.4	0.4	1.0
direct *	12.2	12.1	18.9	47.6	21.4
other	21.2	20.0	24.2	2.0	41.5**
total	100 %	100%	100%	100%	100%

source: The data used in this table was extracted from, Hannon, Segal, Stein, Serber, Energy Use for Building Construction, (Urbana-Champaign, Ill: Center for Advanced Computation, University of Illinois). Feb. 1977, figures A6, A7, A10.

*Direct energy is energy consumed on the job site. Included are coal, crude petroleum, refined petroleum, electricity, and natural gas. Products such as gasoline, diesel fuel, no. 6 oil, asphalt, road oil, and propane are considered to be refined petroleum products.

**Of this category 31.3 percent is attributed to steel products, foundry products, and pipe.

Table III- 6

ENERGY INTENSITY OF SELECTED CONSTRUCTION MATERIALS*

material	unit	Before Delivery Btu/$	Before Delivery Btu/unit	Trade & Delivery Btu/$	Trade & Delivery Btu/unit	Total at Job Site Btu/unit
standard board	bd ft	65,000	6,000	30,000	2,800	8,800
plywood	sq ft	68,000	5,100	21,300	1,600	6,700
hardwood board	bd ft	56,000	9,000	30,000	5,000	14,000
glass	sq ft	102,800	11,800 to 185,000	15,200	1,700 to 27,400	13,500 to 212,400
brick & structural tile	—	340,290	—	17,800	—	—
	brick	"	23,000	"	3,600	26,600
	tile	"	32,400	"	2,400	34,800
concrete block	block	141,600	29,000	13,700	2,800	31,800
ready mix concrete	cu yd	180,100	2.6 million	655	9,400	2.6 million
cement	bbl 280 lbs	479,600	1.5 million	17,500	55,600	1.6 million
steel/iron products (bars, shapes wire, sheets, pipes)	lb	267,000	30,400	13,900	1,600	32,000
aluminum products (sheets, rods, bars, shapes.)	lb	244,200	99,800	3,479	1,400	101,200

*source: Data was derived from, Hannon, Segal, Stein, Serber, Energy Use for Building Construction, (Urbana-Champaign, Ill: Center for Advanced Computation, Un. of Illinois), Feb. 1977, pp. 41-59.

of energy.

Embodied energy cannot be the only factor in material selection. Material cost, performance, esthetics and other considerations must go into material selection as well. However, when these other factors are equal energy intensity of materials can provide the margin upon which a decision about building materials and designs are made. Within the buildings sector various approaches can be taken to reduce embodied energy content to building construction. Switching to less energy intense materials within a products category, substituting for traditional products with new products, decreasing the size of structures, reducing dependency on designs that mandate predominant use of certain materials, such as brick and glass in schools, can all contribute to the reduction of energy consumed in construction. Appendix C contains more complete and detailed information on the energy intensity of various building materials for reference and use in evaluating construction proposals as has been presented in this section. Included in Appendix C is information on material costs which can be factored into decisions.

In the information for one family dwellings, which is presented in Table III-5, the large wood contribution to construction would possibly lead one to the conclusion that this sector must be the least energy intensive of all building sectors (in view of wood's comparatively low energy intensity). This is not the case however, as Table III-7 shows that two to four family and garden apartment structures are even lower in BTU's/ft.^{2} This table also points to laboratories, hospitals, librar-

1967 ENERGY EMBODIMENT PER SQ FT OF BUILDING TYPE

1967 I/O 399 LEVEL NEW BUILDING CONSTRUCTION	1967 SQ FT + $ ESTIMATED VALUE REPORTED TO F.W. DODGE CO.[1] SQ FT	$	TOTAL $/SQ FT	BTU/$[2]	BTU/ SQ FT	TOTAL BTU PER SECTOR[2]	TOTAL SF BUILT (PER BEA) (BTU ÷ BTU/SF)
RESIDENTIAL - 1 FAMILY	1,050,517,000	13,285,874,000	12.65	55.511	702,047	780.98×10^{12}	1,112,432,899
RESIDENTIAL - 2-4 FAMILY	40,609,000	486,827,000	11.99	52,139	625,050	34.83	55,723,505
RESIDENTIAL - GARDEN APT	352,452,000	4,323,280,000	12.27	52,864	648,445	147.76	227,868,071
RESIDENTIAL - HIGH RISE				60,000	735,978	117.96	160,276,608
RESIDENTIAL - ALTER & ADDN	-	-	-	51,646	-	216.85	-
HOTEL/MOTEL	35,633,000	581,310,000	16.31	69,184	1,128,655	69.05	61,179,014
DORMITORIES	42,372,000	858,629,000	20.26	70,604	1,430,724	57.82	40,413,106
INDUSTRIAL BUILDINGS	269,650,000	3,700,726,000	13.72	70,864	972,551	463.38	476,458,548
OFFICE BUILDINGS	158,318,000	3,781,344,000	23.88	68,737	1,641,748	258.66	157,551,585
WAREHOUSES	95,390,000	686,843,000	7.20	77,556	558,432	57.78	103,467,569
GARAGES/SERVICE STATIONS	37,720,000	381,812,000	10.12	76,217	771,489	32.24	41,789,319
STORES/RESTAURANTS	170,146,000	2,188,587,000	12.86	73,183	941,353	197.01	209,283,984
RELIGIOUS BUILDINGS	41,379,000	793,407,000	19.17	65,597	1,257,766	68.61	54,549,077
EDUCATIONAL	204,258,000	4,168,058,000	20.41	67,924	1,386,046	437.36	315,544,880
HOSPITAL BUILDINGS	65,820,000	1,873,269,000	28.46	60,512	1,722,200	117.21	68,058,263
OTHER NON-FARM BUILDINGS	123,698,000	2,564,814,000	20.73	69,894	1,449,216	231.07	159,444,843
a. AMUSEMENT, SOCIAL & REC[4]	42,249,000	834,047,000	19.74	69,894	1,379,793	-	-
b. MISC NON-RESIDENTIAL BLDG[4]	43,299,000	682,678,000	15.77	69,894	1,101,991	-	-
c. LABORATORIES[4]	20,387,000	604,970,000	29.67	69,894	2,074,056	-	-
d. LIBRARIES, MUSEUMS, ETC.[4]	17,763,000	443,119,000	24.95	69,894	1,743,588	-	-
FARM RESIDENCES	29,463,000	303,930,000	10.32	53,773	554,703	30.22	54,479,560
FARM SERVICE	380,760,000	737,565,500	1.94	76,956	149,071	57.88	388,272,615
						TOTAL SQ FT:	3,686,793,446

NOTES:

1. SOURCE: F.W. DODGE CO., DODGE CONSTRUCTION STATISTICS 1967 (BASED ON CONTRACTORS' BID PRICES)
2. SOURCE: FROM CENTER FOR ADVANCED COMPUTATION
3. SOURCE: 1969 CENSUS OF AGRICULTURE, VOL. V, SPECIAL REPORTS, FARM FINANCE
4. INCLUDED IN TOTAL FOR 38

Table III-7

source: Table taken from, Hannon, Segal, Stein, Serber, Energy Use for Building Construction, (Urbana-Champaign, Ill.: Energy Research Group, Center for Advanced Computation, University of Illinois, February 1977), p. 84.

Table III-8

EMBODIED ENERGY FOR A TYPICAL HOUSING UNIT

(3 bedroom semi detached, 100 m^2)*

material	quantity	energy intensity Btu/unit	Btu embodied**	percent energy embodiment
brick	16,000 bricks	26,600/ brick	425.6 million	71
steel	3,000 lbs	32,000/ lb	96.0 million	16
glass	300 ft^2	13,500/ ft^2	4.1 million	1
concrete	20,000 lbs	1,300,000/ ton	13.1 million	2
cement	14.3 bbl	1,600,000/ bbl	22.9 million	4
plaster	6,000 lbs	6,970,000 ton	20.9 million	3
timber	1,400 bd ft	8,800 bd ft	12.3 million	2
paint	12 gal	489,000/ gal	5.9 million	1
			600.7 million	100

CONVERSION FACTORS

concrete:

1 ft^3 = 150 lbs

1 yd^3 = 27 ft^3

1 yd^3 = 4050 lbs

board foot:

1x12x12 = 1 bd ft

$$\frac{l \times w \times h}{144} = \text{bd ft}$$

*source: Data for typical house taken from, Tom Bender, "Living Lightly: Energy Conservation in Housing", October, 1973, p. 19.

**column 2 (quantity) x column 3 (energy intensity) = Btu embodiment.

ies and museums as the most energy intensive.

Application of the methodology to specific building construction projects in the community is easily accomplished. The procedure is as follows:

1. List the materials to be used in the construction project.
2. List the quantities of each material.
3. Refer to Table III-6 (or Appendix C for more detail) and determine the BTU/unit value for the materials listed.
4. Multiply the quantity of the material by BTU/unit value in Table III-6.
5. Total the figures that were determined in number four, above, and determine the percentage of energy ambodiment for each material component.

Table III-8 presents an example of how this is done for a typical one family housing unit. The predominance of brick in this particular structure is apparent. Table III-6 portrays brick as a very energy intensive building material Reduction in the amount of brick used in this structure would result in considerable energy savings. Replacing the brick with wood construction would require 1,876 board feet to cover the same surface area. The comparative BTU embodiment would be 425.6 million for the brick and 16.5 million for use of the wood substitution.

Referring again to Table III-5, opportunities for savings in the non buildings sector can be identified. Two predominant components of the community infrastructure are the water supply system and highways. Table III-5 points out that a considerable protion of the energy embodied in the water system is for steel, with pipe being one of the predominant steel products (see footnote). Table III-9 illustrates the energy advantages inherent in the use of plastic pipe, with steel pipe consuming about 2.7 times the amount of energy to produce an equal amount of plastic pipe.

A viable and more energy conscious alternative exists with regard to material components to highway construction and maintenance. Table III-5 shows the high direct energy component to new highway construction. Highway maintenance construction exceeds this fugure of 47.6 percent direct energy for new highways with a direct energy requirement of over 52 percent.[12] This high direct energy contribution in highway construction is due to the heavy use of asphalt which is considered a refined petroleum product. The use of bituminous emulsions as an alternative to liquid asphalts and asphalt cements can reveal energy savings because emulsions utilize less petroleum product as an ingredient and can be prepared for application with little or no heating. Since 1974 the FHWA has been encouraging the use of emulsified asphalts to save energy. The FHWA estimated that in 1972 309 million gallons of petroleum product could have been saved in the U.S. through use of emulsions rather than traditional cut back asphalt products.[13] Table III-10 shows why this is so.

Energy savings can be obtained in three ways with regard to asphalt applications.[14]

1. Substitution of plant mixed emulsified asphalt at ambient temperature for hot plant-mixes using asphalt cement. The primary energy saving here is elimination of the fuel required to heat and dry the aggregate.

Table III-9 ENERGY EMBODIED IN PIPE

COMPARISON OF STEEL PIPE & PLASTIC PIPE
(UNIT: LINEAL FOOT)
PLASTIC PIPE (PVC)

Diameter	lb/lf	Total Btu/unit
3"	1.53	71,344
4"	2.16	100,821
6"	3.76	175,329
8"	5.80	270,454

STEEL PIPE

Diameter	lb/lf	Total Btu/unit
3"	7.58	195,663
4"	10.79	278,522
6"	18.97	489,673
8"	28.55	736,961

source: Hannon, Stein, Segal, Diebert, Buckley, Nathan, Energy Use for Building Construction, Supplement, (Urbana-Champaign, Ill.: Energy Research Group, Center for Advanced Computation, University of Illinois, October 1977), p.11.

Table III-10 ENERGY REQUIRED TO PRODUCE AND MIX ASPHALT MATERIALS

Energy Required to Produce Asphalt

type of material	energy required* (Btu/gallon)	gallons per ton
asphalt cement	2,500	235
liquid asphalt:		
RC-250	46,200	249
MC-250	47,000	249
SC-250	51,800	249
emulsified asphalt:		
RS-2	2,070	241
CRS-2	2,100	241
MS-2	2,100	241
CMS-2	2,100	241

Energy Required to Produce Mixes**

type of mix	Btu/yd^2 1 inch thick
Hot Plant-Mix Asphalt Concrete	27,800
Emulsified Asphalt Plant-Mix	15,600

*Does not include energy potential of base asphalt.

**A one inch layer of each mix may not be structurally equivalent.

source: Transportation Research Board, Bituminous Emulsions for Highway Pavements, (Washington, D.C.: Transportation Research Board, 1975) p.5.

2. The use of emulsified hot-plant-mixes. Energy is saved here through the reduction of temperatures for the production of mixes to 220 to 260 F.[15]

3. Improved efficiency in the production of hot plant mixes could result in a savings of 22 percent according to the National Asphalt Paving Association.[16]

The capability of emulsified asphalts for some applications is not yet fully agreed upon within the industry however, and caution should be taken to determine this for specific applications. Table III-11 lists the various applications of emulsified asphalts which have been made in a number of states. U.S. DOT advises that engineers and technicians should receive special training in the use of emulsions to take advantage of maximum application and to ensure proper application. Table III-12 illustrates the amount of asphalt products used in building construction sectors. Emulsions and other alternatives presented in Table III-13 may be substituted here as well.

ENERGY CONSUMPTION BY BUILDINGS

This section addresses energy consumed by new and existing residential and commercial buildings. Table III-14 illustrates that the sectors consume a considerable amount of energy nationally. In the New England region, where the economy has matured and become oriented towards services, the contributions by these sectors is even more pronounced. Most of the energy consumed by these sectors is for space conditioning, heating and cooling, and as a result this section will focus primarily on the thermal efficiency of construction. Space conditioning accounts for approximately 75 percent of the energy consumed in the residential sector and for about 50 percent in the commercial sector.

Table III-11 STATE USE OF EMULSIONS *

A- State use of Emulsions by Class and Type

Anionic Emulsions		Cationic Emulsions	
type used	# of states	type used	# of states
RS	26	CRS	35
MS	13	CMS	16
SS	35	CSS	20

B- State Use of Emulsions by Construction Item Transportation Research Board Survey

construction item	# of states
surface treatments and seal coats	42
soil stabilization**	6
base course mixes	15
surface course mixes	13
oter (seals, patches, etc.)	14

C- State Use of Emulsions by Construction Item "Rural and Urban Roads" Survey

construction item	# of states
surface treatments and seal coats ------	38
slurry seal treatments ------	24
cold or hot patching mixes ------	15
subbases ------	8
base mixes ------	15
cold-mix surfacing ------	10
shoulders ------	20
primes ------	30

*Information used in tables A and B was compiled in a 1974 survey of the Transprotation Research board entitled "Survey of Emulsion Use by State Highway Agencies". Information in table C is found in, "How States are Using Emulsions", Rural and Urban Roads (Feb. 1972) pp. 40-44.

**Emulsions are better for this type of use than petroleum based asphalts because they are more compatible with plants.

Table III-12 SUMMARY BREAKDOWN OF REFINED PETROLEUM USAGE PER BUILDING SECTOR IN BTU X 10^{12}

BUILDING TYPE	ASPHALT & ROAD OIL	GASOLINES GAS	GASOLINES DIESEL	FUEL OIL	LIQ PETROL GASES	LUB OILS	TOTAL
Residential 1-Family	55.38	31.41	-	1.82	-	0.05	88.66
Residential 2- to 4-Fam	3.52	0.54	1.27	-	-	-	5.33
Residential Garden Apts	17.28	2.01	5.19	0.53	-	0.02	25.03
Residential Highrise Apts	13.92	2.29	6.12	0.28	-	0.02	22.63
Residential Add'n & Alt	5.09	2.17	-	1.42	-	0.02	8.70
Hotel/Motel	8.72	1.46	3.78	-	-	0.02	13.98
Dormitories	7.50	1.28	3.45	0.27	-	0.02	12.52
Industrial Buildings	20.44	3.17	14.47	5.68	0.93	0.13	44.82
Office Buildings	31.68	5.38	14.41	0.85	0.97	0.08	53.37
Warehouses	4.09	0.50	2.22	0.75	-	0.02	7.58
Garage/Service Stations	3.48	0.65	1.54	0.27	-	-	5.94
Stores/Restaurants	25.04	4.88	11.58	1.66	-	0.08	43.24
Religious Buildings	7.31	0.70	4.52	0.57	-	0.02	13.12
Educational Buildings	46.59	4.10	26.46	1.13	-	0.08	78.36
Hospitals	14.03	0.74	7.63	-	-	-	22.40
Other Non-Farm	26.93	4.90	13.04	1.98	-	0.08	46.93
Farm Residential	0.84	0.49	-	0.25	-	-	1.58
Farm Service	1.14	1.17	-	0.83	-	0.02	3.16
Sub-Total New Building	292.98	67.84	115.68	18.29	1.90	0.66	497.35
Percentages New Building	58.9%	13.6%	23.3%	3.7%	0.4%	0.1%	100.00%
M + R Residential	15.78	9.42	-	-	0.72	-	25.92
M + R Non-Residential	15.94	19.08	1.29	7.26		0.17	43.74
M + R Farm Residential	1.37	0.85	-	-	-	-	2.22
M + R Farm Service	1.38	0.24	-	0.60	-	-	2.22
Sub-Total M + R	34.47	29.59	1.29	7.86	0.72	0.17	74.10
Percentages M + R	46.6%	39.9%	1.7%	10.6%	1.0%	0.2%	100.00%
TOTAL	327.45	97.43	116.97	26.15	2.62	0.83	571.45
PERCENTAGES	57.3%	17.0%	20.5%	4.6%	0.5%	0.5%	100.00%

source: Hannon, Stein, Segal, Diebert, Buckley, Nathan, Energy Use for Building Construction, Supplement, (Urbana-Champaign, Ill.: Energy Research Group, Center for Advanced Computation, University of Illinois, October 1977), p.52. Data for base year 1967.

Table III-13 ALTERNATIVES FOR TYPICAL RESIDENTIAL DRIVEWAY (10' wide x 45' long)

Material	Energy (Btu x 10^6)	Labor (man hours)	Cost (1977 $)
Asphalt (1)	24.3	34	$ 420
Concrete (2)	20.3	27	930
Concrete strips (2)	6.1	8	280
Brick (3)	69.1	60	1,280

Notes:

(1) Asphalt

Material - Mix by weight: 6% asphalt, 94% aggregate (Civil Engineering Handbook); 1 ton of asphalt = 235 gallons (Asphalt Institute); 1 CF of asphaltic concrete = 145 lbs (Asphalt Institute); 1 gallon of asphalt = 158,100 Btu (EBC Supplement, Table 5).
Therefore, 1 lb of asphalt = 18,577 Btu and 1 CY of asphalt concrete = 4,363,740 Btu.
4" thick driveway = 5.56 CY.

Labor and cost - Applied in two layers (1977 Dodge Manual)
top course, 1½" = 0.27 man hours/SY & $5.00/SY
base course, 2½" = 0.40 man hours/SY & $3.37/SY
Total, 4" = 0.67 man hours/SY & $8.37/SY

(2) Concrete

Material - 1 CY ready mix concrete = 2,594,338 Btu/CY (EBC p. 50); 1 lb welded wire mesh = 24,187 Btu (EBC p. 55); 6 x 6 x 10/10 mesh = 21 lb/CSF (conc. Reinf. Stl. Institute Design Handbook); 5" thick conc. driveway = 6.94 CY of conc. and 94.5 lb of mesh; 2 - 18" strips 5" thick = 2.08 CY of conc. and 28.35 lb of mesh.

Labor and cost - 5" thick reinf. conc. paving = 0.54 man hours/SY and $18.63/SY (1977 Dodge Manual).

(3) Brick

Material - Brick on edge = 6 bricks/SF; ea brick = 25,582 Btu (EBC p. 49).

Labor and cost - Brick set in sand = 1.20 man hours/SY and 25.65/SY (1977 Dodge Manual).

source: Hannon, Stein, Diebert, Buckley, Nathan, Energy Use for Building Construction, Supplement, (Urbana-Champaign, Ill.: Energy Research Group, Center for Advanced Computation, University of Illinois, October 1977), p.63.

Table III-14 ENERGY USE BY COMBINED RESIDENTIAL/COMMERCIAL SECTOR
(10^{12} Btu)

year	total primary energy use	total energy use (point of use)	% by residential/comm. of all U.S. energy use
1960	14,132	11,436	29.9
1965	17,759	13,778	30.4
1970	23,227	16,988	30.4
1975	24,848	17,584	31.2

source: Table derived from, Liepins, Smith, Rose, Haygood, Building Energy Use Data Book, (Oak Ridge Tennessee: Oak Ridge National Laboratory, April 1978) pp.18,19.

Other significant areas of energy consumption are for lighting and water heating.

As was previously stated, the largest area of energy consumption in the residential/commercial buildings sector is space heating. This energy consumption comes as a result of the need to establish and maintain a steady state environment for man. Steady state refers to the temperature, humidity, and even light levels that occur in buildings for man's comfort and convencience. We have already discussed the energy which is consumed to create the structure within which this mini environment is contained but, the other aspect is the energy consumed in maintaining the internal environment. Climate, of course, is a big factor in the level of energy which is consumed within structures. The greater the difference between the outside conditions and the desired inside conditions the more energy will be required to create a steady state internal environment. Climatic considerations will be discussed in the next chapter.

The performance of materials was presented in the previous section as an important consideration in the selection of materials for construction. In addition to structural performance and other considerations, the thermal performance of materials should be a consideration. In many states this is already the case. As of January 1979 39 states have adopted statewide building codes containing thermal efficiency provisions. These codes are minimum standards and are left up to the local community to enforce. It would be advisable for communities to strive to exceed these standards by adopting more stringent code provisions or adopting review procedures which encourage more energy efficient construction, at least with regard to public building construction. Taking measures to weatherize existing structures by modifying buildings with materials having good thermal properties is also recommended.

Table III-15 lists the U value and R value of various building materials. The U value represents the rate of heat transmission through a material expressed in $BTU/ft^2/^oF/hr$. The R value is its reciprocal. U values and R values are used to rate materials for their thermal efficiency. The lower the U the more energy efficient the material. The higher the R the more energy efficient the material.

In the previous section the embodied energy of the construction material was the point of focus. However, no decision about the selection of a material for energy conservation purposes should be made without considering whether it is important in terms of the thermal efficiency of the structure, and if so, what the thermal performance of the material is. Any material which makes up the outside shell of a building should be assessed for its thermal performance.

Figure III-3 and Table III-16 illustrate the implications of building material selection on energy consumption in buildings. A square foot of the wood frame wall with insulation has a total R value of 13.79 as compared the brick on wood frame wall with an R value of 14.01. This extra R value was achieved at a cost of an extra 94,140 BTU per square foot embodied in construction. The long term comparison of these options is presented in Table III-16 where the energy consumed over a twenty year period in the brick construction is 324,206

Table III-15 RESISTANCE VALUES OF STRUCTURAL AND FINISH MATERIALS, INSULATIONS, AIR SPACES AND SURFACE FILMS

Wood bevel siding, 1/2 x 8, lapped	R-0.81
Wood siding shingles, 16", 7½" exposure	R-0.87
Asbestos-cement shingles	R-0.03
Stucco, per inch	R-0.20
Building paper	R-0.06
1/2" nail-base insul. board sheathing	R-1.14
1/2" insul. board sheathing, regular density	R-1.32
25/32" insul. board sheathing, regular density	R-2.04
1/4" plywood	R-0.31
3/8" plywood	R-0.47
1/2" plywood	R-0.62
5/8" plywood	R-0.78
1/4" hardboard	R-0.18
Softwood, per inch	R-1.25
Softwood board, 3/4" thick	R-0.94
Concrete blocks, three oval cores	
Cinder aggregate, 4" thick	R-1.11
Cinder aggregate, 12" thick	R-1.89
Cinder aggregate, 8" thick	R-1.72
Sand and gravel aggregate, 8" thick	R-1.11
Lightweight aggregate (expanded clay, shale, slag, pumice, etc.), 8" thick	R-2.00
Concrete blocks, two rectangular cores	
Sand and gravel aggregate, 8" thick	R-1.04
Lightweight aggregate, 8" thick	R-2.18
Common brick, per inch	R-0.20
Face brick, per inch	R-0.11
Sand-and-gravel concrete, per inch	R-0.08
Sand-and-gravel concrete, 8 inches thick	R-0.64
1/2" gypsumboard	R-0.45
5/8" gypsumboard	R-0.56
1/2" lightweight-aggregate gypsum plaster	R-0.32
25/32" hardwood finish flooring	R-0.68
Asphalt, linoleum, vinyl, or rubber floor tile	R-0.05
Carpet and fibrous pad	R-2.08
Carpet and foam rubber pad	R-1.23
Asphalt roof shingles	R-0.44
Wood roof shingles	R-0.94
3/8" built-up roof	R-0.33
Glass	
Single glass (winter)	U = 1.13
Single glass (summer)	U = 1.06
Insulating glass (double)	
1/4" air space (winter)	U = 0.65
1/4" air space (summer)	U = 0.61
1/2" air space (winter)	U = 0.58
1/2" air space (summer)	U = 0.56
Storm windows	
1" to 4" air space (winter)	U = 0.56
1" to 4" air space (summer)	U = 0.54
Insulation	
2" – 2½" thick	R-7.00
3" – 4" thick	R-11.00
5" – 7" thick	R-19.00

Air Spaces (3/4")	
Heat flow UP	
Non-reflective	R-0.87
Reflective, one surface	R-2.23
Heat flow DOWN	
Non-reflective	R-1.02
Reflective, one surface	R-3.55
Heat flow HORIZONTAL	
Non-reflective (also same for 4" thickness)	R-1.01
Reflective, one surface	R-3.48

Note: The addition of a second reflective surface facing the first reflective surface increases thermal resistance values of an air space only 4 to 7 per cent.

Surface Air Films	
INSIDE (still air)	
Heat flow UP (through horizontal surface)	
Non-reflective	R-0.61
Reflective	R-1.32
Heat flow DOWN (through horizontal surface)	
Non-reflective	R-0.92
Reflective	R-4.55
Heat flow HORIZONTAL (through vertical surface)	
Non-reflective	R-0.68
OUTSIDE	
Heat flow any direction, surface any position	
15 mph wind (winter)	R-0.17
7.5 mph wind (summer)	R-0.25

Example calculations
(to determine the U value of an exterior wall)

Wall Construction	Uninsulated Wall Resistance	Insulated Wall Resistance
Outside surface (film), 15 mph wind	0.17	0.17
Wood bevel siding, lapped	0.81	0.81
½" ins. bd. sheathing, reg. density	1.32	1.32
3½" air space	1.01	
R-11 insulation		11.00
½" gypsumboard	0.45	0.45
Inside surface (film)	0.68	0.68
Totals	4.44	14.43

For uninsulated wall, $U = \frac{1}{R} = \frac{1}{4.44} = U = 0.22$

Therefore, heat loss for the above uninsulated wall section at a +10° F. outside design temperature is equal to 0.22 x 60 (or 70-10) equals 13.2 Btuh per sq. ft. of wall section.

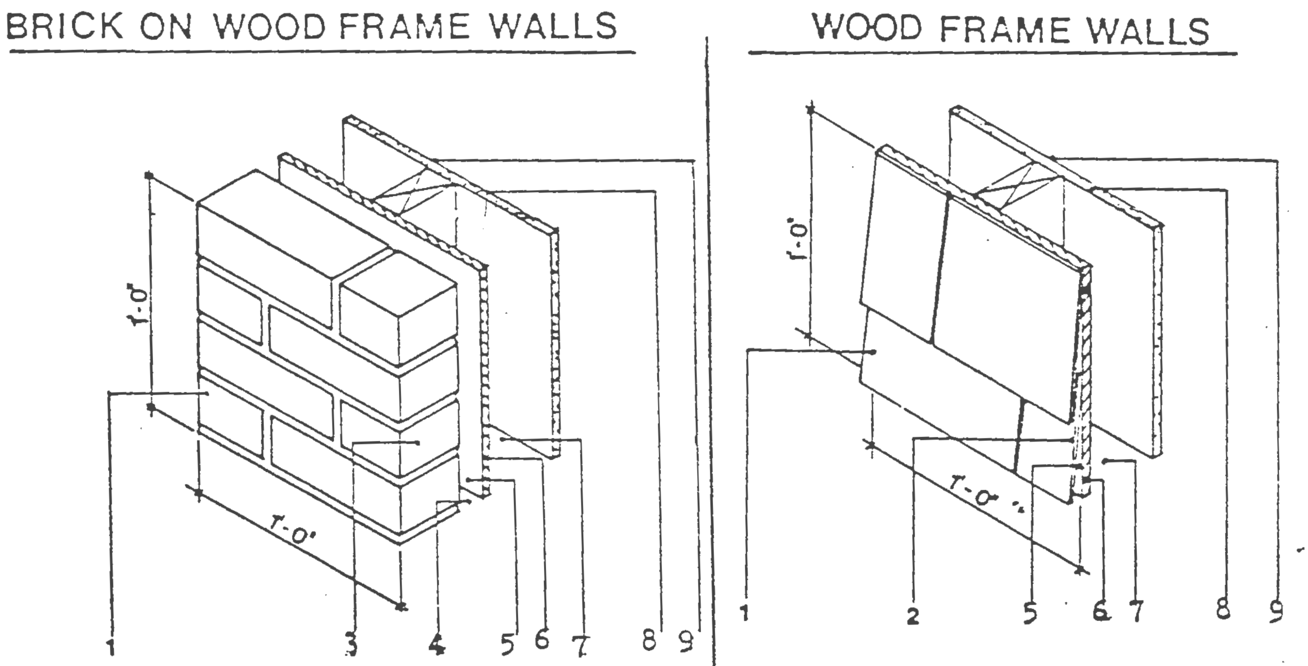
For insulated wall, $U = \frac{1}{R} = \frac{1}{14.43} = U = 0.07$

Therefore, heat loss for the above insulated wall section at a + 10° F. outside design temperature is equal to 0.07 x 60 (or 70-10) equals 4.2 Btuh per sq. ft. of wall section.

* Additional resistance values can be obtained from ASHRAE Handbook of Fundamentals published by the American Society of Heating, Refrigerating and Air-Conditioning Engineers.

source: Insulation Manual, (Rockville, Md.: National Association of Home Builders Research Foundation, Sept 1971) p.22.

Figure III-3 COMPARISON OF TWO WALL SECTIONS



	Brick on wood frame: R value	Brick on wood frame: embodied energy Btu/ft²	Wood frame: R value	Wood frame: embodied energy Btu/ft²
1. outside surface	.17	--	.17	--
2. wood shingles	--	--	.87	7,315
3. brick/masonry	.44	105,004	--	--
4. 1" air space	.97	--	--	--
5. bldg paper	.15	--	.15	--
6. plywood	.47	5,779	.62	7,705
7. 4" air space	.97	--	.97	--
8. gypsum wall board	.32	5,297	.45	6,920
9. inside surface	.68	--	.68	--
subtotal	4.17	116,080	3.91	21,940
10. add 3.5" insulation	11.00	6,860	11.00	6,860
total	15.17	122,940	14.91	28,800

note: Difference in figures for plywood and gypsum wall board due to thickness of material required for the two types of construction.

source: Table derived from, Hannon, Segal, Stein, Serber, Energy Use for Building Construction, (Urbana-Champaign, Ill.: Energy Research Group, Center for Advanced Computation, University of Illinois, February 1977) pp. 96,97.

Table III-16 COMPARISON OF CONSTRUCTION ALTERNATIVES (New York City)

COMPARISON OF ENERGY EMBODIMENT AND OPERATIONAL ENERGY DEMAND FOR HEATING IMPOSED BY 1 SQUARE FOOT OF SINGLE OR DOUBLE GLAZING

		1 SF Embodied Btu	U-Factor	Annual Demand/SF NYC (4,848 deg day)
Glass:	a) Single glass	15,430	1.13	131,477 Btu
	b) Double with ¼" sp	30,860	.65	75,628 Btu
	c) Double with ½" sp	30,860	.58	67,484 Btu

Over a 20-year period, 1 Square Foot of glass will require (Embodiment & Demand)

		No. 6 Fuel Oil Equivalent (gal)
a) Single glass:	2.64 million Btu	17.6
b) Double with ¼" sp	1.54 million	10.3
c) Double with ½" sp	1.38 million	9.2

COMPARISON OF ENERGY EMBODIMENT AND ANNUAL OPERATIONAL ENERGY DEMAND FOR HEATING IMPOSED BY 1 SQUARE FOOT OF WOOD FRAME WALL WITH VARYING THICKNESS OF INSULATION

Nominal Wall Thickness	Type of Framing	Insul.	U-Factor	Embodied Energy (Btu)	Annual Demand (Btu)	Total Energy Consumed Over 20 Years (Btu)	no. 6 Fuel Oil Equivalent (Gal)
Brick Veneer Walls							
10"	2 x 4 @ 16"	0	.24	119,566	27,924	678,046	4.52
10"	2 x 4 @ 16"	3½"	.085	126,406	9,889	324,206	2.16
Shingled Walls							
4"	2 x 4 @ 16"	0	.25	25,426	29,088	617,356	4.12
4"	2 x 4 @ 16"	2½"	.10	31,126	11,635	273,996	1.83
4"	2 x 4 @ 16"	3½"	.085	32,286	9,889	240,236	1.60
6"	2 x 6 @ 24"	5½"	.051	34,670	5,934	163,520	1.09
8"	2 x 8 @ 24"	7½"	.043	38,074	4,889	146,024	0.97
10"	(2) 2 x 4 @ 24"	9½"	.032	40,174	3,770	125,744	0.84
12"	(2) 2 x 4 @ 24"	11½"	.025	42,274	2,932	111,084	0.74
14"	(2) 2 x 4 @ 24"	13½"	.022	44,374	2,560	105,744	0.70

note: Paint one coat every 5 years, reshingle 50% every 20 years.

source: Hannon, Segal, Stein, Serber, Energy Use for Building Construction, (Urbana-Champaign, Ill.: Energy Research Group, Center for Advanced Computation, Un. of Ill., Feb. 1977) pp. 102, 103.

Figure III-4

ATTIC INSULATION IN INCHES

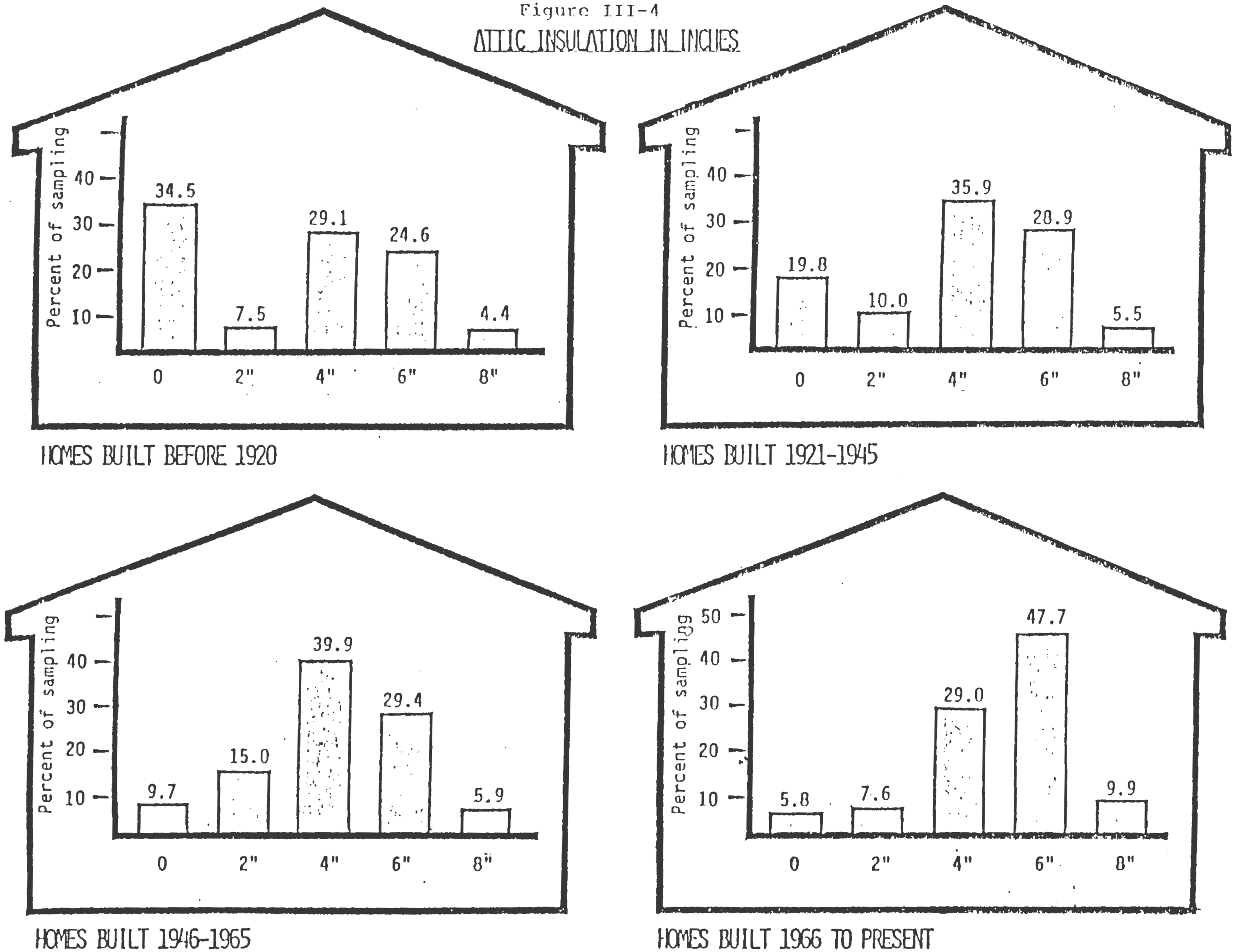


Table III-17 ENERGY USE IN EXISTING NEW YORK OFFICE BUILDINGS

Dates	No. of Bldgs.	% of Bldgs.	% of Area	Energy Consumption (Btu x 10^3)	Average Consumption
Before 1900	3	6.8	1.1	83-115	95
1901 - 1919	8	18.2	12.8	76-135	105
1920 - 1940	18	40.9	28.3	68-223	109
1941 - 1962	12	27.3	36.2	66-198	126
1962 - 1970	3	6.8	21.6	78-163	115

source: Syska and Hennesey, Phase I report for "Energy Conservation in Existing Office Buildings", (New York: 110 West 50th Street) p.III-20.

per ft^2 as compared to 240,236 in the wood frame construction. The option of reducing glass area, which was considered to be an energy efficient alternative in the previous section on energy embodiment, also is shown to be the wise alternative from the point fo view of thermal performance of materials as is shown in Table III-6.

The most likely targets for energy conservation programs in existing buildings are those which have walls that are constructed with materials possessing poor thermal performance. Many commercial buildings, particularly supermarkets, chain stores, and public buildings are constructed with thermally inefficient brick, cinder block, etc. Figure III-4 illustrates that older homes are typically underinsulated. Conversely, Table III-17 shows that in office buildings older structures are more energy efficient.

Street surveys of structures in conjunction with mail-out survey results is a method which can be used to assess the energy reduction opportunities in the residential/commercial building sector of the community. A sample questionnaire for conducting mail-out or phone surveys to determine insulation levels and general thermal efficiency of residences by age, size, location and other characteristics is included in the appendix. A sample structure street-survey questionnaire is included in the appendix as well. The street survey would be used in the field to inventory the condition of building stock. These surveys are typically done by housing authorities, redevelopment agencies, and community development agencies to establish base data for improvements to be undertaken in programs. Including additional information regarding the age of structure and the construction materials used in the shell would take very little extra time and would provide valuable information for the formulation of energy conservation programs. Matching the street-survey inventory of structures with the results of a survey of a sample of buildings in each building category will provide information to help in targeting programs.

CONCLUSION

Chapter three has dealt with energy savings available through conscientious and informed selection of materials for use in construction. The performance of building materials as well as the energy embodied in materials have implications for the most efficient use of energy resources. Through the application of tables and figures enclosed in this chapter and its corresponding appendix the energy implications of specific decisions about the physical growth of the community can be determined. Also, through other information which has been presented in this chapter, a more generalized picture of the implications for energy and approaches to community energy planning have been conveyed. Finally, planning and research tools have been presented that can help give the planner insight to the energy situation, both in terms of its use and the attitudes related to it in the community, and guide him toward an appropriate response in plans, programs, and recommendations to decision makers. Whereas this chapter has primarily examined the buildings sector and approaches to analyzing it, the next chapter will look at the overall community and the linkages among it and portray energy implications in a less quantifiable manner.

CHAPTER III

Footnotes

[1]It would be inappropriate for this study to dwell upon research methods. However, for further information see, Readings in Evaluation Research, ed. Francis G. Caro, (New York: Russel Sage Foundation, 1975): The Language of Social Research, ed. Paul F. Lazarsfeld and Morris Rosenberg, (New York: The Free Press).

[2]The most appropriate document to this discussion is, U.S. Department of Commerce, Bureau of the Census, Annual Survey of Manufacturers. For a listing of other energy data compiled by the Bureau of the Census see Appendix C.

[3]In a survey of the nine most energy consumptive/energy intensive industries in Rhode Island which was conducted by the Governor's Energy Office in the summer of 1978, 78 percent of the firms responding considered coping with energy costs to be important to the success of their business, "Industrial Sector Energy Conservation Survey", Governor's Energy Office, July 1978.

[4]Rhode Island Director of Manufacturers, Rhode Island Department of Economic Development, 1978.

[5]The U.S. Bureau of Census defines value added as follows: "This measure of manufacturing activity is derived by subtracting the cost of materials, supplies, containers, fuels, purchased electricity, and contract work from the value of shipments for products manufactured plus receipts for services rendered. The result of this calculation is then adjusted by the addition of value added by merchandising operations (that is the difference between the sales value and cost of merchandise sold without further manufacture, processing, or assembly) plus the net change in finished goods and work in progress inventories between the beginning and end of the year." See Appendix C for a complete list of industries energy consumption by percent value added for New England States and the overall U.S.

[6]The average cost of a million BTU's of energy in New England is $3.94. This figure can be applied to the data in this table to determine the part of the dollar which goes to energy in New England industry groups.

[7]Note that by following these guidelines the Governor's Energy Office questionnaire to industry had a 27.6 percent response rate.

[8]Hannon, Segal, Stein, Serber, Energy Use for Building Construction, (Urbana-Champaign, Ill.: Energy Research Group, Center for Advanced Computation, University of Illinois, February 1977), abstract.

[9]Ibid.

[10]Ibid.

[11]See Appendix C for more information regarding the energy intensity of glass and other building materials.

[12]Hannon, Segal, Stein, Serber, Energy Use for Building Construction, (Urbana-Champaign, Ill.: Energy Research Group, Center for Advanced Computation, University of Illinois, February 1977) p. 11.

[13]Transportation Research Board, Bituminous Emulsions for Highway Pavements, (Washington, D.C.: Transportation Research Board, 1975) p. 5.

[14]These three points are addressed in, Ibid.

[15]American Society for Testing and Materials Standard Specification for Hot-Mixed Hot-Laid Emulsified Asphalt Paving Mixtures specifies this temperature range.

[16]The National Asphalt Paving Association has prepared a report on fuel conservation.

CHAPTER IV

ENERGY AND URBAN FORM

Introduction

As was presented in the introduction to Chapter III, the planner's ability to serve a useful function relative to community based energy planning is largely dependent upon two things. They are:

1. his ability to assemble meaningful and valid information
2. his ability to apply this information to plan development and implementation

This chapter, Chapter IV, will continue to address these considerations by picking up where Chapter III left off. While Chapter III focused on energy consumed in the manufacture of products, in construction, and in the operation of buildings as if they were isolated entities, Chapter IV will address community energy consumption holistically. This chapter addresses energy in the context of the overall physical development of the community. It examines land use and its implications for community energy consumption. The chapter examines site design, land use density, building juxaposition, and the situation of land use types. It also explores various design components and considerations, primarily related to transportation, which have implications for community energy consumption.

Chapter IV will be less oriented toward facts and primary data than Chapter III. Although many facts and data have been collected with regard to subjects presented in Chapter III, there has been little such activity with relation to subjects in Chapter IV. Information in this chapter is primarily useful as a qualatative guide rather than as a basis for a specific quantitative analysis.

Space and form are the key concepts examined in the chapter. Space is important because the manner in which the space is used has direct bearing on the amounts of energy which will be used in communication across that space. The efficient consolidation of space will result in the most efficient use of energy. Form refers to the urban landscape and natural relief, which combined, compose the topography of the community. Form is an important consideration from an energy standpoint because natural terrain affords opportunities for energy conscientious community growth that can be realized through proper design of the man made form. In this chapter the concept of space primarily applies to transportation and infrastructure within the community and the concept of form primarily refers to building and site design.

SPATIAL CONSIDERATIONS

Overview

The energy for communication[1] is one of the most fundamental aspects of community energy use and can be understood intuitively, yet quantitative data regarding the specific energy use for different land use patters is scarce. Intuitively, one understands that time and energy are required to transport something between two points in space. One can also readily accept the fact that the greater the space between two points the greater the costs for communication between them. An entire body of economic theory is constructed with this principal as its central tenet. Location theory[2] maintains that the space between two points comprise the "friction of distance" and the costs of overcoming the friction of distance is central in determining the location of points in space and the manner in which they relate to one another. Access to needed commodities becomes the controlling factor in the make up of our urban landscape, according to location theory. Access to raw materials and to markets becomes the controlling factor to industry. Access to markets becomes the controlling factor to commercial establishments. And access to goods and services is the controlling factor to households.

Overcoming the friction of distance has costs attributed to it. The friction of distance can be diminished in one of two ways. It can be diminished by increasing our ability to overcome distances or by decreasing the distance. In our modern society technology has allowed us to greatly reduce the friction of distance by increasing our ability to overcome it. Transport and communication advancements of the past two centuries, and the twentieth century in particular, have allowed us to greatly decrease the friction of distance. This factor is reflected in the nature of our urban landscape since the turn of the twentieth century. The advent of streetcars in the late nineteenth century gave rise to suburbs and facilitated the economic prosperity of all of society.[3] The advent of the automobile resulted in the further decentralization of our cities and the creation of urban sprawl patterns of development. The costs of overcoming the friction of distance were decreasing thanks to technology.

The technology which enabled society to reduce the friction of distance required markedly different inputs than did previous modes of transportation. The new means of communication and transport require substantial amounts of fuel and energy in their operation and manufacture. Table IV-1 illustrates the increase in energy consumption within the transportation sector which has occured in the United States, with transportation currently accounting for 25 percent of all energy use. The modern transportation technologies have permitted us to overcome greater distances at less costs than previous transportation modes. However, it has also created a landscape which is highly consumptive of energy and greatly dependent upon a minimal friction of distance. Increased costs of energy will have the effect of increasing the friction of distance and leave us with a fixed pattern of land use which is inappropriate, in view of the increased costs of overcoming the friction of distance.

In taking this discussion out of the realm of the abstract, the subject matter relates to modes of transport for freight, people, power, water, and anything that must be moved. On the macro scale, nationally and internationally, the modes of transportation that come to mind are shipping, air transport, pipelines, long haul trucking, and rail. Table IV-2 portrays some of the characteristics of these modes of transportation. Note that under the costs column, fixed cost for rail and pipelines are high. This is in large part due to the high energy embodiment of these transportation modes. For example, it has been calculated that the Bay Area Rapid Transit

Table IV-2 COMPARATIVE CHARACTERISTICS OF MODAL SYSTEMS

(North America)

Mode	Costs	Unit Cost (Mile) (Rail = 1.0)	Distance	Rates	Characteristic Goods	Distinction	Drawbacks
Railroad	*Capital intensive; large initial investment (incl. right of way). Profitability rests on intensity of use: 350,000 to 500,000 tons/mile/year is operational margin. Terminal costs high.*	*1.0*	*Increasing effectiveness with length of haul. Large shipments cheaper by long or short haul.*	*Subject to class rates, freight rates, territories in-transit rates, etc.*	*Minerals; unprocessed agric. products; building mats, chemicals. Pass'rs minor.**	*Large volumes of bulk goods in comparatively short time at low costs.*	*Cost and time of assembling units*
Waterways	*Investment low, especially where natural waterways utilized. Terminal and handling costs several times line haul costs.*	*0.29*	*Increasing effectiveness with length of haul.*		*Marine: semi-finished and finished products. Inland: bulk raw goods—coke, coal, oil, grain, sand, gravel, cement. Pass'rs negligible.*	*Low freight rates; slow speed; spec. of goods carriage.*	*Slow speed.*
Motor Transport	*Fixed costs negligible. Operates on small margins — operating costs high; vehicle turnover high.*	*4.5*	*Short hauls, less costly than rail. Wide areal coverage.*	*Rail acts as price leader.*	*Perishable goods; lumber. Pass'rs important.*	*Light loads, short distances, short time. Flexible and convenient. Improved service. Minimizes distribution costs.*	*Inadequate capacity for moving heavy volumes, bulk materials. High costs of long hauls. High vehicle operating costs.*
Air Transport	*Fixed costs low. Investment in stock very high. Terminal, take-off costs, high.*	*16.3*	*Long hauls, economy with distance.*	*Rates set by national and international regulations.*	*Pass'rs dominant. Perishable, light weight, high value goods.*	*Speed.*	*Very high costs.*
Pipelines	*Fixed costs high. Large economies through diameter of pipe. Costs increase almost directly with distance. Viscosity adds costs.*	*0.21*	*Long haul in bulk.*		*Crude oil and petroleum products in large volume. Natural gas. Some solids.*	*Bulk movement of liquids.*	*Restricted commodity use. Regular flow and demand needed. Large market.*

*In Europe, passenger revenues usually exceed freight revenues.

3. Class rates. *The Interstate Commerce Commission (I.C.C.) authorizes rates applicable to items moving in small quantities. These rates vary for thirty classes. Thus a commodity in class 400 has four times the base rate (100), while the rate for class 13 would be 13 percent of the base rate.*

4. Commodity rates. *These are specific rates allowed by the I.C.C. for goods moving in large quantities between specific origins and destinations. They are the rates commonly used for the great majority of freight.*

5. In-transit rates. *These are special privileges granted by the I.C.C. that allow goods to travel at an initial raw freight rate, despite intermediate processing. Thus railroad*

System's construction consumed almost half of what it will need in energy for fifty years of operation.[4] Table III-4 (Chapter III), lists petroleum pipelines as the most energy intensive construction sector. Of the top ten energy intensive activities six of them are related to energy production or transportation of energy. Table IV-3 and Figure IV-1 chart the transport of energy in the U.S. by various modes including rail, motor carrier, waterway, and pipeline. As these figures bear witness, a large and increasing amount of energy is required to transport energy. Overall, freight has been estimated to account for about nine percent of total U.S. energy consumption, and about one third of total consumption in the transportation sector.[5]

Facts bear out that over the years changes in the land use of this country correspond with increased energy use by generating more freight transportation, longer hauls, and by greater use of more energy intensive trucks. Since 1939 all land freight modes have markedly increased their total ton-miles of commodity haulage. The average length of haul for land freight transport has increased between 1963 and 1972 as illustrated in Table IV-4. Shifts in freight modes from rail to truck results in transport which is more energy intensive. Transport of freight by rail requires 714 BTU's per ton mile whereas transport by truck requires 2,280 BTU's per ton mile.[6]

Spatial implications of Community Energy Consumption

These macro changes are indicative of what is occuring within communities. Within communities the friction of distance refers to the energy costs associated with passenger

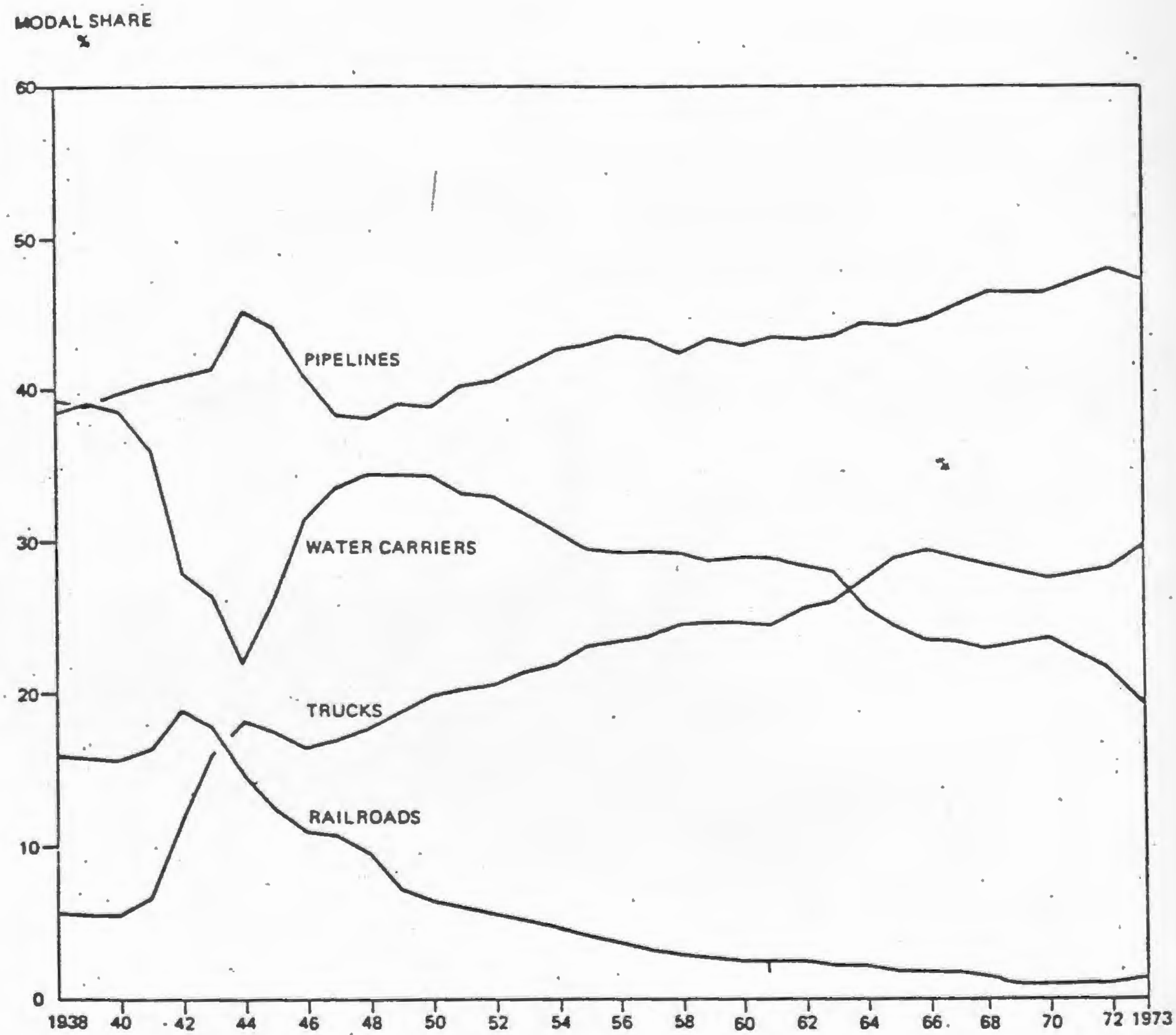
Table IV-3 **Total Crude Petroleum and Petroleum Products Transported in the U.S. by Method of Transportation, 1938 - 1973**

Year	Pipelines: Tons Carried	Pipelines: Per Cent of Total	Water Carriers: Tons Carried	Water Carriers: Per Cent of Total	Trucks[1]: Tons Carried	Trucks[1]: Per Cent of Total	Railroads: Tons Carried	Railroads: Per Cent of Total	Total Tons Carried
1973	912,209,868	46.57	421,205,848	21.50	595,767,175	30.41	29,736,210	1.51	1,958,919,091
1972	876,248,100	47.53	426,603,200	23.14	513,500,000	27.86	27,098,200	1.47	1,843,449,500
1971	806,671,000	46.90	416,792,000	24.24	470,700,000	27.37	25,649,900	1.49	1,719,812,900
1970	790,241,700	46.88	402,667,900	23.88	466,100,000	27.65	26,732,200	1.59	1,685,741,800
1969	769,612,000	46.81	378,862,700	23.88	468,000,000	28.22	26,299,900	1.62	1,622,774,600
1968	726,443,900	46.47	361,002,600	23.09	449,700,000	28.76	26,251,200	1.68	1,563,397,700
1967	679,321,600	45.64	349,815,800	23.50	433,600,000	29.13	25,742,200	1.73	1,488,479,600
1966	629,753,680	44.81	332,877,049	23.68	417,001,000	29.67	25,809,500	1.84	1,405,441,229
1965	587,795,480	44.43	323,671,414	24.47	385,480,600	29.14	25,856,600	1.96	1,322,804,094
1964	559,392,037	44.54	321,805,229	25.63	347,279,800	27.65	27,381,079	2.18	1,255,358,145
1963	521,149,137	43.57	335,611,860	28.06	312,583,106	26.14	26,658,686	2.23	1,196,002,789
1962	502,464,600	43.36	329,734,368	28.46	297,698,196	25.69	28,855,082	2.49	1,158,752,236
1961	484,170,055	43.60	322,695,527	29.06	273,619,665	24.64	29,964,233	2.70	1,110,450,480
1960	468,409,682	43.01	318,295,654	29.22	270,375,253	24.83	32,057,140	2.94	1,089,137,729
1959	464,290,959	43.22	310,098,034	28.86	266,642,261	24.82	33,343,787	3.10	1,074,375,011
1958	433,027,566	42.57	298,656,025	29.36	252,024,743	24.78	33,470,881	-3.29	1,017,179,215
1957	441,078,169	43.25	299,800,463	29.40	242,331,559	23.76	36,643,971	3.59	1,019,854,162
1956	441,386,180	43.49	297,826,330	29.34	235,960,622	23.25	39,757,144	3.92	1,014,930,276
1955	412,533,395	42.94	284,007,134	29.56	222,604,360	23.17	41,663,502	4.33	960,808,391
1954	373,327,262	42.57	268,524,812	30.62	192,564,326	21.96	42,533,486	4.85	876,949,886
1953	359,142,335	41.63	273,476,440	31.70	184,625,431	21.40	45,451,188	5.27	862,695,394
1952	337,594,240	40.60	274,913,642	33.06	171,744,588	20.66	47,204,525	5.68	831,456,995
1951	324,667,831	40.31	267,417,940	33.20	163,566,274	20.30	49,842,061	6.19	805,494,106
1950	283,853,383	38.82	252,765,749	34.57	145,780,986	19.93	48,882,196	6.68	731,282,314
1949	261,023,757	39.23	229,928,665	34.56	126,217,294	18.97	48,199,099	7.24	665,368,815
1948	262,452,531	38.24	237,516,329	34.61	120,897,800	17.62	65,407,170	9.53	686,273,830
1947	237,879,554	38.42	209,087,669	33.77	105,603,500	17.05	66,638,669	10.76	619,209,392
1946	222,266,138	40.76	172,513,605	31.64	88,852,600	16.29	61,696,782	11.31	545,329,125
1945	240,749,492	44.06	142,498,332	26.08	96,135,600	17.60	67,003,259	12.26	546,386,683
1944	244,001,439	45.21	117,688,301	21.81	99,048,800	18.35	78,975,455	14.63	539,713,995
1943	196,391,443	41.46	115,995,425	24.49	76,471,500	16.14	84,875,255	17.91	473,733,623
1942	175,486,660	41.11	120,076,511	28.13	49,524,400	11.60	81,818,135	19.16	426,905,706
1941	170,684,472	40.53	152,430,794	36.20	28,695,020	6.81	69,323,685	16.46	421,133,971
1940	153,502,082	89.79	149,594,453	38.78	21,849,000	5.67	60,797,161	15.76	385,742,696
1939	147,534,686	39.11	148,064,469	39.25	21,557,680	5.72	60,057,437	15.92	377,204,272
1938	139,220,962	39.28	137,728,491	38.86	20,538,060	5.80	56,933,147	16.06	854,420,660

[1] Estimated

source; Association of Oil Pipelines, "Shifts in Petroleum Transportation", June 1975

Figure IV-1



Modal Shares for Total Crude Petroleum and Petroleum Products Transported in the U.S., 1938 - 1973

source: U.S. Department of Transportation, Energy Statistics: A Supplement to the Summary of National Transportation Statistics, (U.S. Government Printint Office, 1975) p.23.

Table IV-4 AVERAGE LENGTH OF HAUL
(all commodities)

mode	1963	1972
motor carriers	273	306
unregulated trucks	137	166
rail	527	577

source: U.S. Bureau of the Census, 1972 Census of Transportation, T C72C2-8, Commodity Transportation Survey Area Services.

transport and utilities. Energy consumed to build and operate systems for transporting people, water, electricity, gas, wastes, and other commodities consumed within households comprise the community infrastructure. Reduction of energy embodied in and consumed in the operation of the infrastructure is a strategy that will reduce community energy dependence and contribute toward overall energy reductions in the macro scale discussed previously.

The facts about the energy savings available through sound community planning and increased density of development are varied but point out both some areas of opportunity and some areas where caution should be taken. The studies that have been done to this point indicate that most of the energy savings that will accrue from planned community development will occur in the transportation sector. In one study of all the savings available through increased density and planned development fifty-two percent of the energy reduction comes from the transportation sector.[7] Table IV-5 portrays the energy reductions that have been estimated in the transportation sector through various studies. Energy reductions of from twenty to fifty percent have been estimated. Increasing density and careful planning of communities reduces transportation energy requirements by decreasing distances of travel and by facilitating alternative modes of transportation to the automobile. Mixed land use provides low order goods[8] in near proximity to households thus affording shorter trips and the opportunity to travel by foot, bicycle, or some other alternative mode. Careful planning and designing of streets and walkways, clustering of activity centers and services, and pro-

Table IV-5 ESTIMATED TRANSPORTATION ENERGY REDUCTIONS*

study title	estimated energy reduction
Capitol Area Plan (Sacramento)	39 percent
Energy Thrift in Urban Transportation	20-35 percent
Costs of Sprawl	50 percent

*Estimates of reductions in energy consumption due to densely planned communities.

source: Fels and Munson, "Energy Thrift in Urban Transportation: Options for the Future", in Robert H. Williams, The Energy Conservation Papers, Reports prepared for the Energy Policy Project of the Ford Foundation, (Cambridge, Mass.: Ballinger Publishing Co., 1975) p.7; Dennis Dickman and Lee Windhiem, "Sacramento Can Do More With A Lot Less Energy", Planning, vol. 43 no. 11 (Dec 1977), pp. 24and 25; Real Estate Research Corporation, The Costs of Sprawl, prepared for the Council on Environmental Quality, the Dep rtment of Housing and Urban Development, and the Environmental Protection Agency, (1974) p.145.

vision of supplementary facilities, such as facilities for securing bicycles,[9] will contribute toward the overall reduction of the dependency on the use of the automobile. Density is also an important factor in the ability of an area to support transit.

Streets within the community should be designed to accomodate only the type of traffic which is suitable to the landuse of the area. Conflicts between different types of traffic should be eliminated. Pedestrians, bicycles, automobiles, and trucks should not come into conflict with one another. To avoid traffic hold ups and conflicts, through traffic should not mingle with local traffic. Local streets can be designed to discourage through traffic. There are several good references which address street design. Appendix D includes information from, Urban Planning and Design Criteria, (DeChiara and Koppelman) which defines and addresses specifications for street design including transportation networks for bicycles. Planning urban areas so that the need for conflicting traffic types is not generated is the other end of the design problem.[10]

Community planning and design can help make the bicycle a very viable mode. Planners have defined bikeways according to three classes. A Class I bikeway is designed and designated exclusively for bicycles. Class I bikeways are often found in parks where they can serve only a recreational purpose and not as an integral part of the community transportation system. Class II bikeways provide semi-exclusive use of a sidewalk or street by marking off a section which occasionally must be utilized by another transit modes such as a car crossing at an intersection. Class III bikeways are a right-of-way which is shared by bicyclists and motor vehicles and are generally indicated by roadway bike route signs. Table IV-6 portrays the costs associated with the construction of these facilities.[11]

Mass transit requirements should be considered by the planner. In transit studies several factors have been determined to be important to the viability of mass transit. According to a recent study these factors include proximity or distance of neighborhoods to nonresidential areas, the quality and cost of service, and the density of the point of origin (the resident trip end) and the nonresidential point of trip destination. Experts have been able to establish minimum residential densities required to support various types of transit. These densities are presented in Table IV-7 by type of transit. Density requirements will vary as depicted, according to some of the aforementioned factors. Community planners who are seeking to make mass transit part of the community should strive to attain appropriate densities called for by this table. Table IV-8 portrays some other factors associated with transit modes including energy consumption, operation and maintenance costs, material consumption, and roadway space consumption. The favorability of mass transit over automobile transit is clear. Another study points out that the city bus and rail need only carry three to five times the auto's average occupancy to be competetive in energy consumed".[12] Communities that do not possess the necessary characteristics to support transit should undertake community planning for future development with the objective of attaining these necessary traits.

In areas where alternatives to the auto exist, the develop-

Table IV-6 BIKEWAY COSTS

bikeway*	construction costs (dollars per mile)
Class I (bike path)	$20,000 to $40,000
Class II (bike lane)	$2,000 to $4,000
Class III (bike route)	$500 to $1,000

*Bikeway types are defined in the text of the chapter.

source: Carl Berkowitz, "The Bicycle", Practicing Planner, vol. 8 no. 1 (March 1978) p.34.

Table IV-7 TRANSIT MODES RELATED TO RESIDENTIAL DENSITY

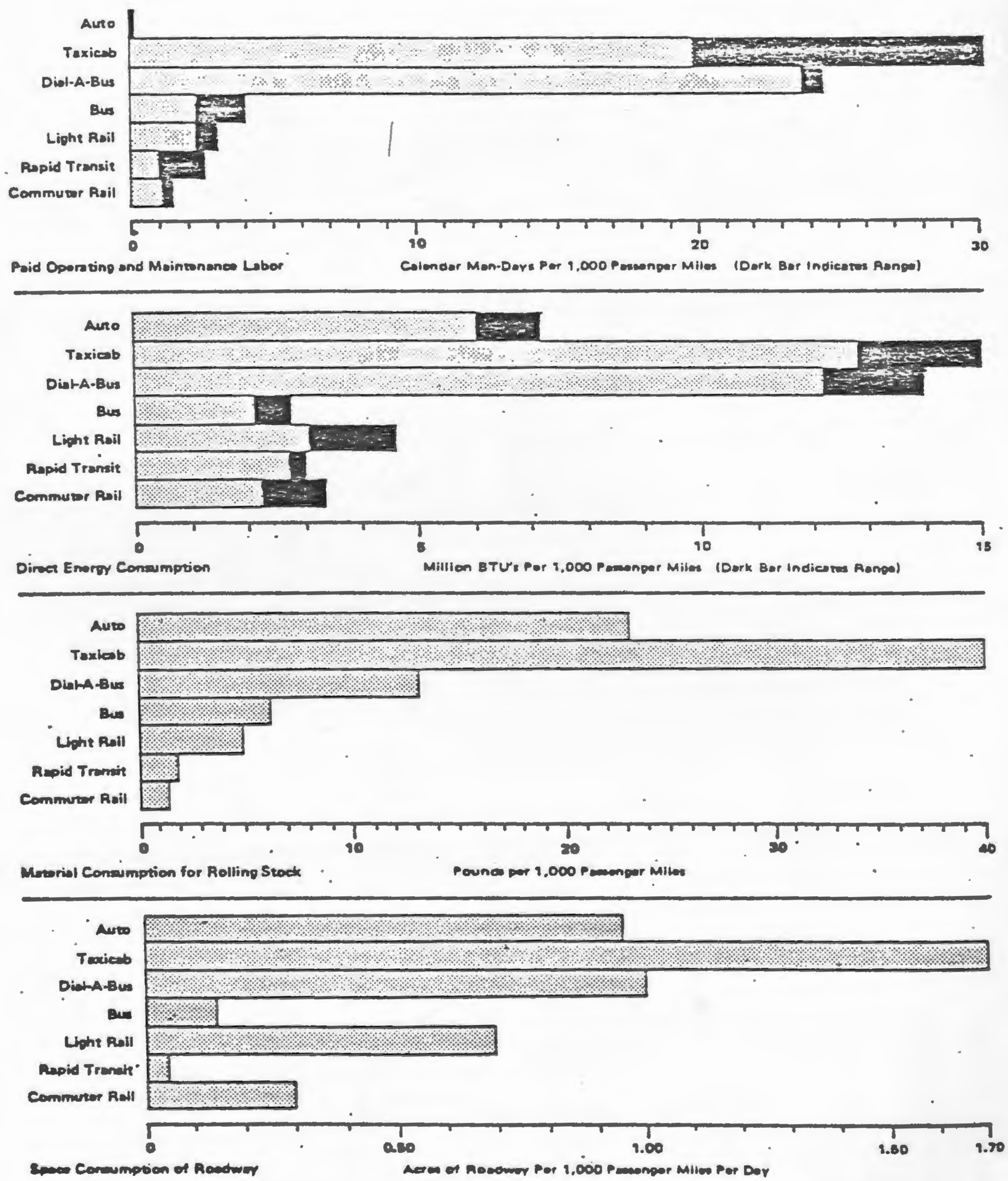
Mode	Service	Minimum Necessary Residential Density (dwelling units per acre)	Remarks
Dial-a-bus	Many origins to many destinations	6	Only if labor costs are not more than twice those of taxis
Dial-a-bus	Fixed destination or subscription service	3.5 to 5	Lower figure if labor costs twice those of taxis; higher if thrice those of taxis
Local bus	"Minimum," ½-mile route spacing, 20 buses per day	4	Average, varies as a function of downtown size and distance from residential area to downtown
Local bus	"Intermediate," ½ mile route spacing, 40 buses per day	7	
Local bus	"Frequent," ½ mile route spacing, 120 buses per day	15	
Express bus —reached on foot	Five buses during two hour peak period	15 Average density over two square mile tributary area	From 10 to 15 miles away to largest downtowns only
Express bus —reached by auto	Five to ten buses during two hour peak period	3 Average density over 20 square mile tributary area	From 10 to 20 miles away to downtowns larger than 20 million square feet of nonresidential floorspace
Light rail	Five minute headways or better during peak hour.	9 Average density for a corridor of 25 to 100 square miles	To downtowns of 20 to 50 million square feet of nonresidential floorspace
Rapid transit	Five minute headways or better during peak hour.	12 Average density for a corridor of 100 to 150 square miles	To downtowns larger than 50 million square feet of nonresidential floorspace
Commuter rail	Twenty trains a day	1 to 2	Only to largest downtowns, if rail line exists

source: Regional Plan Association, printed in, Boris Pushkarev and Jeffrey Zupan, Public Transportation and Land Use Policy, (Bloomington: Indiana University Press, 1977) p. 190.

Table IV-8

Resource Use of Transportation Systems

Exhibit assumes the following average occupancies (persons per vehicle):
Auto, 1.5; Taxicab, 0.7; Dial-A-Bus, 1.2; Bus, 11; Light Rail, 10; Rapid Transit, 24; Commuter Rail, 31.



source: Pushkarev and Zupan, Public Transportation and Land Use, (Bloomington: Un. of Indiana Press, 1977) p. 180.

ment and adoption of an automobile parking management plan will support and reenforce these modes.[13] Through a well thought out automobile parking management plan reduction in auto dependency can be induced which will serve to attain community objectives for air quality, traffic circulation, downtown commercial viability, and energy conservation. Strategies for parking management are aimed at the regulation of the supply of parking spaces, regulation of the cost of parking, and design of parking facilities. Although available data on actual energy reductions due to parking management programs is scarce, the value of increasing the relative attractiveness of modes alternative to auto transport is apparent. Cities which have adopted auto parking management plans, such as Boston, Pittsburgh, New York, San Francisco, and Washington D.C., lay claim to energy conservation as one of its benefits. In Washington D.C. it was found that a forty-two percent reduction in parking spaces resulted in a thirteen percent reduction in auto commuting.[14] A Council of Governments study determined that a two dollar daily surcharge on long term commercial parking would cause a fifteen percent reduction in vehicle miles traveled, a fourteen percent increase in commuter transit trips, and a daily savings of 23,481 gallons of gasoline.[15]

Development of an appropriate and workable traffic management plan requires the community to commit itself to a research and planning process that will provide essential data from which to develop the plan. To gain an effective understanding of the existing parking situation the community should inventory and classify the parking spaces within the effected downtown area and identify the groups that have interests in the parking. In inventorying parking spaces, it is important to note the type (off street, on street, garage, lot,), nature and level of the rate (long term or short term), how much it is used when it is used, who uses it, its proximaty to traffic generators, and its proximaty to alternative transportation modes. When investigating groups that have interests in the parking facility it is important to note who owns the parking spaces, who pays for the parking (employer or employee for example), and the direct effect that the availability of parking has on politically strong interest groups and economic sectors (merchants, powerful land holders). When inventorying parking the planner should develop a log sheet which addresses all of these factors for each parking facility such as in Figure IV-2.

An effective parking management plan will address all types of parking and will be aimed at the commuter. Realistic parking management programs will insure compensation of lot owners[16] when parking space reductions are involved and will charge the actual user directly and on a daily basis. This will insure that its adoption is politically feasible and insure that the program is impacting the proper target group for maximum effectiveness. Ensuring that sufficient parking and convenient parking is available to shoppers will keep merchants happy, will assist the downtown economy, and will save energy. Energy will be saved by curtailing or eliminating the need to search for a parking space. Providing convenient short term parking may require imposing before 10 a.m. parking bans in areas or in a percentage of parking spaces, as was done in Boston. This will

Figure IV-2 PARKING INVENTORY LOG SHEET

TYPE OF PARKING:

____ open lot with attendents

____ garage

____ on street

____ other(describe)

LOCATION: (describe; bordering streets, access to which streets)

PROXIMATY TO TRANSIT:(describe, location of stops, type of transit)

PROXIMATY TO CBD:(describe, distance)

FEES AND RATES:(describe fees and long term rates available)

OWNER:

OPERATOR:

OF SPACES, TOTAL:

OF SPACES FILLED AT 9:30 A.M.:_____ % OF SPACES:_____

OF SPACES FILLED AT 6:00 P.M.:_____ % OF SPACES:_____

USERS:

employees of:(name firms)

customers of:(name firms)

PARKING PAID BY:

employer 100%_____

employer 100%_____

parker _____

other _____

prohibit commuters from using these spaces, because most commuters arrive at work prior to 10 a.m., and make them available for short term parking.

The three strategies to parking management are supply, price, and design. Pricing strategies are aimed at making transportation alternatives to the automobile attractive in terms of comparative out of pocket costs. This can be accomplished by establishing rate structures which discourage long term parking or through taxation. Taxation has the advantage of making money available to the community to administer the program. Reducing the supply of parking will indirectly raise prices while also cutting down on the actual number of spaces. Limiting supply on a temporal basis, such as before 10 a.m., is one approach. Limiting supply within a geographical area is another approach. Limiting parking to areas outside the immediate commercial area and forcing commuters to walk greater distances to their jobs will hamper the convenience of the automobile, one of the most important independent variables in the choice of transportation modes. Supply reduction programs should be oriented to allow parking owners to raise the price of parking to compensate for their loss in revenues. The design of parking facilities also has energy implications. Table IV-9 shows how the physical configuration of a parking facility can impact on the total vehicle miles traveled within the facility to obtain a parking space.

Any parking management plan or mass transit promotion program should take care to inform the intended target group and other affected parties of their alternatives and the benefits

Table IV-9 PARKING FACILITY CONFIGURATIONS AND ENERGY CONSUMPTION

Facility Design

Physical Configuration[a]	*No. of Stalls*	*Sq. Ft. Per Stall*	*Total Vehicle Miles Per Day*
1. Split Level: one outside bay offset a half level in height from the other three bays.	984	317	580
2. Double Helix: Sloping floor configuration with a double helix in the center two bays for up and down traffic.	1000	320	530
3. Express Ramp: Flat floors with a double helical spiral express ramp system with an 80 foot diameter.	990	347	405

Source: *Adapted from* Charles M. Boldon, "Environmental Impact on Parking," *Parking*, January 1975, at 25-28.

a. Assumptions:
- (i) Site is 215 feet x 300 feet.
- (ii) Entrance at one corner, exit at another.
- (iii) 9 foot stalls, bay width and parking angle determined by parking standards curve.
- (iv) No driver recirculates to find empty stall.
- (v) Lower level used for 500 short-term patrons (198 stalls x 2.58 turnover rate).
- (vi) Upper levels used for all day patrons (1.0 turnover rate).

Parking Angle

Angle	*Bay Width*	*Total Vehicle miles Per Day*
90°	62'0"[b]	308
70°	57'6"	498
57½°[c]	53'9"	530
50°	51'0"	568

Source: *Adapted from* Charles M. Boldon, "Environmental Impact on Parking," *Parking*, January 1975, at 28.

a. Based on Double Helix configuration, No. 2, Table 1.
b. Bay width of 62' would require a larger lot than is available under previous assumptions.
c. Parking angle used in Double Helix configuration, No. 2., Table 1.

Stall Width

Configuration (See Table 1)	*Total Vehicles Miles/Day With 8'8" Stall Width*	*Savings From 9'0" Stall Widths*
Split Level	562	18
Double Helix	516	14
Express Ramp	395	10

Source: *Adapted from* Charles M. Boldon, "Environmental Impact on Parking," *Parking*, January 1975, at 28.

source: Printed in, Durwood J Zaelke, Jr., Energy Conservation and Urban Transportation, (Environmental Law Institute) that can accrue to them. Commuters should be aware of alternate transportation modes available to them. Merchants should be aware of the benefits in convenience to shoppers that will accrue to them. Facility owners should be aware of the compensation they will have for reduced parking supply. Employers should be informed of the savings they can attain by not having to provide parking spaces, and may even be convinced to put some of this savings toward subsidizing employee transit trips.

Energy Embodied In Community Infrastructure

In addition to the energy required to move things about the community, energy embodied in these communication systems is also a significant consideration. Energy consumption for construction and embodied in materials was discussed in Chapter IV in detail. Table IV-10 depicts infrastructure requirements for six prototype neighborhoods which were presented by Real Estate Research Corporation in <u>The Costs of Sprawl</u>, a report prepared for the federal government.[17] The report presents the costs of operation and resource utilization in neighborhoods and in communities composed of various mixtures of those neighborhoods. As Figure IV-3 shows, density sucessively increases in neighborhood types A through E. Neighborhood F is a combination of types A through E. As would be expected, the requirements for community infrastructure are less in the more densely developed neighborhoods. Table IV-11 depicts that the cost of providing infrastructure in the more densely developed neighborhoods is correspondingly less expensive. Table IV-12 illustrates that construction activities involved in providing

Table IV-10

NEIGHBORHOOD STREET AND UTILITY LENGTHS

	A	B	C	D	E	F
Total Street Length	60,000'	44,750'	28,500'	17,005'	8,950'	30,000'
Total Utility System Lengths	54,000'	35,800'	22,800'	13,604'	8,055'	25,500'
Utility Length as Percent of Street Length	90%	80%	80%	80%	90%	85%

source: Real Estate Research Corporation, The Costs of Sprawl, (U.S. Government Printing Office, Washington D.C. April 1974) p. 59.

Figure IV-3
SUMMARY OF PROTOTYPES

	Neighborhood	Community
Population	Varies according to housing type; three populations ranging from 2,825 to 3,520 used	Population of 33,000; same for all communities
Dwelling Units	1,000 for each neighborhood	10,000 for each community
Acreage	Varies from 100 to 500 acres, depending on assumed densities and housing types	6,000 acres for each community
Development Pattern	Conventional and clustered	Planned, sprawl, and combination
Housing Types	(A) Single-family, conventional (B) Single-family, clustered (C) Townhouses, clustered (D) Walk-up apartments (E) High-rise apartments (F) 20% mix of each type (A)-(E)	(I) 20% mix; planned (II) 20% mix; combination (III) 20% mix; sprawl (IV) 75% single-family conventional; planned (V) 75% single-family conventional, 25% single-family clustered; sprawl (VI) 10% single-family clustered, 20% townhouses, 30% walk-ups, 40% high-rise apartments; planned
Environments	"Undistinguished" site with typical environmental features; not site specific	Same as neighborhood
Commercial	Convenience center, 7,500 square feet of building area, 21,780 square feet of land area.	(a) Strip commercial development, 200,000 square feet of building area, 1,056,000 square feet of land area (b) Center commercial development, 240,000 square feet of building area, 740,000 square feet of land area.

source: Real Estate Research Corporation, The Costs Of Sprawl, (U.S. Government Printing Office, Washington D.C., April 1974) p. 59.

Table IV-11

NEIGHBORHOOD COST ANALYSIS

UTILITIES-CAPITAL AND OPERATING COST SUMMARIES

Cost Category	A: Single-Family Conventional — Cost	A: Percent of Total Cost	B: Single-Family Clustered — Cost	B: Percent of Total Cost	C: Townhouse Clustered — Cost	C: Percent of Total Cost	D: Walk-Up Apartment — Cost	D: Percent of Total Cost	E: High-Rise Apartment — Cost	E: Percent of Total Cost	F: Housing Mix (20 Percent Each A - F) — Cost	F: Percent of Total Cost
	Housing Pattern (1,000 Units) (In thousands)											
CAPITAL COSTS												
Water and Sewer												
Sanitary Sewerage	$ 912	17%	$ 605	17%	$ 385	16%	$ 230	15%	$ 136	14%	$ 431	15%
Percent of A	-		66%		42%		25%		15%		47%	
Storm Drainage	$1,596	29%	$1,068	29%	$ 711	30%	$ 462	29%	$ 205	30%	$ 824	30%
Percent of A	-		70%		46%		29%		18%		52%	
Water Supply	$2,443	45%	$1,620	44%	$1,043	44%	$ 736	47%	$ 447	47%	$1,262	45%
Percent of A	-		66%		43%		30%		18%		52%	
Subtotal	$4,951	90%	$3,293	90%	$2,139	90%	$1,428	90%	$ 868	91%	$2,517	90%
Percent of A	-		67%		43%		29%		18%		51%	
Energy and Communications												
Gas	$ 161	3%	$ 107	3%	$ 68	3%	$ 53	3%	$ 31	3%	$ 84	3%
Percent of A	-		66%		42%		33%		20%		52%	
Electricity	$ 111	2%	$ 74	2%	$ 47	2%	$ 28	2%	$ 17	2%	$ 52	2%
Percent of A	-		67%		42%		25%		15%		47%	
Telephone	$ 259	5%	$ 176	5%	$ 115	5%	$ 70	4%	$ 42	4%	$ 128	5%
Percent of A	-		68%		44%		27%		16%		49%	
Subtotal	$ 531	10%	$ 357	10%	$ 230	10%	$ 151	10%	$ 90	9%	$ 264	10%
Percent of A	-		67%		43%		28%		17%		50%	
Total Networks - Capital (not including plants)	$5,482	100%	$3,650	100%	$2,369	100%	$1,579	100%	$ 958	100%	$2,781	100%
Percent of A	-		67%		43%		29%		17%		51%	
OPERATING AND MAINTENANCE COSTS												
Water and Sewer												
Sanitary Sewerage	$ 32	7%	$ 31	6%	$ 28	8%	$ 27	10%	$ 23	9%	$ 28	8%
Percent of A	-		97%		87%		84%		72%		87%	
Water Supply	$ 32	7%	$ 32	7%	$ 30	9%	$ 30	11%	$ 26	11%	$ 30	8%
Percent of A	-		100%		94%		94%		81%		94%	
Subtotal	$ 64	13%	$ 63	13%	$ 58	17%	$ 57	21%	$ 49	20%	$ 58	16%
Percent of A	-		98%		91%		89%		77%		91%	
Energy and Communications												
Gas	$ 201	42%	$ 201	42%	$ 139	41%	$ 109	39%	$ 93	38%	$ 148	40%
Percent of A	-		100%		69%		54%		46%		74%	
Electricity	$ 219	45%	$ 219	45%	$ 143	42%	$ 112	40%	$ 101	42%	$ 159	44%
Percent of A	-		100%		65%		51%		46%		73%	
Subtotal	$ 420	87%	$ 420	87%	$ 282	83%	$ 221	79%	$ 194	80%	$ 307	84%
Percent of A	-		100%		67%		53%		46%		73%	
Total Operating and Maintenance	$ 484	100%	$ 483	100%	$ 340	100%	$ 278	100%	$ 243	100%	$ 365	100%
Percent of A	-		100%		70%		57%		50%		75%	

Note: No operating cost estimates are included for storm drainage and telephone.

source: Real Estate Research Corporation, The Costs of Sprawl, (U.S. Governemnt Printing Office, Washington D.C., April 1974) p.60.

Table IV-12 CONSTRUCTION SECTORS RANKED BY ENERGY INTENSITY

RANK	INDEX	I/O CODE	NAME	TOTAL PRIMARY INTENSITY
1	43	110305	NEW CONST PETROL. PIPE.	147197.
2	42	110304	NEW CONST GAS UTIL.	140038.
3	47	110400	NEW CONST HIGHWAYS	121745.
4	63	120208	MAINT CONST PETR. PIPE.	117159.
5	50	110503	NEW CONST OIL/GAS WELLS	116895.
6	70	120215	MAINT CONST OIL/GS WELLS	109103.
7	58	120203	MAINT CONST FARM SERVICE.	96288.
8	68	120213	MAINT CONST CONSER.,DEV.	92963.
9	51	110504	NEW CONST OIL/GAS EXPL.	92941.
10	54	110507	NEW CONST OTH. NON-BLDG.	89466.
11	53	110506	NEW CONST CONS.,DEV.	84788.
12	62	120207	MAINT CONST GAS UTIL.	83078.
13	52	110505	NEW CONST MILITARY	77815.
14	40	110302	NEW CONST RAILROADS	77585.
15	32	110203	NEW CONST WAREHOUSES	77555.
16	45	110307	NEW CONST SEWER	76629.
17	33	110204	NEW CONST GAR.,SRV. STA.	76217.
18	69	120214	MAINT CONST HIGHWAYS	76044.
19	49	110502	NEW CONST FARM SERVICE	75956.
20	44	110306	NEW CONST WATER SUPPLY	73738.
21	34	110205	NEW CONST STORES,RSTRNTS	73183.
22	57	120202	MAINT CONST FARM RESID.	71292.
23	30	110201	NEW CONST INDUST. BLDG.	70864.
24	29	110107	NEW CONST DORMITORIES	70604.
25	38	110209	NEW CONST OTH. NON-FARM	69894.
26	28	110106	NEW CONST HOTELS,MOTELS	69184.
27	31	110202	NEW CONST OFFICE BLDG.	68737.
28	36	110207	NEW CONST EDUC. BLDG.	67924.
29	41	110303	NEW CONST ELECT. UTIL.	66639.
30	39	110301	NEW CONST TELEPH.,TELEG.	66636.
31	35	110208	NEW CONST RELIG. BLDG.	65597.
32	46	110308	NEW CONST LOC. TRANSIT	62447.
33	67	120212	MAINT CONST MILITARY	62352.
34	71	120216	MAINT CONST OTH. N-BLDG.	62045.
35	64	120209	MAINT CONST WATER SUPPLY	61927.
36	37	110206	NEW CONST HOSPITAL BLDG.	60572.
37	26	110104	NEW CONST HIGH-RISE APT.	60000.
38	23	110101	NEW CONST RES--1 FAM.	55511.
39	48	110501	NEW CONST FARM RESID.	53773.
40	25	110103	NEW CONST RES--GRDN APT.	52864.
41	24	110102	NEW CONST RES--2-4 FAM.	52139.
42	27	110105	NEW CONST RES--ALT.,ADD.	51646.
43	55	120100	MAINT CONST RESID.	50072.
44	56	120201	MAINT CONST OTH. NON-FRM	49720.
45	66	120211	MAINT CONST LOC. TRANSIT	48542.
46	65	120210	MAINT CONST SEWER	45044.
47	60	120205	MAINT CONST RAILROADS	42796.
48	59	120204	MAINT CONST TEL.,TEL.	35530.
49	61	120206	MAINT CONST ELECT. UTIL.	26418.

source: Hannon, Segal, Stein, Serber, Energy Use For Building Construction (Urbana-Champaign, Ill.: Energy Research Group, Center for Advanced Computation, University of Illinois). Feb. 1977, p. 134.

community infrastructure are among the most energy intensive. Of the forty-nine construction activities listed, new highway construction, new sewer construction, new water supply construction, and highway maintenance are among the top twenty. New electrical and telephone utilities construction are ranked twenty-ninth and thirtieth respectively.

This information points to the energy savings available through reduction of length of infrastructure and transportation systems. In Davis, California the reduction of right of way widths was determined to be an energy saver, not only in terms of the material reduction, but also in terms of the reduction of asphalt surface available to collect and hold heat and also by increasing the capability of the using of trees to shade a larger percentage of road area from the sun.

Street Lighting

Streetlighting is another area where substantial energy savings can be attained. Although not primarily related to spatial considerations, streetlighting can provide considerable energy and cost savings through increasing lighting efficiencies. Upgrading traditional incandescent streetlighting systems to the use of mercury vapor luminaires or high pressure sodium luminaires can yield significant energy savings. High pressure sodium lighting is about 2.5 times as efficient as mercury vapor lighting and about 8.5 times efficient as incandescent lighting. In a case study conducted in a Massachusetts community under the auspices of the Department of Community Affairs it was found that the current streetlighting system could be upgraded to result in a 32 percent increase in illumination while obtaining a 28 percent decrease in power and 6.6 percent decrease in cost.[18] Table IV-13 depicts the present and proposed street lighting system for Southbridge, Massachusetts.

In many communities there is substantial opportunities for energy savings in street lighting. It has been determined that in Massachusetts over 33 percent of the fixtures are of the obsolescent incandescent type. The process that has been recommended for making decisions about the upgrading of street lighting systems is as follows.[19]

1. Establish a working committee to formulate recommendations regarding street lighting upgrades. It is suggested that the committee include an official with budgetary responsibility for street lights, a representative of the policy department (because of his familiarity with crime areas which require good lighting levels), representatives of the businesses and neighborhoods which may be affected, citizens with technical backgrounds, and a lighting expert from the utility.

2. Inventory the existing lighting system. Knowledge of the current installation is the baseline for making decisions about the improvements. The information required includes the number of each type of fixture installed, the location of the fixtures and the approximate spacing. Also obtain the rate the utility is charging for the current system. The utility can provide this information.

3. Find out what alternatives are available from the utility. Obtain information on the cost and availability of more efficient lighting alternatives. Obtain information on standards and guidelines for spacing, pole heights, and light intensity which are recommended by the utility (Appendix D).

4. Identify specific opportunities for lighting upgrades by examining each installation in the inventory. Remember the importance of matching the lighting to the task. The intensity of light from high pressure sodium is not always appropriate to certain uses, such as in residential areas. Development density is important when upgrading to higher intensity lighting because the area which one fixture is capable of lighting is much greater, therefore it is more appropriate to higher density developments. Caution

Table IV-13

SOUTHBRIDGE

MUNICIPAL STREET LIGHTING SYSTEM

Lamp Types		Present	Proposed	% Change
incandescent	1,000 lumen	521	0	
"	2,500 lumen	52	0	
mercury	4,000 lumen	375	607	
"	8,000 lumen	127	14	
"	11,000 lumen	5	0	
"	22,000 lumen	117	2	
"	63,000 lumen	6	0	
sodium	16,000 lumen	0	179	
"	30,000 lumen	0	72	
"	50,000 lumen	0	11	
"	130,000 lumen	0	6	
total number installed		1,214	891	- 26%
total initial lumens		6,262,000	8,272,000	+ 32%
total power consumption (KWH)		566,832	405,240	- 28%
annual rate charges		$ 51,210	$ 49,742	- 2.8%
fuel adjustment charge at .0157/KWH		$ 8,899	$ 6,362	- 28%
total cost		$ 60,109	$ 56,104	- 6.6%

source: Massachusetts Department of Community Affairs, "Energy Management in Municipal Street Lighting", (March 1977) p.23.

Table IV-14

COMPARISONS OF COMMONLY USED STREET LIGHTING LAMPS

Lamp Type	Watts [a]	Rated Initial Lumens [a]	Maintained Lumens at End of Relamping Period	Lumens Per Watt (Ratio)	Average Utility Rate (1976) [b,c]	Economy in Dollars Per 1000 Lumens [b,c]	Typical Mount Height	Average Footcandles Illumination Over Area 6000 sq. ft.
Incandescent	103	1,200	960	10.7	$ 34.29	$ 31.17	25'	negligible
Incandescent	202	2,900	2,320	12.6	56.87	22.30	25'	negligible
Incandescent	327	4,850	4,025	12.3	70.14	17.43	25'	.27
Mercury	100	4,000 [d]	1,952 [d]	31.6	48.59	15.38	30'	.21
Mercury	175	8,150 [d]	4,824 [d]	40.1	64.22	9.16	30'	.45
Sodium	70	5,800	3,387	74.6	n/a [e]	n/a [e]	30'	.50
Sodium	100	9,500	5,548	85.5	n/a [e]	n/a [e]	30'	.81
Sodium	150	16,000	9,344	90	n/a [e]	n/a [e]	35'	1.08
Sodium	250	30,000	17,520	92.8	123.84	5.34	35'	1.86
Sodium	400	50,000	29,200	112.5	176.96	3.93	40'	3.32

[a] wattage and lumen data were taken from lamps manufactured by General Electric

[b] includes fuel charges

[c] utility rates for this table were derived from the rate schedules of the following companies: Boston Edison, Mass Electric, Western Mass. Electric, Fall River Electric Light

[d] horizontal burning position

[e] although lighting companies produce these lamps, they are not widely enough available on utility rate schedules to draw conclusions as to costs

source: Massachusetts Department of Community Affairs, "Energy Management in Municipal Street Lighting", (March 1977), p. 35.

should also be taken with regard to conversion to high intensity lighting because the possible need for higher poles may make the economics undesirable.

SITE PLANNING AND BUILDING DESIGN

Structures consume a great deal of energy in keeping their internal environment in a steady state (within a temperature and relative humidity comfort range). Energy is consumed in keeping a structure in the steady state because there exists a situation of disequilibrium between the internal environment and the external environment. The amount of energy needed to keep a structure in the steady state depends upon the stress put on it by the external environment. This external environment of a structure can be diminished by minimizing the conflict between the external environment and the internal environment. This conflict can be minimized by decreasing a building's vulnerability to environmental stress and by increasing its capability for utilizing energy which is available naturally in the external environment.

Climate

The amount of energy available in the environment is dependent upon global conditions and local conditions. Globally, sun angle varies with latitude and season of the year. The most energy is available to the earth when the sun angle is closest to 90 degrees, perpendicular to the earth. This only happens in the tropics, between 23 degrees north latitude and 23 degrees south latitude. In higher latitudes the sun angle is always less than 90 degrees and less energy is available. In Providence, 42 degrees north latitude, the maximum sun angle during the year is about 70 degrees. This occurs on the summer solstice, June 22, of each year. The minimum sun angle in Providence occurs on the winter solstice, December 22, and is about 25 degrees. This means that only about forty-three percent of the energy available on June 22 is available on December 22. The range of stress which this example portrays is as important a factor in building energy useage as the magnitude of stress. This means that the desired steady state condition of 68°F will have to be maintained under external conditions ranging from -5°F to 100°F annually. The sun also creates wind currents and ocean currents which prevail over certain sections of the globe.

Local conditions serve to modify global climate and create unique climatic conditions which are specific to an area. Natural features and man made aspects of the landscape are both factors in the nature of the local climate. Breezes occur near water bodies and in mountain valleys due to the creation of convection currents as a result of different temperatures in proximate areas. Sea breezes[20] occur because of the difference in specific heat of water and earth. Water heats up more slowly than earth and retains heat longer. As a result, the heat over the earth during the day time rises and is replaced by the cooler ocean air. At night, the land quickly loses its heat and becomes relatively cooler than the adjacent water body thus creating a wind in the reverse direction. Sea breezes will commonly penetrate from fifteen to fifty miles inland in the middle latitudes and are prominant in the summer.

The same effect occurs in cities.[21] This is called the urban heat island effect. Concrete, asphalt and other building materials which predominate in the city tend to heat up quickly and hold more heat than the surrounding countryside, thus setting the conditions for the creation of convection currents. Other conditions in the city also effect climate. Pollutants in the atmosphere tend to cause increased rainfall and also serve to create a greenhouse condition which serves to hold heat in the city from radiating into the atmosphere. Wind currents are also created in the city due to large buildings which tend to channel winds and increase their momentum.

Mountain and valley winds[22] are common local occurances which, like sea breezes, may modify the prevailing wind pattern. The thermal up slope wind is created perpendicular to the valley (up and down the slopes). The southern slopes of mountains in the valleys with an east west axis are most effected in the northern hemisphere because of the intense solar radiation received. Imbalances between the temperature of the valley floor and the heated slope cause convection currents which create winds based on the same principle as land/sea breezes. This principle also applies to mountains with a north-south axis. In the early morning east facing slopes will receive the greatest insolation after noon Winds develop accordingly. Valley winds are winds that follow the valley axis and are again based on convection currents. As the valley floor heats up the hot air rises up the valley. At night the cold air drains back down into the valley.

These local climatic effects occur diurnally and are predominant in the summer months in the middle latitudes. The summer predominance and diurnal nature are logical because these local climate conditions are dependent upon intense insolation to create convection currents. In mountains, at night when the temperature is cool, cold air will drain down to the valley floor making the effects even more extreme than in the case of urban breezes and sea breezes.

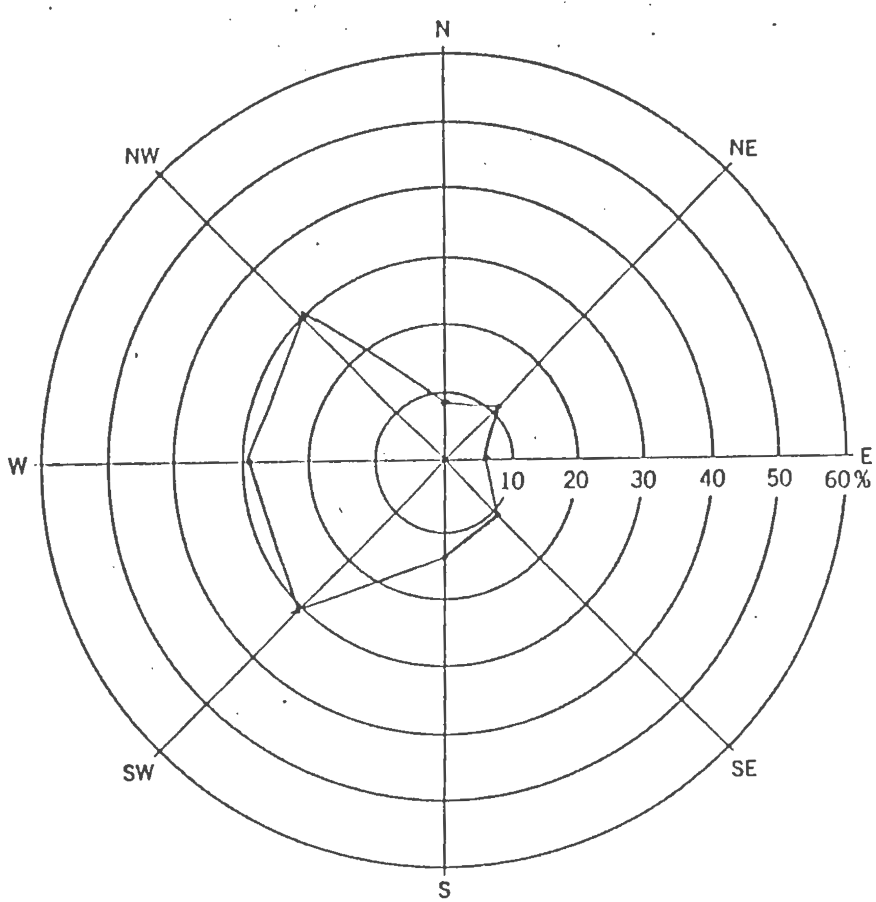
The two most important conditions to have information on with regard to climate are wind and insolation. Understanding the dirunal and annual ynamics of these conditions are important when attempting to reduce energy use through site and building design. Local climate interacts with global climate. Diurnal cycles interact with annual cycles. Energy efficient design can be best achieved with site specific data. Data available through local weather stations at colleges, television stations, radio stations, and the U.S. Weather Bureau will be the second best alternative to site specific data. Plotting wind information on a wind rose Figure IV-4 will reveal the net affect of winds in the area. Specific information about the direction and velocity of winds on a seasonal or monthly basis is particularly important to good site design. Awareness of topography and surrounding geography is a prerequisite to understanding local climate and making it a consideration in site planning and building design.

Building Design Considerations

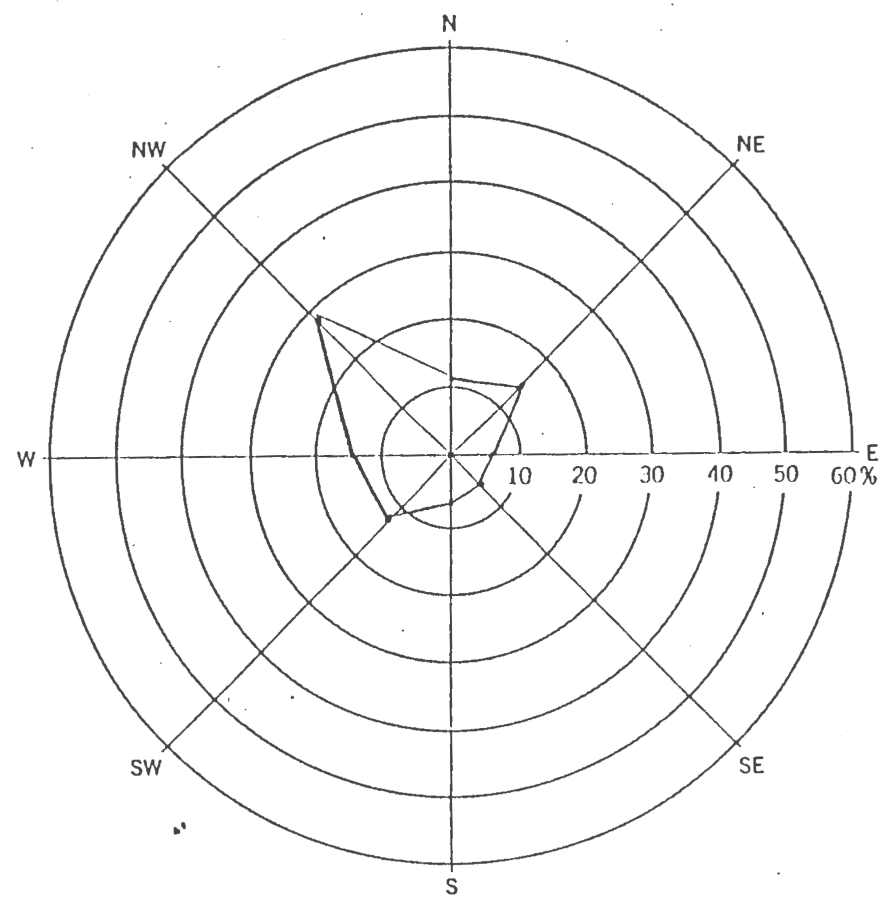
The amount of energy that can be saved by incorporating energy efficiency into building design is considerable. Some estimates maintain that new buildings explicitly designed to be energy efficient could save as much as eighty percent of the fuel they would consume at present levels. The American In-

Figure IV-4 WIND ROSE FOR SUMMER AND WINTER
NORTHEAST LOCATION

(percent of seasonal winds from each compas direction)



summer



winter

stitute of Architects has determined that with thirty percent energy savings for existing buildings and sixty percent savings for new structures the U.S. would save 12.5 million barrels of oil a day by 1990.[23] In Chapter III, energy savings through the selection of and performance of building materials was discussed. In this chapter, energy savings through design performance is discussed. This section will focus on the residential sector but, the same principles can be applied to other building types.[24]

When building energy efficient housing there are two general guiding principles that should be followed. They are:

1. Minimize vulnerability to unwanted aspects of the environment.
2. Maximize capability to utilize energy naturally available in the environment.

Both of these principles can be attained through proper site selection, orientation of the building on the site, landscaping, structural design, and materials selection. These points will be addressed briefly relative to locations in the northeast.

Minimizing vulnerability to unwanted aspects of the environment will involve selection of a site that is not a collection basin for cold air drainage in the winter and provides breezes in the summer. If a site is selected that is exposed to unwanted winter winds, for example, it can be sheltered from these winds through the use of coniferous shrubbery and trees as barriers to divert and diffuse the wind. Conversely, elements of the landscape which serve to trap unwanted cold air or divert cooling summer breezes should be avoided or removed. This includes removal of trees which may be blocking desirable winter heat gain in the southern face of housing. Figures IV-5

Figure IV-5

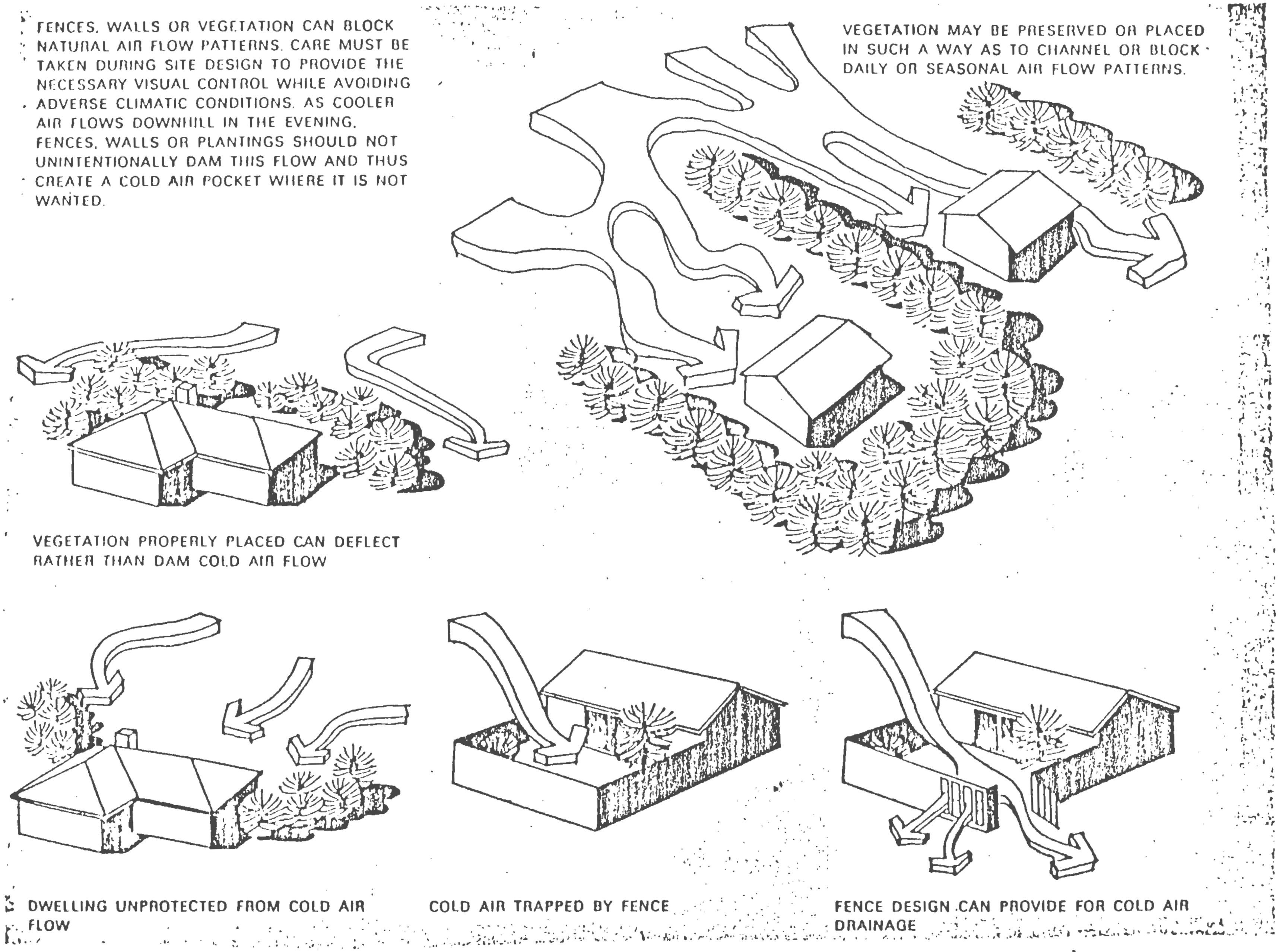
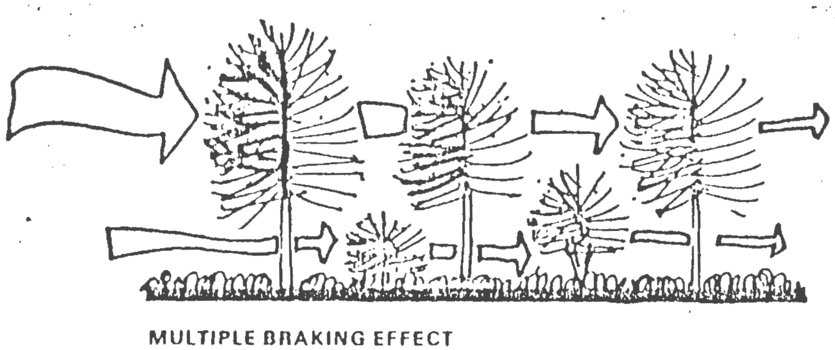
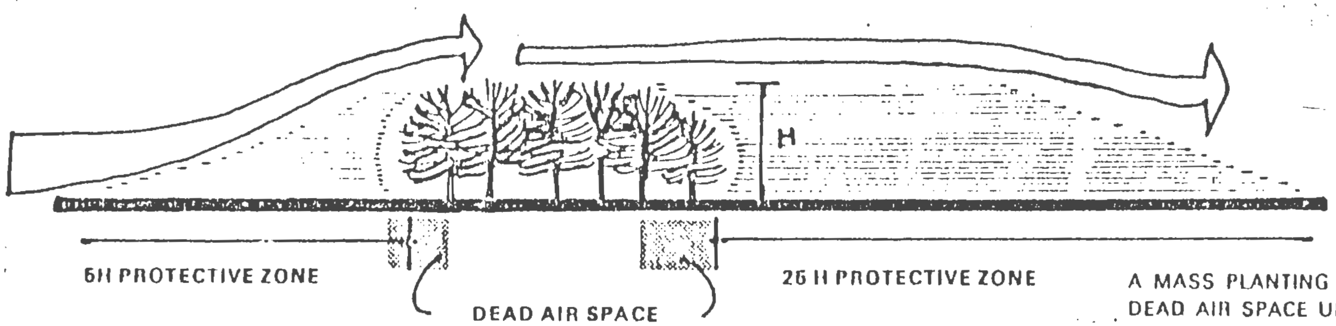

FENCES, WALLS OR VEGETATION CAN BLOCK NATURAL AIR FLOW PATTERNS. CARE MUST BE TAKEN DURING SITE DESIGN TO PROVIDE THE NECESSARY VISUAL CONTROL WHILE AVOIDING ADVERSE CLIMATIC CONDITIONS. AS COOLER AIR FLOWS DOWNHILL IN THE EVENING, FENCES, WALLS OR PLANTINGS SHOULD NOT UNINTENTIONALLY DAM THIS FLOW AND THUS CREATE A COLD AIR POCKET WHERE IT IS NOT WANTED.
VEGETATION MAY BE PRESERVED OR PLACED IN SUCH A WAY AS TO CHANNEL OR BLOCK DAILY OR SEASONAL AIR FLOW PATTERNS.
VEGETATION PROPERLY PLACED CAN DEFLECT RATHER THAN DAM COLD AIR FLOW
DWELLING UNPROTECTED FROM COLD AIR FLOW
COLD AIR TRAPPED BY FENCE
FENCE DESIGN CAN PROVIDE FOR COLD AIR DRAINAGE

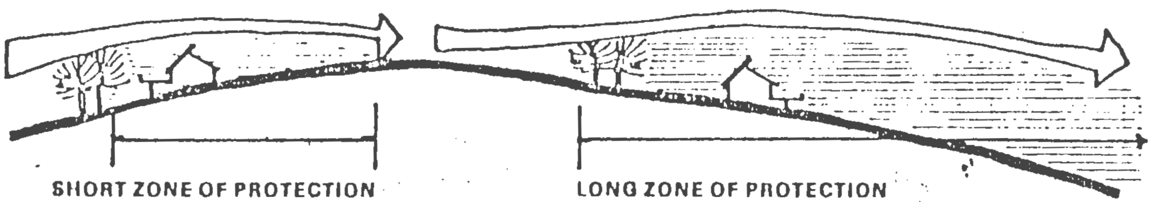
Figure IV-6



MULTI-LAYERED VEGETATION INCLUDING CANOPY TREES AND UNDERSTORY TREES OR SHRUBS PROVIDES A MULTIPLE BRAKING EFFECT, SUBSTANTIALLY DECREASING THE WIND VELOCITY MOVING OVER A SITE.



A MASS PLANTING OF TREES PROVIDES A DEAD AIR SPACE UNDER AND AROUND ITSELF. IT ALSO DECREASES THE AIR VELOCITY 5 TIMES ITS HEIGHT TO WINDWARD AND 25 TIMES ITS HEIGHT TO LEEWARD OF THE PLANTING.



PLANTING ON THE LEEWARD SIDE OF A HILL SUBSTANTIALLY INCREASES THE DOWNWIND ZONE OF REDUCED AIR VELOCITY, WHILE PLANTING ON THE WINDWARD SIDE CORRESPONDING DECREASES THE ZONE.

and IV-6 depict some points of how landscaping can be used in energy efficient design.

Minimizing a structure's vulnerability to the environment also involves some principles of building design and building material performance. In the middle latitudes structures can minimize their vulnerability by decreasing heat loss in the winter and decreasing heat gain in the summer. Winter heat loss can be minimized by reducing susceptibility to winds, which are a factor in heat loss, as described above and by increasing the R value of the wall composition. As discussed in Chapter III, this can be achieved by using materials with good resistance to heat flows and minimizing the use of building materials that do not. Minimizing glass area on the vulnerable north side of structures is a good way to decrease heat loss. Figure IV-7 illustrates how building overhang can be designed to provide for minimal summer heat gain by shading while providing unimpeded insolation during the heating season.

Ralph Knowles, in his book Energy and Form, hypotesizes that the vulnerability of structures to the external environment can be described as a function of the ratio between exposed surface and contained volume.[25] Surface to volume ration (S/V) is referred to by Knowles as the coefficient of susceptibility. Higher stress environments require lower coefficients of susceptibility, while lower stress environments require higher coefficients of susceptibility. Two attributes of form that effect the coefficient of susceptibility are size and shape.

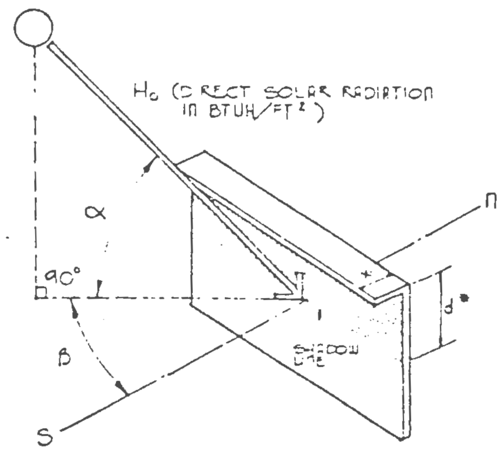
Figure IV-8 depicts the correlation between size and shape and surface to volume ration. Figure IV-8a depicts an expand-

Figure IV-7 SUN ANGLE AND BUILDING DESIGN

Sun Angles

Bearing (or azimuth) angle (β) and altitude angle (α) of the sun are given in solar tables.* These sun angles, along with the angle of orientiation relative to the north-south axis, can be used to predict shadows for a particular time at a specific latitude. The depth of shade (d) in feet can be found by $d = x\ (\tan \alpha / \cos \beta)$ where x is the overhang width in feet. Basic sun angle geometry is given below.

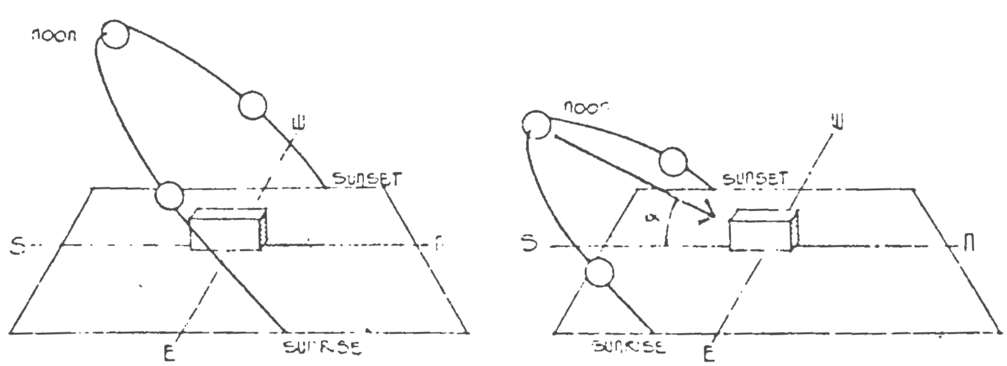
*See: pp. 388-92. ASHRAE Handbook of Fundamentals (1972).



VERTICAL SURFACE (WITH OVERHANG)

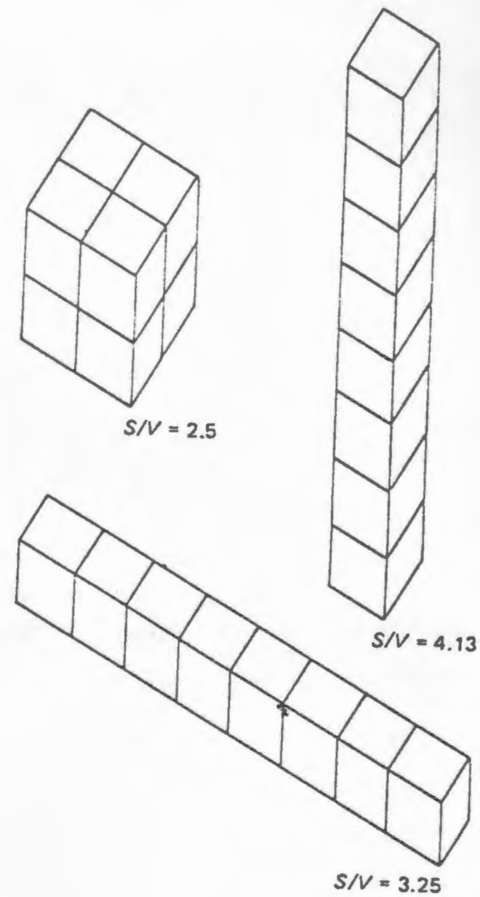
Solar Orbit (at 40° North Latitude)

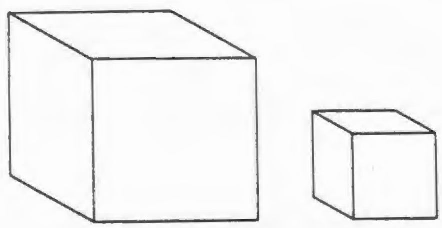
The sun's movement across the sky differs in bearing and altitude angles with the seasons. Exaggerated orbits for summer and winter conditions at 40° north latitude are shown below. Note that seasonal variations also alter the solar radiation values.



source: M. David Egan, Concepts in Thermal Comfort, (Engle Wood Cliffs, New Jersey: Prentice-Hall, Inc., 1975) p.24.

Figure IV-8 SURFACE TO VOLUME(S/V) RATIO





Doubling the dimensions of a cube decreases its surface-to-volume ratio by one half.

Figure IV-8a
Size

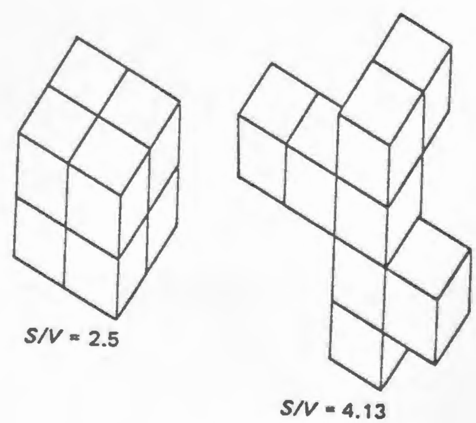


Figure IV-8b
Shape

The shape of the form has an effect on its surface-to volume ratio.

Simple shapes generally have a lower surface-to-volume ratio than complex shapes of the same volume.

source: Ralph Knowles, Energy and Form, (Cambridge: MIT Press, 1974) ing cube. A unit cube in contact with the ground on one of its faces exposes five unit surfaces while its volume is one, therefore S/V=5. If the edge diminsions of that cube are doubled its surfaces total 20 while volume is eight, therefore S/V=2.5, or half of the smaller cube. The small cube then is more vulnerable simply because smaller things have higher surface to volume ratios. S/V is to a lesser extent a function of shape and can be illustrated by comparing the same volume in different configurations. Figure IV-8b takes the larger of the two cubes and rearranges the volume into a stack of eight equal cubes and a row of eight equal cubes. The results are depicted. Estimates of energy consumed in various types of housing in the Baltimore/Washington area that are illustrated in Table IV-15 show some agreement with this theory. Energy consumption per ft^2 and per person is shown to decline in the larger structures.

Maximizing capability to utilize energy naturally available in the environment will involve selection of a site that has access to the sun during the heating season. A site that also has access to seasonal breezes during the cooling season is most desirable. Proper orientation of the structure on the site to take advantage of available solar insolation is essential. The long axis of a structure should run east to west to take full advantage of available sunlight. In this way the maximum area of the house is available to collect solar insolation. The average solar insolation outside of the earth's atmosphere when the sun's rays are perpendicular is equal to 428 BTU's/hr/ft^2. At 42^o north latitude this figure ranges from 398 to 171 BTU's/hr/ft^2 depending on the season. Cloud

Table IV-15 COMPARISON OF ESTIMATED ENERGY CONSUMPTION VALUES FOR CHARACTERISTIC SINGLE-FAMILY AND MULTI-FAMILY DWELLINGS

Type of Dwelling Unit	Area Ft^2	Persons Per Unit	Total Energy Consumption, Therms/Year* Per Unit	Per Person	Per Ft^2
Balanced Home, 4 bedroom (Ref. 20)	1500	4	2886	721	1.92
Town House 3 bedroom	1300	4	2363	566	1.75
Low Rise 2 bedroom apartment	1140	3	1724	575	1.51
High Rise 1 bedroom apartment	850	2	1323	662	1.56
High Rise 2 bedroom apartment	950	3	1482	494	1.57

* as gas consumed in unit plus therms used to generate electric power consumed in unit

source: Hittman Associates, Incorporated, "Residential Energy Consumption-Multi-Family Housing Data Acquisition", prepared for Department of Housing and Urban Development, October 1972, p.55.

cover, pollution, and other atmospheric conditions further reduce this figure. However, Table IV-16 shows insolation which is available at approximately 42^{o} north latitude, in Boston. As this table depicts, a verticle glazing (90^{o}slope) facing due south (azimuth 0) would receive larger shares of insolation in the heating season, months with mean temperatures below 65^{o}F., than in the three summer months. A large south facing window would capture this energy for use in colder months, while an appropriately designed overhang would shade the window from unwanted rays in the heating months. Use of rock, concrete, or other media in the floor of construction or some other aspect of house design will absorb and store excess heat that may be gained during times of the day when insolation is too intense to be totally consumed in heating the structure. When using flat plate collectors to receive insolation Table IV-16 indicates that approximately a 50 degree tilt (slope) of the panel is most desirable, at this latitude.

This section on site planning and building design presented some very fundamental concepts. Specific building designs can incorporate numerous passive and active solar design features.[26] The economics of active solar systems have not been established as being cost competitive with conventional fuel sources as of 1979 prices. As prices of fuel go up and costs of solar systems go down, with improved technology, solar likely will become competitive with conventional energy sources. Currently, solar is already competitive with electricity for use in heating domestic hot water. Orienting new structures to take advantage of energy available through passive means will also

Table IV-16 INSOLATION AND WEATHER DATA FOR BOSTON

BOSTON	MA	42.22											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	
HORIZONTAL RAD.	511	729	1078	1340	1738	1837	1826	1565	1255	876	533	438	(BTU/DAY-FT2)
AVE. TEMP.	30.2	30.2	35.6	46.4	57.2	66.2	71.0	69.8	62.6	53.6	42.8	32.0	(F)
DEGREE-DAYS	1088.	972.	846.	513.	208.	36.	0.	9.	60.	316.	603.	983.	(F-DAYS)

AVERAGE DAILY RADIATION ON TILTED SURFACES (BTU/DAY-FT2)

SLOPE	AZIMUTH	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
20	0	740	944	1262	1418	1730	1778	1789	1616	1416	1106	740	651
30	0	830	1021	1313	1414	1677	1701	1722	1593	1449	1184	818	736
40	0	900	1074	1333	1379	1592	1595	1623	1536	1450	1234	878	803
50	0	947	1101	1322	1316	1477	1461	1494	1448	1417	1254	916	850
60	0	970	1101	1281	1226	1335	1303	1340	1331	1352	1244	931	875
70	0	969	1075	1211	1112	1172	1128	1166	1190	1258	1205	923	879
80	0	943	1024	1114	978	993	943	979	1028	1136	1136	893	860
90	0	895	950	996	831	810	759	791	857	993	1044	842	820
20	15	732	936	1256	1417	1732	1781	1792	1616	1412	1097	732	643
30	15	818	1009	1304	1414	1681	1707	1727	1595	1445	1171	807	724
40	15	884	1058	1322	1382	1600	1604	1632	1541	1445	1217	863	788
50	15	928	1082	1310	1322	1489	1475	1507	1457	1414	1234	898	832
60	15	949	1080	1269	1236	1352	1322	1358	1346	1352	1222	911	856
70	15	946	1052	1199	1127	1194	1152	1190	1210	1260	1180	902	857
80	15	919	1000	1103	998	1021	971	1008	1054	1142	1111	871	837
90	15	870	925	987	858	844	792	826	809	1005	1017	820	797
20	30	707	913	1238	1411	1735	1788	1798	1614	1397	1073	709	620
30	30	781	975	1280	1410	1692	1723	1742	1597	1427	1137	774	691
40	30	837	1016	1295	1382	1621	1631	1657	1551	1427	1175	821	745
50	30	872	1033	1282	1328	1522	1514	1545	1476	1398	1186	848	781
60	30	886	1026	1242	1249	1398	1375	1410	1376	1339	1170	854	797
70	30	877	994	1175	1149	1255	1219	1257	1253	1254	1127	841	794
80	30	847	941	1084	1031	1097	1052	1090	1112	1145	1058	807	771
90	30	798	867	975	903	935	885	922	962	1018	960	755	730
20	45	669	870	1209	1399	1736	1797	1803	1606	1372	1036	676	585
30	45	728	928	1242	1396	1700	1743	1756	1591	1395	1087	726	640
40	45	769	958	1252	1371	1639	1664	1684	1551	1393	1116	761	680
50	45	793	967	1237	1322	1553	1563	1588	1485	1365	1120	779	705
60	45	798	955	1198	1251	1444	1441	1470	1396	1311	1101	778	712
70	45	784	922	1135	1161	1317	1302	1333	1206	1233	1057	760	703
80	45	752	870	1051	1054	1175	1152	1184	1159	1133	992	725	677
90	45	704	802	952	937	1028	1000	1031	1024	1019	910	675	636

source: U.S. Department of Energy, Introduction to Solar Heating, Cooling, Design, and Sizing, 1977, p.2-26.

enable structures to adopt active solar systems if and when they become economically feasible. There are many books available from which a person who has no experience in building design can obtain an education in passive and active solar design of buildings. One of these is the U.S. Department of Energy, Introduction to Solar Heating - Cooling and Design and Sizing. This book can give the planner, review boards, and other appropriate officials in the community a more complete education in energy efficient design that can be incorporated into their daily routine and decision making process. A paradox that should be noted is that in order to take maximum advantage of site design concepts for energy efficiency it implies a relatively low density development. However, many of the principles of site design can be incorporated into higher density development to be used in harmony with other energy efficient design principles previously considered and aimed at attaining higher densities.

CONCLUSION

This chapter has presented some fundamental concepts and information on the manner in which the effective use of space can contribute towards reductions in energy consumption. As the introductory discussion suggests however, our communities have developed under conditions of cheap energy, when the friction of distance was at its smallest. Thus, the development pattern that exists is entirely inappropriate to the conditions which are expected to exist in the future, expensive energy and increased friction of distance. The job of the planner will be to adapt existing development patterns to accomodate these changing circumstances and to plan new physical growth in such a manner that it will not only be efficient unto itself but will support needed modifications to already existing urban forms. The next chapter addresses the mechanisms and resources available to the planner to accomplish this task.

12 Phyllis Myers, "Land Use Policies and Energy Conservation", Conservation Foundation, p. 85.

13 Durwood J. Zaelke, Jr., "Energy Conservation Through Automobile Parking Management", Energy Conservation Project Report, no. 6, (May 1976).

14 Ibid., p. 7.

15 Ibid., p. 14, Table 6.

16 In a suit challenging the Clean Air Act Transportation Control Plan for Boston, the U.S. Court of Appeals for the First Circuit rejected an assertion that a regulation mandating that forty percent of the total commercial off-street parking supply remain vacant until 10 a.m., amounted to a taking without just compensation.

17 Real Estate Research Corporation, The Costs of Sprawl, (Washington D.C., U.S. Government Printing Office, April 1974), prepared for HUD, CEQ, EPA.

18 Massachusetts Department of Community Affairs, "Energy Management in Municipal Street Lighting", (March 1977), p. 23.

19 Ibid. pp. 8-10.

20 For more information on sea and land breezes see, Glenn Trewartha, An Introduction to Climate, (New York: McGraw-Hill Company, 1968) pp. 108-110.

21 For more information see, Arthur N. Strahler, Introduction to Physical Geography, (New York: John Wiley & Sons, Inc., 1973), p. 75: and for a discussion of winds in cities see Nathan Cobb "High Rise in Windy Boston", in New England Magazine, Boston Sunday Globe, October 10, 1976.

22 For more information see Glenn Trewartha, An Introduction to Climate, (New York: McGraw-Hill Company, 1968), pp. 110-111.

23 American Institute of Architects, Energy and the Built Environment: A Gap in Current Strategies. (Washington D.C., 1974) p. 11.

24 These principles apply to residential buildings and most commercial buildings. However, commercial buildings and industrial plants which use heat in manufacturing processess or generate heat for other than comfort purposes will operate under different circumstances to be energy efficient. These buildings will want to increase heat loss to be energy efficient for comfort purposes and decrease heat loss in the process.

25 Ralph Knowles, Energy and Form, (Cambridge: The MIT Press, 1974).

[26]Passive solar energy does not use mechanical power (e. g.: pumps and fans) but instead uses natural energy flows for transfer of thermal energy into, out of, and through a building. Active systems utilize a mechanical system to transport energy between collectors, storage, and the building.

CHAPTER V

IMPLEMENTATION RESOURCES AND MECHANISMS

Introduction

This final chapter addresses resources and mechanisms that can be used to implement community energy programs. Programs that result from comprehensive planning can only be effective within the limitations of resources and mechanisms that are available to implement them. When developing programs it is not only necessary to know the community's needs and goals, as determined in the planning process, but it is also important to foresee implementation resources and mechanisms which are required for successful implementation and see that they can be made available.

Implementation mechanisms, as discussed in this chapter, are those authorities, controls, regulations, and laws which the community government can apply to promulgate, initiate and enforce a program. In this chapter, implementation mechanisms refer primarily to the police powers of the community (i.e. zoning, building codes, etc.). Powers that exist or can be established within community governments with regard to these implementation mechanisms are essential to the implementation of some community energy program measures and to the implementation of a comprehensive energy program.

Resources refers primarily to funding. This chapter will address itself to resources that may be available through the federal government through various programs which have been established through federal legislation. Some of these programs may have expired or may not have received appropriations from Congress so it would be wise for planners to investigate before proceeding very far along in the program planning and development process. Even programs for which authorizations have been made may have received reduced appropriations or no appropriations. Some programs are offered on a voluntary basis, that is, all targeted entities are invited to participate. Others are on a competitive basis whereby applications outlining programs must be submitted to the appropriate federal agency and grants are made to those applicants that best meet evaluation criteria. Unsolicited proposals and requests for funding to appropriate federal agencies sometimes meet with success. The best source of information on federal funding which is available on a competitive basis is the Commerce Business Daily. This is a publication of the federal government in which all federal agencies must place advertisements for bids and proposals for all contracts they want to issue. This publication is issued daily.

IMPLEMENTATION RESOURCES

Most of the programs which can potentially provide resources to local governments to undertake energy programs are administered by four federal agencies: U.S. Department of Housing and Urban Development, U.S. Economic Development Administration, U.S. Department of Energy, and the U.S. Department of Transportation. Resources available under these programs are in the form of outright grants (some with matching requirements), loans, loan guarantees, below market interest rates, and manpower. Many of the resoruces which will be addressed were not made available specifically for energy program purposes. This particularly applies to programs where resources are available for rehabilitation but not explicitly for building retrofits. With the passage of the National Energy Conservation Policy Act of 1978, this situation has begun to change. NECPA has amended various sections of housing legislation to specifically provide for energy considerations. With the growing national concern about our energy situation this adjustment of existing programs may continue. In the meantime, the following listing contains programs which explicitly or implicitly provide funding and/or resources for local energy programs. Local planners should be alertly looking for new federal sources of energy program funding. This will be followed by a discussion of methods for financing weatherization projects and then the second section of this chapter which addresses implementation mechanisms. Resources will be addressed under the following headings:

A. Loans (including guarantees and below market interest rates)

B. Grants

C. Other

A. Loans[1]

Twenty five federal loan programs are listed in this section. Many of them apply specifically to the undertaking of conservation measures. The remainder of the programs are directed towards property rehabilitation. The extent to which property rehabilitation includes energy retrofit work is only implied in program regulations. Loan programs are targeted toward certain geographic areas and certain clientele, for the most part. Loan programs which are listed herein include programs which provide outright loans or loan guarantees. In some cases the programs provide lower than market interest rates. In some cases the interest rates are at market levels but the loan making criteria is made less stringent in order to free up money for various retrofit and rehabilitation projects that the money market might not otherwise serve. Most of the loan programs which are listed have loans being made through FHA approved lenders, rather than through federal agencies. Community planners should check with lending institutions which serve their area to see which banks provide these programs. With very few exceptions community energy programs will not be able to rely on the federal loan programs listed herein to make them successful. In most cases these programs should be used to supplement other implementation resources and mechanisms rather than as the core of a program.

1. Section 241 of the National Energy Conservation Policy Act (NECPA) amends Title I of the National Housing Act to provide loan insurance explicitly for purchasing and installing energy conservation improvements and solar energy systems.

2. Section 242 of NECPA amends section 314 of the Federal National Mortagage Association Charter Act to allow GNMA (Government National Mortgage Association) to purchase loans to be used by low and moderated income families for the purpose of installing energy conserving improvements in one to four family units subject to the following provisions:

-payment of loan must occur within 15 years of date of issue

-interest rates will be at or below maximum interest rates available for such loans

-the loan may not exceed 2,500 dollars

-priority must be given to low and moderate income families (those whose income does not exceed 100 percent of the median income of the area).

3. Section 243 of NECPA amends section 315 of the Federal National Mortagage Association Charter Act to provide the Secretary of the Department of Housing and Urban Development the standby authority to direct GNMA to purchase loans for purchasing and installing energy conservation improvements. These loans would be available to owners of one to four family dwellings insured under Title I and section 241 of the National Housing Act at interest rates which are established by the secretary of HUD.

4. Section 244 of NECPA amends section 316 of the Federal National Mortagate Association Charter Act to allow GNMA to purchase loans to be made to owners of one to four family houses, and insured under Title I of the National Housing Act, and which are made for the purpose of installing solar energy systems. These loans are subject to the following provisions:

-the amount of the loan does not exceed 8,000 dollars

-the period of repayment does not exceed 15 years

-at interest rates to be established by the secretary

5. Section 245 of NECPA amends section 302 (h) of the Federal Home Loan Mortgage Corporation Act to permit secondary

financing by the Federal Home Loan Mortgate Corporation of solar energy and energy conserving improvements for those residential mortgages insured under Title I of the National Housing Act and for such loans to borrower's whose credit worthiness is based primarily on forecasts of income and lacking other security or such loan insurance mentioned above.

6. Section 246 of NECPA amends section 302 (b) of the Federal National Mortgage Association Charter Act to permit secondary financing by the Federal National Mortgage Association of solar energy and energy conserving improvment loans.

7. Section 247 of NECPA amends section 241 of the National Housing Act to provide loan insurance for the purchase and installation of energy conserving improvements, solar energy systems and utility meters in multi family housing whether or not the project is covered by a mortgate under the act. Loans insured under this program are insured subject to the following provisions:

- -must bear interest rates which the Secretary determines to be necessary to meet market demands
- -cover 90 percent of any loss incurred except for in the case of projects receiving assistance under section 236 or 221 (d) (3) where 100 percent of loss is insured.

8. Section 248 of NECPA makes amendments to various established programs to provide increases in mortgage limits to cover the costs of solar energy systems.

- -Section 203 (b) (2) of the National Housing Act is amended to increase the amount of loan permitted to be insured by twenty percent to cover the costs of solar energy systems in multi family housing

-Section 501 of the Housing Act of 1949 is amended to give the Farmers Home Administration the authority to increase the amount on any loan which is made, insured or guaranteed under Title V by twenty percent to account for the increased cost of the purchase of a dwelling due to the installation of a solar energy system.

9. Title II of the Economic Development Act of 1965 authorizes loans for the rehabilitation of locally owned structures. This program is administered by the Economic Development Administration. Funding for energy conserving improvements has been made available explicitly under programs administered by EDA.

10. The U.S. Small Business Administration administers a loan program which is aimed at providing a means for small business firms to enter, continue, or expand in the fields of manufacturing, selling, installing, servicing, and developing specific energy measures. This program is provided for by section 7 (1) of the Small Business Act.

11. Section 312 of the Housing Act of 1964 provides low interest long term loans to undertake rehabilitation projects in residential, non-residential, or mixed use properties within approved program areas. Approved program areas include: Neighborhood development projects, urban renewal areas, Section 117 code envorcement areas, and areas approved under the Fair Access to Insurance Requirements Plan. Loans are also available for participants in the Section 810 Urban Homesteading Program. These loans are available at a three percent interest rate to bring properties into conformance with codes and re-

habilitation standards. In certain instances they also may be used to bring property above code standards, but the amount of the loan covering general improvements cannot exceed 40 percent of the total loan. There are no income limits on the program although priority is given to low and moderate income families. It is unclear as to the extent that this program can be used for funding weatherization projects.

12. Section 203 (k) one to four family mortgage insurance for home improvement loans outside urban renewal areas. This program is currently inactive due to the ceiling interest rate of 8.5 which was set by law.

13. Section 235 Mortgage Insurance and Assistance payments for home ownership and project rehabilitation. This program insures loans and provides payments to lenders to reduce interest rates. This program is aimed at those families which make no greater than 95 percent of the area's median income.

14. Section 221 (d) (2) provides loan insurance for home ownership and rehabilitation of one to four family housing. The program is aimed at low and moderate income families having incomes which are no higher than 95 percent of the area median income.

15. Section 220 (h) provides mortgage and major home improvement loan insurance for urban renewal areas. This program is not very active due to the phase out of urban renewal.

16. Section 223 (e) provides loan insurance for housing in

declining neighborhoods. Through this program FHA requirements for insurance on housing in older, declining, but still viable urban areas are relaxed.

17. Section 207 provides insurance for loans to public or private developers to construct or rehabilitate multi family rental housing. Projects must contain at least eight rental units and be located in areas where market conditions indicate a need for such housing.

18. Section 221 (d) (3) and (4) provides insurance for multi family rental housing for low and moderate income families. This insurance program can be used to construct or rehabilitate rental or cooperative housing. Detached, semidetached, row, walk-up, and elevator structures of five or more units are eligible. Section 221 (d) (3) insures mortgages up to 100 percent of the project value for cooperative nonprofit organizations, and up to 90 percent for limited-dividend groups. Section 221 (d) (4) insures mortgages up to 90 percent for limited-dividend groups.

19. Section 236 provides mortgage insurance, interest reductions, operating subsidies to nonprofit or limited profit sponsors for long term (40 years) low interest rate mortgages for rehabilitating multifamily housing for lower-income families. Tenants must contribute more than 25 percent of adjusted income to rent.

20. Section 223 (f) can be used to refinance existing indebtedness in projects undergoing moderate renovation. The property owner, through refinancing, can extend

the terms of the mortgage and increase the principal amount without increasing the debt service thereby providing a margin of capital for renovation.

21. Section 213 provides mortgage insurance for nonprofit corporations, trusts organized to construct homes for a trust member, or trusts to finance the rehabilitation of cooperative housing projects with five or more dwelling units.

22. Section 234 insures mortgages for profit-motivated or nonprofit project sponsors to finance rehabilitation of detached, semidetached, row, walk-up or elevator structures containing at least four dwelling units. Projects may include nonresidential units, but must be predominantly residential. After rehabilitation, the units in such projects are released from the blanket mortgage, sold to individual owners, and financed seperately.

23. Section 502 provides financing to low and moderate income rural families to repair their owner-occupied single family dwellings.

24. Section 504 provides loans to low income rural households to repair their owner-occupied, single family dwelling.

25. Veterans Administration loan guaranty programs make funding available to eligible veteran homeowners for repairs and improvements to their homes including energy conservation improvements.

B. Grants[2]

This section lists 21 grants programs which make funding available for undertaking energy conservation projects or related projects. As in the federal loan programs all the programs are not directed specifically toward energy conservation projects explicitly. Some of the grants programs listed may be defunct, particularly programs administered by the EDA. The DOT, HUD and DOE programs however, are for the most part funded and in operation. The grants programs, like the loans programs, are targeted towards specific areas and clientele. Funding available through these grants program; particularly the Community Development, Urban Development Action Grants, and the DOE Retrofit grants programs,could form the core of a community energy program.

1. Section 701 of the Housing Act of 1954 provides grants to states and regional planning councils to prepare comprehensive plans. These plans must address themsleves to strategies for growth management and include studies, criteria, and implementing procedures necessary for guiding that growth. Recent language in 701 regulations specifically address the neeed to consider energy conservation. This is a HUD administered program.

2. Section412 of the Energy Conservation and Production Act (ECPA) provides 100 percent grants of up to 800 dollars to weatherize low income households, with priority given to elderly and handicapped. Funding is available to families which are within 125 percent of the federal proverty guidelines. The program is administered by the U.S. DOE and run on the local level by Community Action Agency Offices. (Labor is provided by the CAA's and does not figure into the $800 project

cost). Funding is available to owned or rented units. 200 million dollars are authorized each year for FY 79 and 80.

3. Section 504 of the Housing Act of 1949 provides grants up to $800 per dwelling unit for low income owners and tenants. Priority is given to low income elderly and handicapped households. The program is administered by the Farmers Home Administration. The legislation sets a minimum appropriation of 25 million dollars. Low income families and eligible expenditures are the same as defined under section 412 of the ECPA, and the legislation provides for coordination among weatherization programs run by various federal agencies.

4. Section 222 (a) (12) of the Economic Opportunity Act of 1964 provides a weatherization program which is subject to the same provisions for project costs, eligible expenditures and eligible recipients as the DOE and FHA weatherization programs. This program is administered by the U.S. Community Services Administration and is run locally by the Community Action Agencies (CAA's).

5. Section 251 of NECPA amends section 5 (c) of the U.S. Housing Act of 1937 to provide up to $10 million per year for grants to pay for the purchase and installation of energy conserving improvements in existing low income housing. Eligible for grants are those projects which are financed with loans under secgion 202 of the Housing Act of 1959 or which are subject to mortgages insured under section 221 (d) (3) or section 236 of the National

Housing Act. Projects assisted under section 8 are excluded. Grants will go to those projects which are most in need, as determined by the Secretary of HUD.

6. Title III of the Older Americans Act provides weatherization assistance to the elderly. These monies must come out of the state agency for the elderly grant allocation which is provided with a ten percent match requirement. The elderly agency must include it in their plan to be eligible.

7. The Community Development Act of 1974 provides funding to eligible communities to be used by the community for a number of broad purposes related to community development and maintenance. Among other things, this funding can be used by the community to rehabilitate housing, public buildings, and private buildings through various approaches including provision of low interest loans, grants, refunds or other approaches to be determined by the community. Funding must be spent to meet objectives included in the community Development application. Funding is generally available to those cities with a population of 50,000 or greater. This program is administered by HUD.

8. The section 8 program provides assistance to tenants of leased housing by subsidizing rents. Under this program the owner enters into a contract with HUD whereby HUD agrees to pay that portion of the rent which exceeds 15 to 25 percent of the tenents income. This program can be used for housing requiring severe rehabilitation

thereby insuring that the owner gets fair market value prices for his investment in rehabilitation projects. This program is administered by HUD.

9. Ten east coast states were selected by to participate in a solar domestic hot water demonstration program. Each state was allocated a number of $400 grants to be applied towards the purchase of a domestic water heating solar system. As of this writing each of the states still has a number of grants available. The grants are available to single family homeowners who are willing to purchase a solar system to compliment their conventional system. The program is administered by HUD and run by the state energy office. States that have received funding for the program include all the New England states except Maine.

10. The Solar Demonstration Act of 1974 provides funding for demonstration projects. Funding has been provided for residential and nonresidential projects and has been aimedboth at design and construction. Funding has been made available to architects, developers, builders, and owners under this grants program. Periodically announcements are made of the eligibility in the Commerce Business Daily. Funding is available on a competitive basis and submission of applications is required. The most recent call for applications was April 26, 1979. The program is administered and run by the HUD national office.

11. Crisis Intervention funding is available to be distributed by local CAA's in a program which is administered on

the federal level by the U.S. Community Services Administration. This funding is available to pick up costs for heating fuels of low income families who are unable to afford it on their budget.

12. Title III of NECPA provides funding, on an equal match basis, for energy audits and the purchase and installation of energy conservation measures in schools and hospitals. It also provides funding to provide energy audits of local government buildings and public care institutions. (Energy audits are an analysis of buildings to determine their energy efficiency.) This program is expected to be funded through FY 1982 for schools and hospitals and through FY 1980 for local government buildings and public care institutions. Funding is available on a limited basis to those applicants which display the greatest need for the funding. Applicantions are made to the state energy office who administers the program on the state level. The program is run on the federal level by U.S. DOE.

13. The proposed Energy Management and Participation Act is currently before the Congress. This act would extend many existing programs which are provided under previous energy acts and would provide for comprehensive energy management planning at the state level. This proposed legislation also marks the first time that funding has been proposed for comprehensive energy planning at the local level (other than funding made available to plan and prepare for the impacts caused by specific energy

related projects through the Coastal Zone Management Act). This act will provide an estimated 5 to 25 million dollars annually through 1984 to selected communities to undertake community energy planning. EMPA is expected to be approved by Congress in calendar year 1979.

14. Title I of the Public Works and Economic Development Act PWEDA of 1965 provides for various public works improvement and development projects including land aquisition, construction, and building rehabilitation. Priority is given to areas which suffer from low imcome and unemployment. Projects which are proposed for grants must create immediate construction job opportunities for the unemployed in the area. This program is administered nationally by the U.S. Economic Development Administration and is run by state agencies.

15. The Urban Development Action Grant (UDGA) program was provided for by the Community Development Act of 1977. This program basically supersedes the Title I Public Works program as it is aimed at similar objectives and is run in a similar manner. The program provides funding to projects which create jobs in older economically stagnating urban areas. The main difference between UDAG and EDA programs is that UDAG requires the stimulation of, or inclusion of, local private investment in proposed projects where PWEDA provided 100 percent funding with no provisions for additional investment. The program is administered by HUD and applications must be submitted to HUD area offices. Large and small cities

which meet criteria for age and economic hardship are eligible.

16. Section 5 of the National Mass Transportation Assistance Act provides transportation subsidies for capital construction and operations.

17. Section 3 of the Emergency Highway Energy Conservation Act of 1974 pays up to 90 percent of the cost of carpool demonstration projects. Eligible for funding are: systems for matching riders in carpools or vanpools, signing to provide preferential parking for carpools, costs of purchasing vanpool vehicles, costs to promote the program. Carpool programs can be originated by a local government but must have the concurrance of the metropolitan planning organization. Applications must be submitted by the state highway agency to the FHWA Division Administrator for that state. No project can be funded for more than one million dollars. More than one project may be funded in a state or urban area.

18. The Federal Highway Act of 1973 authorized funding for construction of bikeways under a formula which provides for a 70 to 90 percent federal share depending on the nature of the project. Pathways that are constructed in conjunction with interstate projects are eligible for higher funding. No more than 2.5 million is allowed to each state per year. Projects must be included in the Transportation Systems Management program which is prepared by the metropolitan planning organization (MPO) to be eligible for funding as part of an areawide trans-

portation improvements program. The MPO is the local contact for this program.

19. Section 119 of the Federal Aid to Highway Act of 1974 authorized funding for bikeway demonstration projects whereby the federal government pays up to 80 percent of costs. This program must also be included in the TSM to be eligible for funding (see above). The MPO should be contacted to persue this locally.

20. The Land and Water Conservation Fund Act of 1965 pays 50 percent of the cost related to aquisition and construction of bikeways for recreational purposes. The U.S. Bureau of Outdoor Recreation administers this program.

21. The Public Works Impact Program, Title I of the Public Works and Economic Development Act of 1965 provides grants that can be used for bikeway construction as can Community Development grants and UDAG grants (see Grants #7, 14, 15 in this section).

C. Other[3]

There are three federal programs of note that can potentially be of benefit to the community planner in formulating and implementing community energy programs. The resources available through these programs are described below.

1. Section 233 of NECPA provides a directive to the Secretary of the Department of Labor to provide labor to the maximum extent feasible in support of weatherization programs which are mentioned in "Grants" items #2,3,4 of this chapter. CETA prime sponsors at the local level

are responsible to allocate positions for this program. The state labor agency can be consulted to determine who the prime sponsor is for a particular agency.

2. Title II, Part 1 of NECPA provides for a residential conservation program to be run by utilities. This program must be run in accordance with a plan submitted by the state which has been developed consistent to regulations published by the Secretary of DOE. Under the law all large regulated utilities are required to participate in accordance with the state plan. Non-regulated utilities are required to participate either according to state plan or a plan approved by the Secretary of DOE, at the Governor's discretion. The Governor may also submit a plan to address home heating oil suppliers, at his discretion. Services provided under this program include provision of information to residential customers on energy and cost savings available through installation of various measures, lists of suppliers and contractors who provide conservation measures, lists of banks which offer loans for conservation measures, on site inspection of residences and suggestions for energy conserving improvements, arranging for contractors to perform work and loans to undertake work, and provisions for repayment of expenses as part of utility bills. This program is due to be in place by January of 1980. The state energy office, governor's office, or division of public utilities will be responsible for administering this program.

3. Section 361 of the Energy Policy and Conservation Act

of 1975 invites each state to develop a State Energy Conservation Plan. In order to be eligible for funding to implement this plan the state must include eight mandatory measures and prove that it can achieve a reduction of at least 5 percent in the energy consumption projected for 1980. Included among the required programs are some measures that have direct impact on local governments. These are: statewide mandatory thermal efficiency standards for all new construction, mandatory standards governing lighting levels in all buildings which the public has access to, a program to provide for qualified energy auditors of residential buildings and other building types, a program to strive for coordination between all levels of government on energy matters within the state, and a program which is aimed at creating public awareness of the energy conserving measures that can be undertaken. State energy offices have developed considerably through the SECP program and are a good source of technical assistance and information on energy conservation to assist planners in developing community energy plans.

D. Methods for Applying Resources

There are several methods which can be employed to apply the previously mentioned resources with other local resources to formulate an effective implementation program. Before devising methods however, it will be necessary to check on the availability of the federal resources and to make some overtures to obtain non federal funding, whether it be public funding or private funding. When investigating the availability of the federal funds it will be necessary to check on the availability of the loan programs which are listed by checking with FHA, HUD, and lending institutions which serve the locality. The availability of grant funding should be checked through the field office or regional office of the administering federal agency. All programs which are listed, and where funding is not explicitly mentioned as being available for weatherization and other energy retro-fit projects, should be investigated because regulations may prohibit such expenditures in some cases.

The various methods for utilizing public and/or private funds for financing the cost of energy conservation improvements come under the headings of loan pooling, revolving loan funds, loan guarantees, interest reduction, deferred payment loans, and interest rate subsidies.[4] Of these approaches, loan pooling usually refers to private funds; revolving loan funds, interest reduction and deferred payment loans usually refers to public funds; and loan guarantees and interest rate subsidies usually refers to combining public and private funds.

Loan pooling involves contributions from lenders to obtain the necessary capital. It is usually aimed at servicing sectors of the population who would not normally be eligible for loans or for financing projects which are not conventional. Participations in the returns on loans would be divided among the contributors according to prearranged formulas. Loan pooling is an approach which allows contributors to share risk and to provide financing for purposes they would not otherwise do individually because of competitive disadvantages it may create.

Loan pools can be used in combination with public funds as well.

Revolving loan funds are usually set up with public finding, and sometimes with private monies. Revolving loan funds are simply funds which replenish themselves as returns are provided. It is a fund which is dedicated to a particular funding purpose. Loan pools could be established as revolving funds rather than as one time loan funds.

Through the use of public funds, primarily, below market interest rate programs can be established. This simply involves providing a lower interest rate than that which is prevailing on the market so as to encourage potential borrowers, the targeted sector, to take the initiative and obtain a loan. Below market interest rate, or interest reduction, programs are often used with revolving loan programs. Lowered interest rate programs are doubly effective with regard to conservation measures because of the payback which results due to the installation of the measure itself.

Deferred payment loans are loans which are usually made with public funds. These loan programs allow for loan repayments in a lump sum at some future time, particularly when the property for which the loan was granted is sold. It is usually used in conjunction with large rehabilitation projects and would probably not be a sensible method when funding only conservation projects. This method depends on the future value of property.

Loan guarantees are a method for making private funds available by bringing public funds to bear. In local loan guarantee programs the town will deposit funds with the lender to cover the cost of outstanding guarantees on loans made by the lender. The interest on these deposited funds can be used to make more loans available or to reduce the interest rate on loans. To establish this type of program it will be necessary to develop an agreement with the lender to establish loan making criteria and the portion of the loan covered by the guarantee.

Interest rate subsidy is a method of applying public funds with private funds to lower the effective interest rate the borrower pays on a loan. In this type of program a subsidy is used to make up the difference between the actual market interest rate charged by the private lender and the interest rate the borrower pays. The interest rates may be reduced by providing periodic interest subsidies to either the borrower or lender, grants to the borrower to reduce the amount of principal that must be covered by a loan, or through a prepayment to the lender of a percent of the interest due over the term of the loan.

The source of the resources to which these methods can be applied are up to the local planner and the community to produce. Community Development (CD) grants have been a major source of funding to which some of these methods of financing have been applied. Many cities recieving CD funding have developed revolving funds and interest reduction programs (with interest rates as low as 3 percent). The local government can also budget funds or sell bonds in order to finance the programs in addition to utilizing the federal sources which were presented previously. Raising private funds is possible and feasible when programs for which funding is being used has the support and strong commitment of community leaders.

IMPLEMENTATION MECHANISMS

As was stated previously, implementation mechanisms are those authorities and powers that the local government possesses which can be used to implement community energy programs. The purpose in applying these implementation mechanisms would be to achieve the energy efficiencies which can be obtained through concentrating physical growth, providing proximaty between different land use types, proper site design, and increased energy efficiency of structures.

This section of Chapter V provides general descriptions of several implementation mechanisms and approaches for their application. All of these implementation mechanisms relate to zoning and/or the police power of the state (and the community) which permits the enactment of legislation to protect the public health, safety, morals and general welfare of citizens. A history of liberal interpretation by the courts has allowed zoning related mechanisms which are discussed below to be adopted as being within the realm of the state's/community's police powers. However, unless the state has enabling legislation which explicitly permits some of the various approaches listed below it may be subject to court challenge. Community planners should investigate the state's enabling legislation (unless it has home rule) to determine whether the authority exists for adopting any implementation mechanisms which will be presented herein.

This section provides a general description of each implementation mechanism. However, a reference from which further information can be obtained has been provided with each mechanism and is contained in a footnote. Implementation mechanisms can be of a mandatory nature whereby compliance is required or they can provide inducements to follow energy conserving practices. This section addresses both.

a. The Davis Approach

The City of Davis California has established specific provisions relating to energy efficiency considerations in subdivisions. These provisions involve standards for street, widths, street orientation, set backs, fence heights, site landscaping and tree shading. Through these provisions the city of Davis is encouraging energy efficiency in new construction by making sure that streets are oriented east-west, so that solar insolation is available; allowing zero lot lines so that buildings on adjacent properties can share outside walls, thereby minimizing heatloss; providing shading from trees that will be beneficial in the cooling season; eliminating shadows from south facing windows which are collecting heat during the heating season; and reducing street widths to minimize the use of asphalt in construction and to minimize the area which will be absorbing and storing heat.[4]

b. Energy Efficiency Checklists

Checklists can be used by the planning board when reviewing plans of a developer who is requesting permission to subdivide and develop property. This checklist can include the energy efficiency items which were mentioned in the Davis case, above, and also include items such as those listed in figure

Figure V-1 Energy Conservation Checklist

	Employed by developer	Partially employed by developer	Considered, but not employed	Not considered
A. Efficiency of Site Design				
1. Most efficient road, water and sewer, and electric utility layout	___	___	___	___
2. Cluster development	___	___	___	___
3. Use of party walls	___	___	___	___
4. Centralized heating for development	___	___	___	___
5. Alternative energy source for development	___	___	___	___
B. Orientation of Development				
1. Land is gently sloping and faces southeast to southwest	___	___	___	___
2. Building(s) face southeast to southwest	___	___	___	___
3. Building(s) positioned in most favorable topographic situation allowed by existing land form (midway up slopes is best)	___	___	___	___
4. Building(s) in wooded or otherwise sheltered sites rather than open sites	___	___	___	___
C. Wind Protection for Developments				
1. Shelterbelts* used or existing	___	___	___	___
2. Most effective possible shelterbelt	___	___	___	___
3. Most of development within 10–20 times the average height of shelterbelt	___	___	___	___
4. Shelterbelts serve more than one purpose	___	___	___	___
D. Wind Protection for Individual Buildings				
1. Wind screen** used for each building	___	___	___	___
2. Wind screen optimal distance from building (not further than 5x height or closer than 1/2x spread)				
3. Building oriented between 45° and 90° prevailing wind	___	___	___	___
4. Nonheated building spaces on windward	___	___	___	___
5. Maximum pitched roof areas and minimum wall areas on windward side of building	___	___	___	___
6. Optimal wind protection to three sides of building	___	___	___	___
7. Use of wind barriers that direct cold winter winds away from buildings and direct cooling summer breezes into it	___	___	___	___
8. Use of snow or other devices for wind protection	___	___	___	___
E. Natural Ventilation				
1. Plants or detached structural elements used for directing air flow for natural ventilation	___	___	___	___
2. Mechanical air conditioning eliminated by using physical devices to manipulate air	___	___	___	___
F. Shading				
1. Outside shading devices used to shade major window areas from 10 A.M. to 5 P.M. during summer months	___	___	___	___
2. Deciduous shade trees used for shading placed in optimal location for summer shade	___	___	___	___
3. Vines used on sunny brick, stone, or concrete walls	___	___	___	___
4. Grass or other plant materials used against buildings rather than paving	___	___	___	___

Source: "State of Vermont Energy Conservation Guidelines," prepared by the Vermont Public Service Board and the Agency of Environmental Conservation (Montpelier, April 1974).

*A shelterbelt is a mass of tree plantings used to reduce wind velocity.

**A wind screen also gives protection from the wind. A wind screen can be provided by a structural part of the building, a structure separate from the building, orientation of the building, plants, or any combination thereof.

V-1. Energy efficiency checklists can serve to heighten the awareness of the developer, the community, and the planning board itself with regard to energy efficiency in construction. Such a checklist can also be used as a way of testing the feasibility and reaction to the adoption of similar provisions as mandatory requirements in zoning or subdivision ordinances.[5]

c. Energy Impact Statements

Energy Impact Statement could be required for submission to the planning board as part of the procedure for subdivision approval. Private developers would be required to address the points such as those contained on the energy checklist, and would be required to explain, in writing or at hearings, why measures were not included in development plans and designs. The developer would be required to present figures on life cycle costs and life cycle energy consumption relating to certain alternatives such as increased insulation levels, use of alternative energy sources, and shading. Preparation of these statements would help the builder/developer to better assess the assets of the aforementioned alternatives and would also provide the consumer with some information about the property's potential for energy reductions through retrofits. These energy impact statements could also be required with the submission of budgets by departments of local government to assess such things as: life-cycle cost and energy efficiency of alternative vehicle purchases; the use of emulsified asphalts and plastic pipe by public works departments; the potential for cost and energy savings by budgeting properly for preventive maintenance and improved operations procedures in public buildings.[6]

d. Density Bonuses

This is an approach whereby increases in density are allowed in exchange for public benefits from the private developer. It is not a system that encourages increased density of development but allows it to happen where there is growth pressure. Traditionally the public benefits are items such as common spaces, recreational facilities, park areas, and other such facilities. As these items are provided by the developer he begins to accrue points which can be used in exchange for increased density of development. This approach could be used with regard to energy conservation by permitting increased density, mixed uses, and other exceptions to the subdivision ordinance in exchange for more energy efficient design of buildings and site including provision of bikepaths, buffering, shading, and incorporation of solar design concepts. This concept can be applied to various scales of development including a few blocks, such was done in the Greenwhich Street development district in New York City, or projects which contain many acres, such as the new town project of the Levitt Company in Prince George's County, Maryland. In either case criteria of exchange of public benefits for ordinance exceptions should be carefully considered and carefully spelled out. Energy Impact Statements which assess the various alternatives should be required from the developer.[7]

e. Performance Zoning

Performance zoning is a method of zoning which provides flexibility which is not otherwise available in conventional zoning by district area. Performance zoning is a move in the direction of eliminating the lines from the zoning map and the prescribed standards from the ordinance which apply universally to areas without regard for unique circumstances of the area. It is a useful approach from the standpoint of energy conservation because its purpose is to allow for development within the natural carrying capacity of the site. It permits mixed uses and provides some freedom for site and architectural design. This is an appropriate approach because it allows for energy efficient design. However, it could be improved to require architectural design. This could be accomplished by establishing standards for site design and building design with regard to energy conservation which are similar to those for carrying capacity of the land. Standards regarding carrying capacity refer to erosion, air quality, traffic generation, percolation, height, bulk, and other aspects of site. Energy conscious development would be concerned with use of available insolation, proximaty to services, and concentrations of development. Standards which are acceptable to the community can be established with respect to these considerations as they have been with respect to the aforementioned considerations. Phased development approaches, such as employed in Ramapo N.Y.,[8] is a form of performance zoning only it is dependent on the carrying capacity of the municipal infrastructure rather than the carrying capacity of the land. The Ramapo approach involved phasing growth to concide with the availability of infrastructure.[9]

f. Transfer Development Rights (TDR)

This is a situation whereby the ownership of the land and the right to develop it are seperate. By seperating these aspects it is possible to direct development to contained areas and reduce development in other areas where it is not desired. TDR works by dividing the community into preservation districts (or sending zones) and receiption districts (or receiving zones). By establishing these districts owners of areas that are to be preserved can sell their development rights (usually to the government) and use the money to support the land while it is maintained in a lower use type. Receiption zones become more dense in development as development rights are purchased. This allows land that is best kept in a lower use to be able to afford to stay in that use. It also requires that the receiving areas are true growth areas and provides a check to see that this is truly the market condition. The use of transfer development rights should only be made when the desire for preservation of an area is high. It should also be used in conjunction with a program of preferred taxation in the case of land preservation. Preservation of lands for uses such as localized recreation, agriculture, and wildlife are desirable from the standpoint of energy as well as environment and other considerations.[10]

g. Transfer Fee Plan (TFP)

The transfer fee plan is another form of incentive, as is TDR, which seeks to allow preservation of areas as well as direct growth to areas of concentration. The TDF differs from the TDR in that it is directed towards private capital paying the fee for development rights whereas in TDR it is the local government that usually purchases the development rights from the land owner and attempts to sell them to private developers. TFP provisions charge the purchaser of the land for the right to buy in preserve areas. The fee is then placed in a fund which is split among all those land owners participating in the preserve to help them afford to maintain the land in a lower use. Land that is sold without the permission of the preserve members gets charged an additional fee. This program, as in the case of TDR is only effective where the desire to preserve land in a lower use is predominant.[11]

h. Mixed Uses and Clustering

Most of the aforementioned mechanisms have been aimed at mixed uses and clustering of land uses through incentives. However, the planning philosophy and the philolophy of many individual life styles have exerted pressure to allow for mixed uses and clustering on its own. In many places this pressure has sought an outlet from conventional zoning practices. Planned Unit Development and Clustering are two planning approaches which have sought the same means as energy efficient development for different purposes. These types of development have as their central tenet the desire to achieve efficient use of land through mixing uses, increasing the density of uses, and making open spaces available for use by the nearby, adjacent, public. In this type of development the average density for a parcel of land is usually kept the same as in conventional zoning conditions which occur in the zoning ordinance. However, uses are grouped to make more efficient use of the land available. Where HUD usually implies mixed uses, clustering usually refers only to residential uses.[12]

i. Building Codes

The use of thermal efficiency standards in building codes has become predominant since the passage of the Energy Policy and Conservation Act (EPCA) of 1975. This Act called for the establishment of mandatory termal efficiency standards on a statewide basis in all 50 states. As of this writing the majority of states have complied with this voluntary program with the help of funding which was made available through EPCA. This legislation was passed subsequent to the issuance of contracts to the major model building code groups accross the nation and an engineering organization which established the standards. The code provisions call for buildings to meet either prescribed standards for insulation levels in new construction or performance standards for overall U values of building components. A new standard is being developed under the auspices of U.S. DOE and HUD which will increase the stringency of the EPCA required standard and provide more flexibility in compliance by making it a standard based totally on building performance. This standard is being developed under ECPA, Title III and is called BEPS (Building Energy Performance Standards). If Congress exercises its sanction no HUD funding will be made available within states which do not adhere to BEPS.

CONCLUSION

These are some of the resources and mechanisms available for implementation of the programs that might be developed as a result of the planning pursued and the policies established through employing tools used in Chapters I-IV. Much information has been presented within the Chapter V and within the overall document. However, there are many more details that will have to be addressed when attempting to undertake a community energy program. Undertaking such a program requires much commitment and many resources, when done in a comprehensive manner. However, it may be the best first step towards drawing the attention of government officials and the people of the community to the role of the community and the benefits of undertaking energy efficient planning.

CHAPTER V

Footnotes

[1]Major references which provided information on loan programs and used in this chapter are: National Energy Conservation Policy Act, Title II, Part 3, PUBLIC LAW 95-619-Nov. 9. 1978; The Bureau of National Affairs, Inc., "Housing Rehabilitation and Neighborhood Conservation", Housing & Development Reporter, HDR RF-95 (October 10, 1977): 14: ooll.

[2]Major references which provided information on grant programs and used in this chapter are: National Energy Conservation Policy Act, Title II Part 2 and Title III, PUBLIC LAW 95-619-Nov. 9. 1978; Curtiss Priest and Maria R. Eigerman, principal authors, "The Energy Vista; Policy Perspectives on Energy Conservation Through Land Use Management", (report prepared for FEA and ERDA byT and E of Cambridge, MA, June 1976): 141-194; Federal Regional Council of New England, "Guide to Federal Consumer Energy Assistance in New England", Feb. 1979; Federal Highway Administration, "Federal Aid Highway Program Manual", June 1976; Carl Berkowitz and Walter Kraft, "The Bicycle", <u>Practicing Planner</u>, 8 (March 1978) 30-35.

[3]Energy Policy and Conservation Act, Title III, PUBLIC LAW 94-163-Dec. 1975; National Energy Conservation Policy Act, Title II, Part 1.

[4]Gloria Shepard McGregor, "Davis California Implements Energy Code", <u>Practicing Planner</u> 6 (Feb. 1976) 24-27; Ordinance No. 784, Ordinance No. 787, Resolution No. 1833 enacted by the City Council of the City of Davis.

[5]Corbin Crews Harwood, <u>Using Land to Save Energy</u>, Environmental Law Institute State and Local Energy Conservation Project, (Cambridge, MA: Ballinger Publishing Company, 1977) 100.

[6]Ibid. pp. 193-202.

[7]Dan Yurman, "Can Density Bonuses Pay Off?", <u>Practicing Planner,</u> 6, (April 1976) 14-21; Marvin Markus and John Pettit, "Urban Design Through Zoning" <u>Planners Notebook,</u> 2 (Oct. 1972).

[8]Charles L. Crangle, "The Ramapo (Rockland County, NY) Experience", printed in Northeast Regional Center for Rural Development, <u>The Proceedings of the Conference on Rural Land-Use Policy in the Northeast</u> (October 1974) 206-210.

[9]Kevin Lynch, Phillip D. Herr "Performance Zoning", <u>Planners Notebook</u>, 3 (Oct. 1973); Lane Kendig, "Performance Zoning: An Update on Euclid", <u>Planning</u>, 32 (Nov. 1977) 18-21; Charles Reiss and Michael Kwartler, "Housing Quality Program Puts Human Scale Into Residential Zoning", Planners Notebook, 4 (Dec. 1974).

[10]Manuel S. Emanuel, "TDR: What's Happening Now", Practicing Planner, 7 (March 1977) 10-14.

[11]Robert W. Burchell, Planned Unit Development, (New Jersey: Center for Urban Policy Research, 1973); Jan. 2. Krasnowiecki, Legal Aspects of Planned Unit Residential Development, (Washington: Urban Land Institute, 1965.

[12]Grant P. Thompson, "Design Features, Shading, and Orientation for Energy Conservation", ECP Report, 7 (Sept. 1976); Arthur D. Little Inc. Energy Conservation in New Building Design: An Impact Assessment of ASHRAE 90-75, prepared for the Federal Energy Administration; Arthur D. Little, An Energy and Economic Assessment of HUD's Minimum Property Standards, prepared for the Federal Energy Administration, October 1976: City of Champaign, Illinois, "An Ordinance Adopting the Campaign Code for Energy Conservation in New Building Construction", Council Bill No. 78-92.

APPENDIX A

1. AN ORDINANCE PROHIBITING THE ISSUANCE OF PERMITS FOR THE INSTALLATION OF GAS BURNING APPLIANCES WITHIN THE CITY, DIRECTING THE CITY ADMINISTRATION TO APPLY TO THE PUBLIC UTILITIES COMMISSION FOR AUTHORITY TO DENY SUCH PERMITS IN THE UTILITY DEPARTMENT SERVICE AREA OUTSIDE THE CITY, AND DECLARING AN EMERGENCY

ORDINANCE NO. 4756

AN ORDINANCE PROHIBITING THE ISSUANCE OF PERMITS FOR THE INSTALLATION OF GAS-BURNING APPLIANCES WITHIN THE CITY, DIRECTING THE CITY ADMINISTRATION TO APPLY TO THE PUBLIC UTILITIES COMMISSION FOR AUTHORITY TO DENY SUCH PERMITS IN THE UTILITY DEPARTMENT SERVICE AREA OUTSIDE THE CITY, AND DECLARING AN EMERGENCY.

WHEREAS, the Utilities Department of the City of Colorado Springs has been notified by its supplier of natural gas, Colorado Interstate Corporation, that the available supply of gas for the fiscal year of 1973-1974 is severely limited. The Utilities Department has calculated that the available supply will be barely enough to serve existing firm customers and committed volumes for the coming fiscal year 1973-1974; and

WHEREAS, new building construction is proceeding at a tremendous rate, almost all of which plans to use natural gas for space heating. If such new construction continues unabated and gas appliances are permitted therein, the available supply of natural gas will be insufficient to serve their needs as well as existing customers.

NOW, THEREFORE, BE IT ORDAINED BY THE CITY COUNCIL OF THE CITY OF COLORADO SPRINGS:

Section 1. The issuance of permits for natural-gas-burning appliances in new construction is hereby prohibited in the City of Colorado Springs until further notice. Permits for the replacement of existing appliances shall be issued, provided such new or replacement appliance is of no greater capacity than the old or replaced appliance.

Section 2. The City Administration is directed to immediately proceed with all necessary applications to the Public Utilities Commission of the State of Colorado requesting permission to deny the issuance of further natural gas appliance permits in the area served by the City of Colorado Springs Public Utilities Department, Gas Division.

Section 3. Because of the natural shortage of natural gas and the inability of the City's supplier to supply more than a limited supply of natural gas for the fiscal year of 1973-1974, the Council hereby finds, determines and declares that a public emergency exists with reference to this ordinance and that this ordinance is necessary for the immediate preservation of the public peace, health and safety and accordingly the same is hereby passed as an emergency ordinance to be effective forthwith upon its passage, as provided by the Charter.

Introduced, read, finally passed as an emergency ordinance, adopted and approved this 28th day of June, 1973.

Andrew Marshall
Mayor and President of the Council

ATTEST:

R E Parker
City Clerk

I HEREBY CERTIFY, that the foregoing ordinance entitled "AN ORDINANCE PROHIBITING THE ISSUANCE OF PERMITS FOR THE INSTALLATION OF GAS-BURNING APPLIANCES WITHIN THE CITY, DIRECTING THE CITY ADMINISTRATION TO APPLY TO THE PUBLIC UTILITIES COMMISSION FOR AUTHORITY TO DENY SUCH PERMITS IN THE UTILITY DEPARTMENT SERVICE AREA OUTSIDE THE CITY, AND DECLARING AN EMERGENCY" was introduced, read, finally passed, adopted and approved as an emergency ordinance and ordered published at a regular meeting of the City Council of the City of Colorado Springs, held on the 28th day of June, 1973, and that the same was published in full in the Colorado Springs Sun, a newspaper published and of general circulation in said City on June 29, 1973.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed the seal of the City this 28th day of June, 1973.

R E Parker

City Clerk

APPENDIX C

1. ENERGY INTENSITY (EI) IN STATE AND LOCAL PROCUREMENT FROM INDUSTRY ESTIMATED FOR 1980

2. 1975 ENERGY USE PER DOLLAR OF VALUE ADDED

3. 1975 PURCHASED ENERGY COSTS AS PERCENT OF VALUE ADDED

4. Outline of Census Bureau Energy Related Statistics
5. Industrial energy Assessment Survey

6. ENERGY EMBODIMENT PER UNIT OF MATERIAL

7. Energy Assessment Survey: Residential

8. Building Condition Survey

ENERGY INTENSITY (EI) IN STATE AND LOCAL PROCUREMENT FROM INDUSTRY
(in thousand Btu's per $) Estimated for 1980

Industry	EI	Industry	EI
New Const., Highways	(110)	Forest, Grn House, Nur. Prod.	(52)
New Const., Nonresidential	(63)	Radio-T.V. Comm. Equip.	(28)
New Const., Pub. Utilities	(75)	Personal Service	(49)
Maint. Const., Other	(54)	Misc. Plastics	(86)
New Const., Other	(81)	Broad Fabric Mills	(85)
New Const., Residential	(52)	Water, Sanitary Serv.	(102)
Motor Vehicles & Parts	(58)	Misc. Manufacturers	(49)
Hospitals	(48)	Athletic Equip.	(52)
Wholesale Trade	(34)	Paperboard Containers	(91)
Med., Health Services	(44)	Dehydrated Products	(60)
Air Transport	(180)	Newspapers	(47)
Misc. Business Services	(25)	Scien. Instr.	(39)
Highway Passngr. Trans.	(63)	Surgical Supply	(43)
Book Publishing	(39)	State, Local Govt. Enterp.	(97)
Drugs	(41)	Conventional Paper Prod.	(80)
Office Supplies	(67)	Farm Machinery	(62)
Paper Mills	(155)	Medical Instr.	(53)
Cleaning Preparations	(73)	Typewriters	(28)
Real Estate	(22)	Canned Fruit, Veg.	(68)
Meat Products	(62)	Misc. Printing	(33)
Motor Freight Transport	(43)	Misc. Chem. Prod.	(122)
Inorganic-Organic Chem.	(206)	Bakery Prod.	(43)
Public Bldg. Furniture	(55)	Hotels	(72)
Commercial Printing	(61)	Hand Tools	(58)
Misc. Professional Services	(24)	Maint. Const., Residential	(47)
Post Office	(35)	Security & Commodity Brokers	(11)
Communications	(16)	Office Machines	(38)
Fertilizer	(122)	Games	(57)
Educational Service	(54)	Metal Stampings	(96)
Auto Repair	(46)	House Furnishings	(71)
Tires	(85)	Periodicals	(45)
Doctors, Dentists	(14)	Advertising	(42)
Apparel from Purchased Mat.	(43)	Wood Office Furniture	(43)
Machine Shop Products	(47)	Pens and Pencils	(48)
Misc. Rubber Products	(82)	Food Preparation	(54)
Metal Office Furniture	(60)	Frozen Food, Vegetables	(67)
Chem. & Fert. Mineral Mining	(187)	Radio, TV Sets	(37)
Photographic Equip.	(40)	Musical Instruments	(47)
Glass Products	(92)	Food Utensils	(85)
Insur. Carriers	(20)	Switchgear	(40)
Railroad	(73)	Motion Pictures	(31)
Service Industry Machines	(56)	Ice Cream	(56)
Water Transp.	(210)	Poultry, Eggs	(68)
Const. Machinery	(58)	Agr. Forestry, Fishery Serv.	(31)
Envelopes	(68)	Coffee	(29)
Agricultural Chemicals	(122)	RR and Street Cars	(95)
Refrig. Machinery	(58)	Laundry Equip.	(52)
Motors, Generators	(54)	Cooking Oils	(79)
Nonprofit Org.	(55)	Wood Household Furn.	(40)
Fluid Milk	(55)	Mech. Measuring Serv.	(40)
Electric Lamps	(39)	Metal Cutting Tools	(35)
Sanitary Paper Products	(79)	Optical Instr.	[illegible]

(continued)

Industry	EI	Industry	EI
Feed Grains	(64)	Paperboard Mills	(169)
Cheese	(66)	Fruits	(41)
Soft Drinks	(54)	Curtains	(56)
Electric Housewares	(60)	Condensed Milk	(69)
Internal Combustion Eng.	(53)	Safes, Vaults	(58)
Pipeline Transport	(87)	Household Appliances	(71)
Brushes	(57)	Watches, Clocks	(38)
Steel Prod.	(233)	Electron Tubes	(45)
Storage Batteries	(82)	Welding Apparatus	(71)
Electronic Components	(44)	Elec. Ind. Apparatus	(51)
Mattresses	(52)	Dental Equip.	(43)
Metal Fixtures	(73)	Fabric Textile Prod.	(53)
Canned Specialties	(66)	Household Laundry	(71)
Pickles, Dressing	(65)	Opthalmic Goods	(40)
Sugar	(107)	Uphol. Household Furn.	(41)
Butter	(71)	Misc. Publishing	(30)
Fish	(55)	Plastics	(158)
Household Cooking Equip.	(68)	Toilet Preparations	(49)
X-ray Equipment	(31)	Footware Cut Stock	(56)
Stone Products	(47)	Footware Except Rubber	(35)
General Ind. Mach.	(55)	Small Arms	(43)
Phono Records	(49)	Fabric Wire Prod.	(132)
Silverware, Jewelry	(40)	Semiconductors	(44)
Elec. Meas. Instr.	(30)	Aircraft	(34)
Motorcycles, Bicycles	(63)	Pottery Products	(80)
Metal Working Mach.	(48)	Household Vacuums	(49)
Prepared Animal Feed	(75)	Misc. Leather	(40)
Household Refrig. Equip.	(65)	Rice Milling	(59)
Metal Household Furn.	(77)	Macaroni	(54)
(Veg.), Misc. Crops	(40)	Floor Coverings	(78)
Forest, Fish Prod.	(62)	Industrial Trucks	(51)
Small Arms Ammun.	(77)	Ind. Controls	(34)
Flour, Cereals	(63)	Steel Springs	(109)
Flavorings	(45)	Special Dies and Tools	(47)
Engine Elec. Equip.	(52)	Alum. Castings	(121)
Boat Building	(55)	Sewing Machines	(46)
Cutlery	(43)	Food Prod. Mach.	(44)
Floor Coverings	(68)	Phono Records	(49)
Wood Products	(62)	Metal Forming Tool	(50)
Furn., Fixtures	(53)	Primary Batteries	(53)
Paint Products	(90)	Asbestos Prod.	(99)
Canned Sea Foods	(54)	Caskets	(76)
Confectionary Prod.	(51)	Rubber Footwear	(56)
Pumps, Compressor	(47)	Meat, Animal Prod.	(61)
Light Fixtures	(61)	Stone, Clay, Min.	(98)
Hardware	(65)	Bricks	(303)
Printing Mach.	(36)	Concrete Blocks	(126)
Scales	(47)	Fab. Metal Products	(89)
Woodworking Mach.	(42)	Signs, Ads	(52)
Radio-TV Broadcast	(27)	Retail Trade	(34)
Wood Fixtures	(41)	Amusmt., Rec. Serv.	(23)

ource: SRI, Op.cit. pp.43-47. 1980 calculations based on SRI formula and data from Energy Costs of Goods and Services, 1963 and 1967," by R.A.Herendeen and C.W.Bullard, II, University of Illinois (November 1974).

TABLE 4.

1975 ENERGY USE PER DOLLAR OF VALUE ADDED

(10^3 BTUs/$ Value Added)

STATE

SIC CODE	CT	MA	ME	NH	RI	VT	US
20	9.10	15.03	23.05	1.52	26.61	47.39	19.05
21	-	-	-	-	-	-	5.04
22	29.10	27.08	27.76	20.68	31.47	-	25.36
23	4.88	2.72	-	-	-	-	4.18
24	47.72	10.43	18.69	12.07	-	18.75	21.93
25	5.66	10.50	-	15.87	-	15.16	7.35
26	36.43	35.08	119.71	83.96	38.99	38.18	67.49
27	4.17	2.96	7.62	5.09	3.32	4.67	3.55
28	14.48	21.76	-	22.08	20.43	-	61.61
29	-	-	-	-	-	-	131.52
30	10.60	12.18	19.88	9.25	8.67	12.83	10.59
31	-	8.34	8.45	11.64	-	-	7.07
32	30.18	27.35	86.02	39.22	57.71	21.64	75.59
33	31.92	13.41	-	-	13.03	-	73.13
34	8.02	10.78	7.45	4.15	8.24	4.60	10.77
35	6.17	3.87	6.47	4.67	6.02	4.64	6.42
36	4.31	4.81	-	2.78	5.11	-	6.54
37	4.93	8.71	-	11.01	8.53	-	7.70
38	3.82	4.38	-	2.84	6.75	-	4.93
39	9.14	6.02	-	-	2.14	-	5.81
TOTAL	9.70	10.11	47.35	16.15	10.98	13.53	27.25

Source: U.S. Department of Commerce, Bureau of the Census, Annual Survey of Manufactures 1975.

NOTE: (-) indicates data not available.

TABLE 5.

1975 PURCHASED ENERGY COSTS AS PERCENT OF VALUE ADDED

STATE

SIC CODE	CT	MA	ME	NH	RI	VT	US
20	3.0	4.7	6.3	0.5	6.5	11.4	
21	-	-	-	-	-	-	
22	8.6	7.5	6.8	6.2	9.9	-	
23	1.9	1.2	1.0	1.5	1.8	-	
24	9.8	3.8	5.5	3.9	-	5.5	
25	1.5	3.1	2.9	4.2	-	6.7	
26	10.8	9.7	24.1	18.7	11.4	9.5	
27	1.6	1.3	1.3	2.4	1.7	1.4	
28	4.0	6.3	-	5.8	4.7	-	
29	-	-	-	-	-	-	
30	4.9	5.6	5.6	4.0	4.1	5.6	
31	-	2.7	2.3	3.6	-	-	
32	7.8	7.8	19.6	11.5	14.6	5.7	
33	11.3	6.3	-	-	5.4	-	
34	3.1	3.5	3.5	1.9	3.1	1.9	
35	2.5	1.6	2.8	2.1	2.5	1.8	
36	2.1	2.2	-	1.4	2.2	-	
37	2.0	3.2	-	4.8	4.0	-	
38	1.8	1.7	-	1.9	2.3	-	
39	3.3	2.3	-	1.8	1.5	4.0	
TOTAL	3.4	3.4	10.6	4.6	3.9	4.2	

Source: U.S. Department of Commerce, Bureau of the Census, Annual Survey of Manufactures 1975.

NOTE: (-) indicates data not available.

Outline of Census Bureau Energy-Related Statistics

A major element of the Census Bureau's statistical program consists of censuses conducted every 5 years which provide benchmark statistics for agriculture, manufacturing, mining, wholesale and retail trade and selected services, sectors of the transportation industry, and State and local governments. These statistics are used to study the economy in depth and permit a detailed examination of specific industries. The censuses generally provide the framework for intercensal monthly, quarterly, and annual programs which provide important information for selected sectors of the economy. In response to data user needs, the Census Bureau attempts to meet many requests for special tabulations and the development of statistical data on a one-time basis.

In the canvass of the quinquennial economic censuses, intercensal surveys, and special survey and tabulation requests, the Bureau does collect and have available information related to energy and is currently involved in developing several new programs in this area. The kinds of data developed are summarized in the attached outline, "Census Bureau Energy-Related Statistics." Highlights of the programs involving energy-related data are summarized below:

1. The Census of Mineral Industries, part of the quinquennial economic censuses, has been published at regular intervals since 1840 and provides detailed information on coal mining and oil and gas operations including expenditures and drilling statistics. The final report for Oil and Gas Field Operations from the 1972 census includes data on number of wells operated by geographic area; drilling statistics for oil, gas and gas condensate, dry and service wells as reported by operators; and drilling statistics for exploratory and developmental wells as reported by operators, by type of well, geographic area, and depth range.

2. An Annual Survey of Oil and Gas Expenditures provides estimates of expenditures separately for the exploration and development of crude petroleum and the exploration and development of natural gas. Originally requested by the Senate Commerce Committee in 1972 in order to determine the impact of the natural gas price ceiling on natural gas exploration and development, these data are now provided annually.

3. In the industrial sector, the Census of Manufactures provides information on petroleum refining and related industries. In addition to general statistics, detailed information on quantity and value of products and materials consumed are provided. Many of the 450 industries include data on consumption of petroleum products or derivatives of petroleum products as raw materials consumed in the manufacturing process.

4. The Annual Survey of Manufactures provides selected information on petroleum and related industries as well as cost of purchased fuels and electric energy used by industry groups.

5. A special report on fuels and electric energy containing information on fuels consumed in 1971 by type of fuel by consuming industry and by geographic area was published as part of the 1972 Census of Manufactures. A similar report is being developed as part of the 1974 Annual Survey of Manufactures. Availability of selected information is expected by the end of the year.

6. The Current Industrial Reports program includes a bi-annual survey on Sales of Lubricating and Industrial Oils and Greases and an annual survey on Asphalt and Tar Roofing and Siding Products. Other monthly, quarterly, and annual surveys in this series provide information related to energy consumption (i.e., plastics products, supply and distribution of snythetic rubber and synthetic fibers).

7. The statistics on construction activities include an annual survey of characteristics of new one-family homes which provides information on major types of heating fuel used in new one-family houses. Similar data were collected in the 1970 census for all of the Nation's housing stock. Information on types of heating fuel used for new multi-family buildings started in 1974 has been published. Collection of these data will be continued. By the end of the year, we plan to publish data on types of fuel used to heat and air-condition privately owned nonresidential building projects in the report "Value of New Construction Put in Place." We are collecting similar information for State and local government building projects and will start publishing information for this sector by mid-1976.

8. In the foreign trade program, export and import data are published for commodities such as petroleum products, coal, natural gas, and nuclear materials as well as machinery and equipment which can be used in mining, drilling, refining and production of energy-related products. These statistics are published on a monthly and cumulative basis at various levels of commodity detail by country of origin for imports and country of destination for exports. The data are based on official import and export documents required to be filed with the U.S. Customs Service.

9. Data on the retail and wholesale distribution of fuels--such as the number of gallons of gasoline sold by service stations--are being published based on the 1972 Economic Censuses. Information is also being developed on distribution outlets for petroleum products. A survey of gasoline service stations is being conducted for the Federal Energy Administration to determine the gallonage sold each month, categorized by sales by dealers of branded and unbranded gasoline.

10. Statistics on transportation activities include a Truck Inventory and Use Survey that includes information by type of truck, type of fuel used and miles driven. Additionally, the 1972 National Travel Survey provides estimates of nonlocal travel by type of destination.

11. The census of agriculture includes farm expenditures for gasoline and other petroleum products.

12. An important feature of our program in State and local government statistics is information on tax revenues by energy type, intergovernmental revenues from energy source, and expenditures for utilities.

13. In addition, the Bureau's demographic and social data collection activities, including both the 1970 Decennial Census program and the monthly Current Population Survey, provide statistics on the general population that have a direct relationship to the current energy crisis. For example, the 1970 Decennial Census data provide information on the geographic distribution of the population and the density of population settlement. Information from the census on the current residence of the population, on their place of work, and on their means of transportation to work will be of great value in determining gasoline use and allocation. Commuting data are available for counties and cities showing the number of persons driving their own cars to work, riding in carpools, and using public transportation. The Annual Housing Survey, both at the national level and in 21 selected SMSA's, contains even more extensive commuting data (e.g., including distance and time from work) on a current basis. The 1970 census also provided a wide variety of information on how America is housed--number of rooms, type of heating equipment, and the presence of energy-using kitchen and laundry equipment to mention only a few. Current national data concerning labor market participation, the occupation and industry of the employed, and personal and family income are also collected by the Bureau. These data could provide indirect measures of some of the effects of the current energy situation.

To put into proper perspective the description of energy-related data compiled by the Census Bureau, brief reference should be made to general areas of information needed in respect to energy problems that are <u>not</u> characteristically compiled by the Census Bureau. Historically, the Bureau has not engaged in regular data collection on subjects such as prices or profits which are covered by other administrative or regulatory agencies, or for which technical or engineering knowledge is required such as in determining oil and other mineral reserves.

UNITED STATES DEPARTMENT OF COMMERCE
Bureau of the Census
Washington, D.C. 20233

OFFICE OF THE DIRECTOR

Census Bureau Energy-Related Statistics
(Revised)

The following describes the Census Bureau's economic data program in the areas of production, distribution, and consumption.

I. Manufacturing and Mining

A. 5-Year Economic Censuses (General economic statistical program covering all the individual industries in manufacturing, mining, retail, wholesale, selected services, and construction.) Mandatory (13 USC)

---Consumption of electricity in manufacturing and mining.

---Consumption of fuels (quantity and cost) for heat and power in manufacturing (1971) and mining (1972).

---Consumption or use of fuels (quantity and cost) in the industrial process.

Crude oil in Refineries (SIC 2911)

✓ Fuel Products (Benzol, Propane, etc.) used by major consuming industries

---Shipments (quantity and value) of specific products of mineral industries and manufacturing

Coal
Crude oil
Refined petroleum products (gasoline, kerosene, etc.)
Petroleum based chemical products

---Development and exploration expenditures in mining for petroleum and natural gas industry.

---Special types of data (crude petroleum and natural gas industries only)

Royalty payments (collected in kind)
Disposition of natural gas production
Number of wells operated
Lease tanks and stocks

Drilling statistics

Number of wells drilled by type (oil, gas, dry, service) and depth range
Depth of wells drilled (by types and depth ranges)
Costs of wells drilled (by types and depth ranges)
Sources of funds for drilling

Special sample survey data on a net working interest basis covering exploration expenditures and assets

B. Annual Survey of Manufactures

General economic information for all industries and for industry groups by area including refining (SIC 2911) and major chemical industries producing processed fuel products. — Mandatory (13 USC)

---Shipments (value only) classes of products, e.g.

Gasoline
Jet Fuel
Kerosene
Distillate Fuel Oil
Liquified Oil and Greases
Asphalt
Asphalt Felts and Coatings
Tires and Inner Tubes
Industrial Gas
Etc.

---Cost of fuels used by Industry

---Quantity and cost of electric energy used by Industry

---Consumption of fuels (quantity and cost) for heat and power in manufactures

C. <u>Annual Oil and Gas Survey</u>

A survey of the domestic crude petroleum and natural gas extraction industry. Statistics are cross-classified by type of producing property (oil, gas, or combination) and by degree of owner operation. Separate statistics are provided for offshore areas and Alaska.

---Expenditures

Exploration
Development
Production

---Revenues

---Sales Volumes

---Assets

D. <u>Other Survey Data Related to Energy</u>

1. Annual Current Industrial Reports (energy-related) — Mandatory (13 USC)

*MA-29C	(biennial) Sales of Lubricating and Industrial Oils and Greases
MA-30D	Shipments of Selected Plastics Products
MA-33L	Insulated Wire and Cable
MA-22F	Textured and Spun Yarn Production
✓MA-34N	Selected Heating Equipment
✓MA-22G	Narrow Fabrics
MA-35M	Air-Conditioning and Refrigeration Equipment
MA-36A	Switchgear, Switchboard Apparatus, Relays, and Industrial Controls
MA-36E	Electric Housewares and Fans
MA-36F	Major Household Appliances
MA-36L	Electric Lighting Fixtures
MA-29A	Asphalt and Tar Roofing and Siding Products
MA-36N	Selected Electronic and Associated Products
MA-30E	Plastic Bottles

2. Quarterly Current Industrial Reports (energy related) — Voluntary

✓MQ-22T	Textile Fabrics
MA-26F	Converted Flexible Packaging Products
MQ-22K	Production of Knit Cloth
✓MQ-22Q	Carpet and Rugs

*Voluntary

3. Monthly Current Industrial Reports (energy-related) <u>Voluntary</u>

Products or by-products of the petroleum industry as reported in the following:

M28A	Inorganic Chemicals
M28B	Inorganic Fertilizer Materials and Related Acids
M28F	Paint, Varnish, and Lacquer
M30A	Rubber: Supply and Distribution for the United States
✓M22A	Woven Fabrics: Production, Inventories, and Unfilled Orders
✓M22P	Cotton, Manmade Fiber Staple, and Linters
M30F	Shipments of Thermoplastics, Pipe, Tube and Fittings

II. <u>Retail and Wholesale Trade</u>

Except where otherwise indicated below, the data described are collected as part of the quinquennial economic censuses. The last such census was published covering 1972. Comparable data will be collected in the 1977 census.

A. Gasoline Service Stations

1. Number of stations, number of gallons of gasoline sold and number of pumps; by State and selected counties and selected SMSA's.

2. Number of gallons of fuel sold (other than gasoline) and number of stations selling such fuel; by State and selected counties and selected SMSA's.

B. LP Gas Dealers

1. Number of establishments, LP gas bulk storage capacity, gallon sales of LP gas; by Divisions and States. (Planned for 1977.)

2. Number of establishments selling bottled LP gas, by selected States. (Same as B1 above.)

C. Fuel Oil Dealers--number of establishments, gallon sales of LP gas, light fuel oil and heavy fuel oil, other types of fuel oil; by selected States.

H. General statistics (number of establishments, total value of sales (and of inventory for wholesale), payroll, employment) for individual kinds of retail, wholesale, and selected service industries are compiled by State, SMSA, county, and city, with less kind-of-business detail for the smaller areas. Kind-of-business categories included are those involved in the distribution or use of fuel products, e.g. -

1. Retail Trade: gasoline service stations, motor vehicle dealers, mobile home dealers, tire, battery and accessory dealers, boat dealers, and utility trailer dealers, motorcycle dealers, fuel oil dealers; LP gas dealers, other fuel and ice dealers;

2. Wholesale Trade: petroleum bulk stations and terminals, other petroleum products wholesalers, motor vehicles, parts and supplies metal service centers, coal and other mineral and ores, chemicals and other allied products; and

3. Service industries: automotive rental and leasing, automobile parking, automotive repair and services, camps and trailering parks, equipment rental and leasing services, hotels and motels, and travel agencies.

(Data presently available for both 1967 and 1972.)

I. Special reports based on the quinquennial censuses are developed for individual industries. (1972 data scheduled for release in early 1976.)

1. Automobile and truck rental and leasing without drivers; source of receipts, types of vehicles on short-term rental vs. leasing (except finance), and number of vehicles in fleet; by selected SMSA.

2. Automobile parking lots and structures: parking facilities; by selected SMSA.

3. Automotive repair establishments; source of receipts: U.S.

D. Petroleum Bulk Stations and Terminals (Wholesale Trade)

1. Number and total dollar sales by type of bulk station (cooperative, independent, commission, and salary) (Information for SFAR available for 1972 only.)

2. Storage capacity and type of fuel (aviation gasoline, motor gasoline, special naphthas, jet fuels, kerosene, distillate fuel oils, residual fuel oils); by county and State. (SFAR by storage capacity size for 1972 only.)

3. Number of gallons sold by type of fuel; county and State. (Same as D1 above.)

4. Number of establishments by primary method of receiving all liquid products (tank truck, tank car, pipeline, barge, or tanker); and gallons of lubricating oils and greases blended by State. (Same as D1 above.)

5. Dollars sales of petroleum products by type. (Planned for 1977.)

E. Retail Establishments--Dollar value of sales of gasoline, other automotive fuels, motor oils and greases, LP gas and other household fuels (for selected kinds of business with detail varying by kind of business); by State and SMSA.

F. Monthly sales of gasoline by gasoline service stations. This survey of gasoline service stations has been conducted on a monthly basis since October 1974. It determines the gallonage sold, the dollar volume gasoline sold, and the number of retail outlets, categorized by (refinery) branded gasoline sales, by independent dealers and all other sales, Effective with data for November 1975, price per gallon was collected. The Census Bureau is serving as the collecting agent for the Federal Energy Administration.

G. Monthly sales and inventories of merchant wholesalers of Petroleum and Petroleum Products (excluding bulk stations).

4. Travel agencies: statistics by size and type of services, source of receipts; by selected SMSA.

J. Sample surveys provide monthly national estimates on total dollar volume of sales of establishments classified by kind of business, including gasoline service stations and the larger kind of business among those listed above; limited kind-of-business detail is provided by geographic division.

III. Export and Import Statistics

Export and import statistics as published on energy-related commodities such as petroleum and products, coal, natural gas, and nuclear materials, as well as machinery and equipment which can be used in mining, drilling, refining, and production of energy. Statistics on electric energy are not compiled by Census but are available from the Federal Power Commission.

The statistics are released at various levels of commodity detail in a variety of arrangements (e.g., commodity by country, commodity by Customs District, etc.). Details on the various arrangements are presented in the Bureau's Guide to Foreign Trade Statistics.

The foreign trade statistics are compiled in accordance with the classifications in schedule B, Statistical Classification of Domestic and Foreign Commodities Exported From the United States for exports and the Tariff Schedules of the United States Annotated (TSUSA) for imports. Publication of the statistics is on a monthly and cumulative basis in terms of both Schedule B and TSUSA. Additionally, in some reports the TSUSA data are presented in terms of a rearranged commodity classification system--Schedule A, Statistical Classification of Commodities Imported Into the United States. Both Schedule B and Schedule A are based on the Standard International Trade Classification (SITC).

IV. Construction Activity

A. New Residential One-Family Houses

Major types of heating fuel used for new one-family houses are published in the Annual C25, "Characteristics of New One-Family Homes." (Note: With modifications to the existing program, we can probably produce these data on a quarterly basis.)

A special tabulation was prepared showing the major types of heating fuel used in new one-family houses completed in 1971, 1972, and January through June 1973 for 29 SMSA's. (Note: This could probably be expanded to cover more SMSA's and provide semi-annual data).

NOTE: Modifications to the program could produce statistics on square feet of floor space completed and heated by the various types of fuel for new one-family houses.

B. New Residential Multi-Family Buildings

Major types of heating fuel used for new multi-family buildings in January 1973.

NOTE: The Bureau could provide major type of heating fuel data by number of units and by square feet of floor space for all types of residential structures at any or all of the stages of construction: starts, under construction, or completions.

C. New Nonresidential Buildings (excludes Private Utilities and Federally Constructed Buildings)

Information on major types of heating fuel used in privately owned nonresidential building projects, excluding public utilities, and for new State and local government building projects is being collected starting January 1974. The survey will provide for the tabulation of information on the square feet of floor space heated and air-conditioned by different types of fuel by major type of construction, e.g., schools, hospitals, etc., for new projects started, under construction, or completed. The Bureau should obtain a fairly comprehensive picture of fuel consumed for heating and cooling purposes. We do not have any publication plans as yet, but we hope to publish as soon as the data are considered "publishable" in the C30 Report, "Value of New Construction Put In Place."

D. Survey of Residential Alterations and Repairs - SORAR

Information on heating and air-conditioning expenditures relating to household alterations and repairs.

NOTE: This information could be expanded to obtain data on conversions from coal to oil, oil to gas, etc. However, the sample for this survey was recently reduced by about 50 percent so that expenditures must be fairly large before reliable data are obtained. Also, supplementary questions could easily be introduced to obtain other household type data.

V. Transportation Activity

A. A final hardbound Volume II has been published containing data from previously published reports for each of the 50 States, the District of Columbia and a U.S. Summary report from the 1972 Truck Inventory and Use Survey. The greatest detail is available in the public use tape. A published description of tape content is available.

For each type of truck, data items related to characteristics of the vehicle and its use are available, particularly, annual and lifetime miles driven and type of fuel used can be tabulated by any of the other characteristics of the vehicle, its use, and location. Vehicles owned by Federal, State, and local governments are excluded.

B. The National Travel Survey data has been published in the final hardbound Volume I containing data previously published in a Spring Report (January-May 1972), Summer Report (June-September 1972) and for the full year in the report entitled "Travel During 1972." A public use tape has been prepared and a manual describing the content of the tape is available. Data items obtained in the survey and included in the record for each trip reported are identified in a published description of the computer tape program.

Estimates of amounts of non-local travel for trips defined as "each time a person goes to a place at least 100 miles away and returns."

Distribution of travel (as defined) by means of transport; distance travelled; destination of travel; person-miles of travel; and seasonality of travel.

C. Data from the 1972 Commodity Transportation Survey is published in three series of reports dealing with the movement of commodities from manufacturing establishments. The report series are Commodity Reports presenting data for about 80 3-digit commodity groups; Area Reports presenting data for each of 27 production areas and selected States and a U.S. Summary report; and Special Reports on Printing, Publishing and Allied Industries (except Newspapers and Periodicals), Traffic Patterns of Small Manufacturing Plants, and Shipper Groups.

Data is available on the intercity flow of commodities from manufacturing establishments at various commodity classification levels showing tons and ton-miles of shipments by means of transport, length of haul, weight of shipment, origin and destination. Of particular interest would be distribution of products from refineries by weight of shipment, distance shipped, and means of transport for the Petroleum Refining and Related Industries. Total movement by means of transport of commodities shipped from establishments representing the Nation's industrial universe is also shown. A computer tape for public use is being prepared.

VI. Enterprise Statistics

A. Company level data will be compiled in the Enterprise Statistics files for all firms engaged in minerals production, contract construction, manufacturing, wholesale and retail trades, and miscellaneous business and personal services. The information is presently being compiled for the 1972 Economic Censuses with comparable data available from the 1967 Censuses.

- Data for all companies on: Number of companies and establishments, employment, payroll, and sales.
- Data for Census covered companies of over 500 employees on capital expenditures, fixed assets, depreciation, rental payments, and total assets.
- Physical location down to Census Tract level for establishments and legal form of parent company.

B. Annual data on employment and quarterly payrolls for employer firms is available from the County Business Patterns at specific economic activity (SIC) within county.

VII. Special Survey of Scientists and Engineers

A survey is being undertaken for the National Science Foundation covering scientists and engineers working on energy-related activities. Information to be collected includes the number of employees by energy source (coal, oil shale, nuclear, etc.) and by activity (extraction, conversion, etc.). Information classifying scientists and engineers by occupation and energy source will also be covered.

VIII. Agricultural Activity

The following data are available from the 1969 Census of Agriculture. Similar data will be collected in the upcoming 1974 Census.

A. Number of automobiles, trucks, tractors, and other specific farm equipment located on farms at the end of calendar year 1969.

B. Farm expenditures during calendar year 1969 for gasoline and other petroleum products in the following categories:

- Gasoline
- Diesel Fuel
- LP, Propane, and Butane Gas
- Oils, greases, and other petroleum products

IX. Government Activity

A. Quarterly

1. Summary of State and Local Tax Revenue Motor fuel sales tax revenues.

2. Construction Expenditure of State and Local Governments

   a. Highways
   b. Electric power systems

B. Annual

1. State Tax Collections

   a. Motor fuel sales tax revenue
   b. Motor vehicle registration license revenue
   c. Severance tax revenue
   d. Public utilities sales and gross receipts tax revenue

2. City Government Finances--national estimates based on sample and data for individual cities of over 50,000 population

   a. Revenue, expenditure, and indebtedness of city-operated utilities--water supply, electric power, transit and gas supply

   b. Public utility sales and gross receipts tax revenue

3. Governmental Finances--presents U.S. totals and State-by-State estimates based on finance data for all States and a sample of local governments

   a. Motor fuel sales and gross receipts tax revenue

   b. Public utilities sales and gross receipts taxes

   c. Local government-operated utility revenue, expenditure, and indebtedness--water supply, electric power, transit, and gas supply utilities

   d. Highway maintenance and construction expenditures

4. Public Employment--number of employees and October payrolls for utilities operated by local governments--water supply, electric power, transit and gas supply.

C. Census of Governments--quinquennial in years ending in "2" and "7." Reports for the 1972 Census have been completed and issued. These censuses started in 1957. Each census presents data comparable to the above-mentioned finance and employment statistics for all State and local governments.

Industrial Energy Assessment Survey

1. What are your major sources of information on energy conservation?

   In house staff ______

   Outside consultants ______

   Trade journals (specify) ______________________________

   Government publications ______

   Government:

   - Federal ______
   - State ______

   Other (specify) ______________________________

2. Is your firm a member of any trade organization which is concerned with energy conservation?

   ______ Yes ______ No

   Specify ______________________________

3. Is someone in your plant responsible for energy conservation?

   ______ Yes ______ No

   Name (optional) ______________________________

   Title ______________________________

   Please indicate any formal technical training this person may have

   a) Degree in a technical field ______

   b) Licensed in a technical field ______

   c) Certificate program completion ______

   d) Other (explain) ______________________________

   If "No" who would be best suited to fill this role?

   Name (optional) ______________________________

   Title ______________________________

   Please indicate any formal technical training this person may have?

   a) Degree in a technical field ______

b) Licensed in a technical field ______

c) Certificate program completion ______

d) Other (explain) ____

4. What is your firm currently engaged in making?

____

____

____

5. How many people does your firm employ?

____

6. Have you implemented any energy conservation programs since January of 1976?

______ Yes ______ No

If "Yes", What types of measures were taken?
(check appropriate responses)

House Keeping

a) Room temperature adjustment ______

b) Lighting adjustment ______

c) Insulation of pipes ______

d) Increased maintenance of steam lines and traps ______

e) Weather stripping ______

f) Insulation (walls or roof) ______

g) Elimination of steam leaks ______

h) Other (please specify) ____

Process Modification

a) Waste heat recovery ______

b) Flash condensate to lower pressure ______

c) Return steam condensate ______

d) Demand control ______

e) Replace burners ______

f) Control modification to reduce energy (explain) ______________

____

g) Other (specify) ____

What % reduction in energy use do you estimate you have achieved by implementing these programs?

____

Was energy awareness for employees a part of your conservation program?

______ Yes ______ No

7. Have you had an energy audit conducted at your building?

______ Yes ______ No

If "Yes" have you implemented any energy saving measures as a result of that audit?

______ Yes ______ No

(please specify what these measures are) _________________________

____

What firm conducted the energy audit? (optional) _________________

____

8. How important do you believe coping with the cost of energy is to the success of your business?

a) No importance ______

b) Little importance ______

c) Somewhat important ______

d) Very important ______

9. Would you be interested in sending a representative to attend a workshop in energy conservation measures for industry?

_______ Yes _______ No

If "Yes" whom do we contact?

Name ____

Position ____

Office Phone No. ____

What energy conservation topics do you feel should be addressed in a workshop/seminar?

(specify) ____

____

____

Energy Assessment Survey: Residential

1. Number of families presently living in structure? ______________

   Number of units in structure? ______________

   Age of structure? ______________

2. What energy conservation measures, if any, have you undertaken in your home since January of 1976?
   (check appropriate responses)

   a) Lowered thermostat in winter ______ Yes ______ No

      If "Yes" by how many degrees? ______________

   b) Raised thermostat for air conditioning or cooling unit in summer? ______ Yes ______ No

      If "yes" by how many degrees? ______________

   c) Caulking and weatherstripping? ______ Yes ______ No

      If "No" was this done prior to 1976? ______ Yes ______ No

   d) Attic insulation? ______ Yes ______ No

      I. If "Yes" how many inches were added? ______________

      II. What type of insulation was used? 1) cellulose ______
      2) glass ______ 3) foam ______ 4) other (specify)
      ____

      III. Did you install insulation yourself? ______ Yes ______ No

      IV. How many inches of attic insulation did you have prior to January of 1976?
      ____

   e) Wall insulation? ______ Yes ______ No

      I. If yes how many inches were added? ______________

      II. What type of insulation was used? 1) cellulose ______
      2) glass ______ 3) foam ______ 4) Other (specify)
      ____

      III. Did you install insulation yourself? ______________

IV. How many inches of wall insulation did you have prior to January of 1976?

____

3. Have you utilized any alternate energy sources in your home since January of 1976?

______ Yes ______ No

(specify which types) ______________________________

4. Has your home or building ever received an energy audit?

______ Yes ______ No

If "Yes" have you implemented any energy saving measures as a result of that audit?

______ Yes ______ No

(Please specify what these measures are) ______________________________

____

Who conducted the audit?

Yourself ______ Auditing firm (specify) ______________

Contractor (specify) ______________________________

Other (specify) ______________________________

5. Would you consider weatherizing your home if reliable information about products, contractors, and instructions on installation were made available to you?

______ Yes ______ No

6. Where do you receive most of your information about energy conservation?

a) Expo/Home shows __________

b) Newspaper __________

c) T.V. __________

d) Radio __________

e) Other (specify) ______________________________

EXHIBIT ONE

STRUCTURAL CLASSIFICATION

STANDARD

Requires at most only normal maintenance. This category is comprised of buildings which have no defects or only surface defects in structural and/or non-structural elements.

STRUCTURE REQUIRING REHABILITATION

Does not meet criteria for being substandard.

But...has major and minor defects in primary and secondary elements that need to be corrected.

STRUCTURALLY SUBSTANDARD

1. Two (2) critical defects in primary components.

or

2. One (1) critical defect in a primary component and two major (2) defects in primary of three (3) major defects in a secondary component.

or

3. Two (2) critical defects in a secondary component and three (3) major defects in a primary or secondary component.

or

4. Five (5) major defects in primary or secondary components.

EXTERIOR SURVEY

Date________________

Inspector____________

Block_____ Parcel_____ Address________________ Construction__________

PRIMARY COMPONENTS

1. Foundation

Rated #1 (Sound) — Sound and solid, fully capable of supporting the superstructure and containing no cracks, holes or open spaces.

Rated #2 (Minor) — Basically sound and solid, but has cracks, small holes or open spaces correctable by minor repair work such as tuckpointing.

Rated #3 (Major) — Deteriorated to the degree that partial replacement of materials is necessary, and the part to be replaced is not an integral part of the structure.

Rated #4 (Critical) — Deteriorated to the degree that total replacement is necessary.

Rating______________

Comments____

____

2. Exterior Wall Structure

Rated #1 (Sound) — Walls are sound, plumb and do not require any repair.

Rated #2 (Minor) — Walls are basically sound and plumb and require minor repair but no replacement.

Rated #3 (Major) — Walls are out of plumb but otherwise sound and capable of being reinforced.

Rated #4 (Critical) — Walls are bowed, sagging, or deteriorated to such a degree that complete replacement is necessary.

Rating______________

Comments____

____

3. Roofing Structure

Rated #1 (Sound)	The roof structure is sound and in proper alignment.
Rated #2 (Minor)	The roof structure is out of line, but requiring only minor repair and no replacement.
Rated #3 (Major)	The roof structure is out of line or sagging and requires repair including partial replacement of covering materials and supporting structure.
Rated #4 (Critical)	The roof structure is so deteriorated that it must be totally replaced.

Rating________________

Comments____

____

SECONDARY COMPONENTS

4. Siding Material

Rated #1 (Sound)	The siding materials are properly applied and in a reasonably sound condition so as to provide full protection of the occupants from the elements.
Rated #2 (Minor)	The siding material is beginning to require normal maintenance in order to return it to its original condition.
Rated #3 (Major)	The siding materials are deteriorated to the degree that replacement of a portion is necessary to return it to its original condition.
Rated #4 (Critical)	The siding materials have deteriorated to the degree that complete replacement is necessary.

Rating________________

Comments____

____

Roofing Material

ated #1 (Sound)	The roofing materials are properly applied and in a reasonably sound condition so as to provide full protection of the occupants from the elements.
Rated #2 (Minor)	The roofing material is beginning to require normal maintenance in order to return it to its original condition such as replacement of a few shingles.
Rated #3 (Major)	The roofing materials are deteriorated to the degree that replacement of a sizable portion is necessary to return it to its original condition.
Rated #4 (Critical)	The roofing materials have deteriorated to the degree that complete replacement is necessary.

Rating ______________

ments ____

____

6. Yard Conditions

1) trash and debris in yard

2) fences in disrepair and/or sidewalks in disrepair

3) porch sagging and having broken floor boards

4) steps and railways unsafe and in disrepair

Rated # 1 (Sound)	yard is in a suitable condition
Rated # 2 (Minor)	yard contains 1 or 2 of the above defects
Rated # 3 (Minor)	yard contains 3 of the above defects
Rated # 4 (Critical)	yard contains 4 of the above defects

Rating ______________

Comments ____

____

7. <u>Windows and Doors</u>

Rated #1 (Sound)	They are solid, weathertight, and workable, and require no repair.
Rated #2 (Minor)	They are solid, weathertight, and workable, but require minor repair such as replacing missing putty.
Rated #3 (Major)	They are sagging, not completely workable or weathertight and require some replacement of broken panes, frames, sills, and sashes.
Rated #4 (Critical)	They have deteriorated to such a degree that total replacement is necessary.

Rating ____________

Comments ____

____

8. Outstructure (garage, shed, etc.)

Rated # 1 (Sound)	structure is plumb, roof adequate, exterior has adequate siding, etc.
Rated # 2 (minor)	structure has minor defects in roof, siding foundation.
Rated # 3 (Major)	structure has major defects in roof, siding and foundation.
Rated # 4 (Critical)	structure has critical defects in roof, siding, and foundation

Rating ____________

Comments ____

____

ENVIRONMENTAL DEFECTS

Building or Lots Having an Adverse Effect on Surrounding Area

1. Inadequate street layout ☐

2. Incompatible uses or land use relationships ☐

   Explain ______________________________

3. Overcrowding of buildings on land ☐

   Explain ______________________________

4. Excessive dwelling unit density ☐

   Explain ______________________________

5. Obsolete buildings not suitable for improvement or conversion ☐

   Explain ______________________________

6. Other hazards to health, safety, and general well being of the community ☐

   a. Building or lot containing trash and debris ☐

   b. Lack of maintenance; unsightly appearance ☐

   c. Other ______________________________ ☐

7. Other ______________________________ ☐

EXTERIOR SURVEY

INSPECTOR ______________________ DATE __________

ADDRESS ______________________ PLAT # __________

CENSUS BLOCK ______________________ LOT # __________

LAND USE __________ COMMENTS: ______________________

ARCHITECTURE __________, CODE __________

PRIMARY COMPONENTS

1. Foundation Rating __________
   Comments ______________________

2. Exterior Wall Structure Rating __________
   Comments ______________________

3. Roofing Structure Rating __________
   Comments ______________________

SECONDARY COMPONENTS

4. Siding Material Rating __________
   Comments ______________________

5. Roofing Material Rating __________
   Comments ______________________

6. Yard Condition Rating __________
   Comments ______________________

7. Windows and Doors Rating __________
   Comments ______________________

8. Outstructure Rating __________
   Comments ______________________

SURVEY SUMMARY

A. Primary Components

Minor Defects ________
Major Defects ________
Critical Defects ________

Secondary Components

Minor Defects ________
Major Defects ________
Critical Defects ________

B. Rating:

(1) [ ] Structurally substandard to a degree warranting clearance

(2) [ ] Deficient

(3) [ ] Standard requiring normal maintenance

EXHIBIT THREE

ATTITUDE SURVEY

Age____________________

Renter__________________ Owner Occupant____________________________

Family Size____

A. NEIGHBORHOOD TRENDS

1. Where is your neighborhood (Draw on map)?
2. Why do you live here?________________________________
3. Do you like your house or apartment?____________________

   ____
4. How long have you lived here?___________________________
5. Where was your last residence?__________________________
6. What changes have occurred in the neighborhoods since you have been here?
   a. Housing?____

      ____
   b. Crime or Law Enforcement?___________________________

      ____
   c. Ethnic Composition__________________________________

      ____
   d. Other____

      ____

B. SERVICES

1. Where do you go shopping?______________________________

   ____
2. Where do your children play?__________________________

   ____

   How are the facilities?_________________________________
3. Where do your children go to school?___________________

   ____

How do you find the educational services? ______________

____

4. How often is your garbage picked up? ______________

5. What social service organizations serve you? (YMCA, health center, family counselling)? ______________

____

Do you socialize inside or outside the area? Where? _____

____

Are you a member of any groups or organizations in the area? ______________

____

C. ENVIRONMENT

1. Do you feel safe on the street? ______________

____

2. Are the police visible? ______________

Do they do a good job? ______________

3. How many friends do you have in the neighborhood? _______

____

4. Is this a good neighborhood to raise a family? Why or why not? ______________

____

____

5. What is the <u>best</u> feature of your neighborhood? _________

____

6. What is the <u>worst</u> feature of the neighborhood? _________

____

D. NEEDS

If you were given one million dollars to improve your neighborhood, what would you do with it? ______________

____

____

EXHIBIT THREE

ATTITUDE SURVEY

Age_______________

Renter_______________ Owner Occupant_______________

Family Size_______________

A. NEIGHBORHOOD TRENDS

1. Where is your neighborhood (Draw on map)?

2. Why do you live here?_______________

3. Do you like your house or apartment?_______________

____

4. How long have you lived here?_______________

5. Where was your last residence?_______________

6. What changes have occurred in the neighborhoods since you have been here?

   a. Housing?_______________

   ____

   b. Crime or Law Enforcement?_______________

   ____

   c. Ethnic Composition_______________

   ____

   d. Other_______________

   ____

B. SERVICES

1. Where do you go shopping?_______________

____

2. Where do your children play?_______________

____

How are the facilities?_______________

3. Where do your children go to school?_______________

____

How do you find the educational services? ____________

____

4. How often is your garbage picked up? ____________

5. What social service organizations serve you? (YMCA, health center, family counselling)? ____________

____

Do you socialize inside or outside the area? Where? ______

____

Are you a member of any groups or organizations in the area? ____________

____

C. ENVIRONMENT

1. Do you feel safe on the street? ____________

____

2. Are the police visible? ____________

Do they do a good job? ____________

3. How many friends do you have in the neighborhood? ______

____

4. Is this a good neighborhood to raise a family? Why or why not? ____________

____

____

5. What is the best feature of your neighborhood? ______

____

6. What is the worst feature of the neighborhood? ______

____

D. NEEDS

If you were given one million dollars to improve your neighborhood, what would you do with it? ____________

____

____

APPENDIX D

1. "GENERAL HIGHWAY AND STREET STANDARDS"

2. "HIGHWAY CLASDIFICATION"

3. "Neighborhood Concept

4. "Costs of Sprawl", Representative Devleopment Patterns

Type of Facility	Function and Design Features	Spacing	Widths R.O.W.	Widths Pavement	Desirable Maximum Grades	Speed	Other Features
Freeways	Provide regional and metropolitan continuity and unity. Limited access; no grade crossings; no traffic stops.	Variable; related to regional pattern of population and industrial centers	200–300′	Varies; 12′ per lane; 8–10′ shoulders both sides of each roadway; 8′–60′ median strip.	3%	60 mph	Depressed, at grade, or elevated. Preferably depressed, through urban areas. Require intensive landscaping, service roads, or adequate rear lot building set-back lines (75′) where service roads are not provided.
Expressways	Provide metropolitan and city continuity and unity. Limited access; some channelized grade crossings and signals at major intersections. Parking prohibited.	Variable; generally radial or circumferential	200–250′	Varies 12′ per lane; 8-10′ shoulders; 8-30′ median strip.	4%	50 mph	Generally at grade. Requires landscaping and service roads or adequate rear lot building set-back lines (75′) where service roads are not provided.
Major Roads (Major Arterials)	Provide unity throughout contiguous urban area. Usually form boundaries for neighborhoods. Minor access control; channelized intersections; parking generally prohibited.	1½ to 2 miles	120–150′	84′ maximum for 4 lanes, parking and median strip.	4%	35–45 mph	Require 5′ wide detached sidewalks in urban areas, planting strips (5′–10′ wide or more) and adequate building set-back lines (30′) for buildings fronting on street; 60′ for buildings backing on street.
Secondary Roads (Minor Arterials)	Main feeder streets. Signals where needed; stop signs on side streets. Occasionally form boundaries for neighborhoods.	¾ to 1 mile	80′	60′	5%	35–40 mph	Require 5′ wide detached sidewalks, planting strips between sidewalks and curb 5′ to 10′ or more, and adequate building set-back lines (30′).
Collector Streets	Main interior streets. Stop signs on side streets.	¼ to ½ mile	64′	44′ (2–12′ traffic lanes; 2–10′ parking lanes)	5%	30 mph	Require at least 4′ wide detached sidewalks; vertical curbs; planting strips are desirable; building set-back lines 30′ from right of way.
Local Streets	Local service streets. Non-conducive to through traffic.	at blocks	50′	36′ where street parking is permitted.	6%	25 mph	Sidewalks at least 4′ in width for densities greater than 1 d.u./acre, and curbs and gutters.
Cul-de-sac	Street open at only one end, with provision for a turn-around at the other.	only wherever practical	50′ (90′ dia. turn-around)	30′–36′ (75′ turn-around)	5%		Should not have a length greater than 500 feet.

OURCE: George Ne[illegible] [illegible]

HIGHWAY C[illegible]SIFICATION

Highway systems are grouped into a number of different classifications for administrative, planning, and design purposes. The Federal Aid financing system, state-county-city's administrative systems, and commercial-industrial-residential-recreational systems are examples of the variety of highway classifications.

In the most basic classification system for design work, highways and streets are grouped into: (1) interstate, primary (excluding interstate), secondary, and tertiary road classes in rural areas, and (2) expressway, arterial, collector, and local road classes in urban areas. These classifications usually carry with them a set of suggested minimum design standards which are in keeping with the importance of the system and are governed by the specific transportation services the system is to perform. The principal consideration for designating roads into systems are the travel desires of the public, land-access requirements based on existing and future land use, and continuity of the system. Four basic purposes of urban street systems have been suggested:

1. **Expressway system (including freeways and parkways)**—providing for expeditious movement of large volumes of through traffic between areas and across the city, and not intended to provide land-access service.
2. **Major arterial system**—providing for the through traffic movement between areas and across the city, and direct access to abutting property; subject to necessary control of entrances, exists, and curb use.
3. **Collect or street system**—providing for traffic movement between major arterials and local streets, and direct access to abutting property.
4. **Local street system**—providing for direct access to abutting land, and for local traffic movements.

These basic purposes of city street systems are similar to those of rural interstate, primary, secondary, and tertiary highways, respectively, so far as the various degrees of accommodation of through traffic and land access is concerned. However, regional as well as national highway transportation requirements must be met by rural highways. The Tables compare the overall criteria of urban street and rural highway classifications.

The principles and elements of geometric design for both urban and rural facilities are generally the same. However, to meet urban and rural traffic demands, design details are often varied because speeds, traffic composition, lengths and purposes of trips, etc., are not the same.

SOURCE: Standards for Street Facilities and Services, Procedure Manual 7A. National Committee on Urban Transportation, Public Administration Service, Chicago, 1958, p. 11.

URBAN STREET CLASSIFICATION CRITERIA

Element	System			
	Expressway	Major Arterial	Collector	Local
Service function:				
Movement	primary	primary	equal	secondary
Access	none	secondary	equal	primary
Principal trip length	over 3 miles	over 1 mile	under 1 mile	under ½ mile
Use by transit	express	regular	regular	none, except C.B.D.
Linkage:				
Land uses	major generators & C.B.D.	secondary generators & C.B.D.	local areas	individual sites
Rural highways	interstate & state primary	state primary & secondary	county roads	none
Spacing	1-3 miles	1 mile	½ mile	....
Percentage of system	0-8	20-35		65-80

RURAL ROAD CLASSIFICATION CRITERIA*

Element	System			
	Interstate	Primary	Secondary	Tertiary
Service function:				
Movement	primary	primary	equal	secondary
Access	controlled	secondary	equal	primary
Linkage to:				
Geographic	major cities	smaller cities	smaller cities & regions	farm-to-market
Urban streets	expressways	expressways & major arterials	major arterials & collectors	collectors & local
Percentage of system	2	17	10	71

*Includes surfaced roads only.

In terms of the minimum desirable number of lanes, a single lane on a Class I bikeway is not particularly effective since it doesn't allow passing without leaving the bikeway. As a recommended minimum on Class I bikeways, two lanes should thus be provided to allow a passing lane capability.

On Class II bikeways the minimum number of lanes that should be provided depends upon where on the street the bikeway is incorporated.

In Class II bikeways additional clearance should be allowed for "dynamic" obstructions. The most obvious example of this is when the bikeway is located adjacent to a parking lane. Since opening doors constitute a dynamic hazard to cyclists, an additional clearance for the car door should be allowed if adequate clearance is not provided in the parking lane and high parking density and turnover exist. Similarly the proximity of the bikeway to traffic lanes (and the speed, volume and mix of passing traffic) may require additional clearance if barriers are not provided and if the traffic lane is not wide enough to provide the necessary spatial separation.

TABLE 1 Minimum Effective Width for Class I and Class II Bikeways as a Function of Number of Bikeway Lanes

Number of Lanes (One Way)	MINIMUM EFFECTIVE WIDTH (FT)	
	German Specifications	Modified German Specifications Based upon a Comfortable Maneuvering Allowance at a 10 mph Design Speed
1	3.3 (1m)	3.3
2	5.3 (1.6m)	6.4
3	8.5 (2.6m)	10.9
4	11.8 (3.6m)	15.3

SOURCE: Bikeway Planning Criteria & Guidelines, University of California, 1972.

GRADE

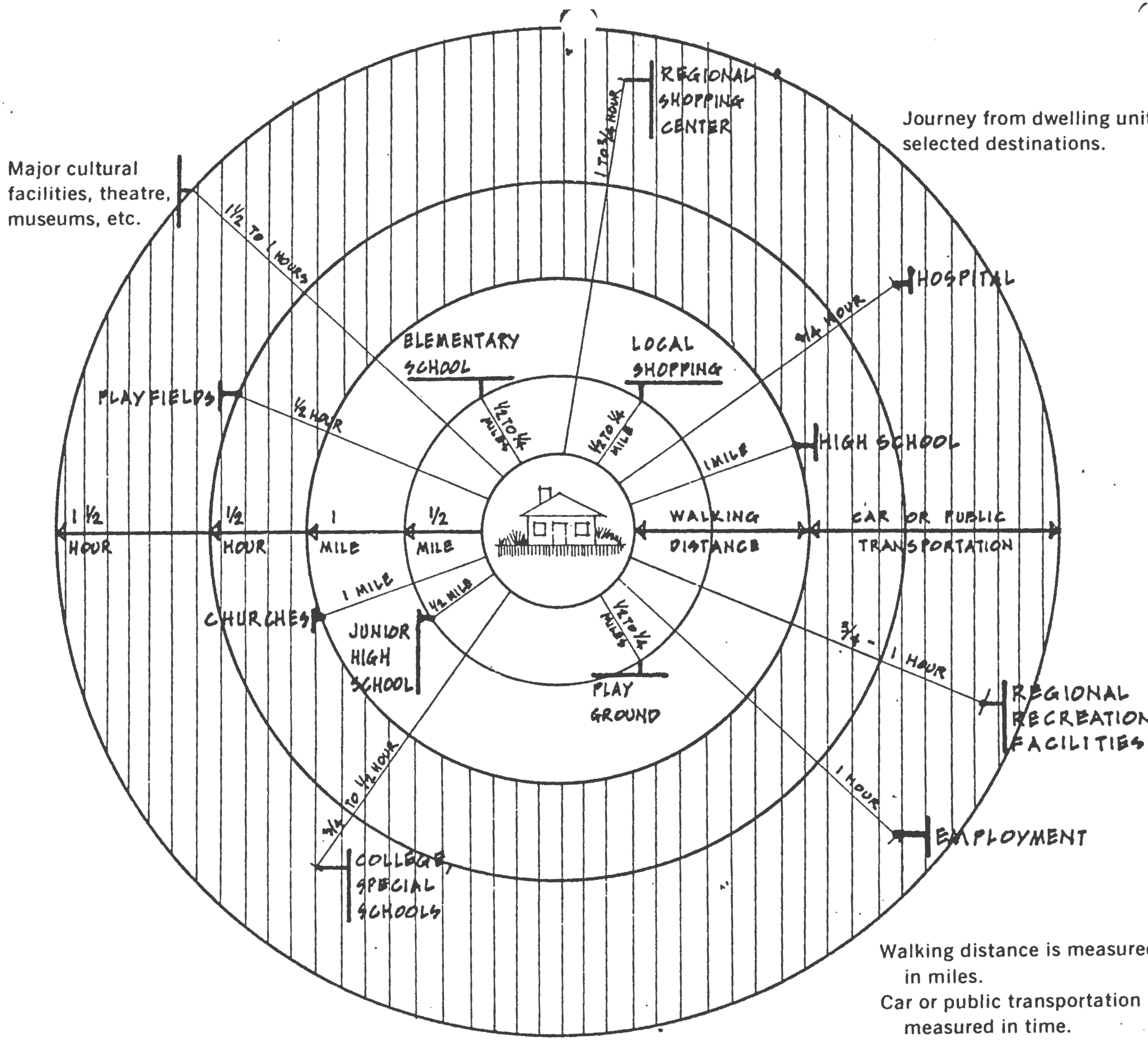
Cyclist characteristics (age, weight, conditioning, oxygen uptake, etc.), bicycle characteristics (gear ratios, type of cycle, tires, weight, etc.), wind velocity, air resistance, and road surface are major determinants of maximum acceptable bikeway grades and the length such grades should be in effect.

Source (1) recommends a 4-5% grade for one-speed cycles with a 9-10% maximum on "short" runs.

VOLUME CRITERIA FOR SEPARATED BIKEWAYS

Internationally, separated bikeways (Class I, II) have generally been recommended where:

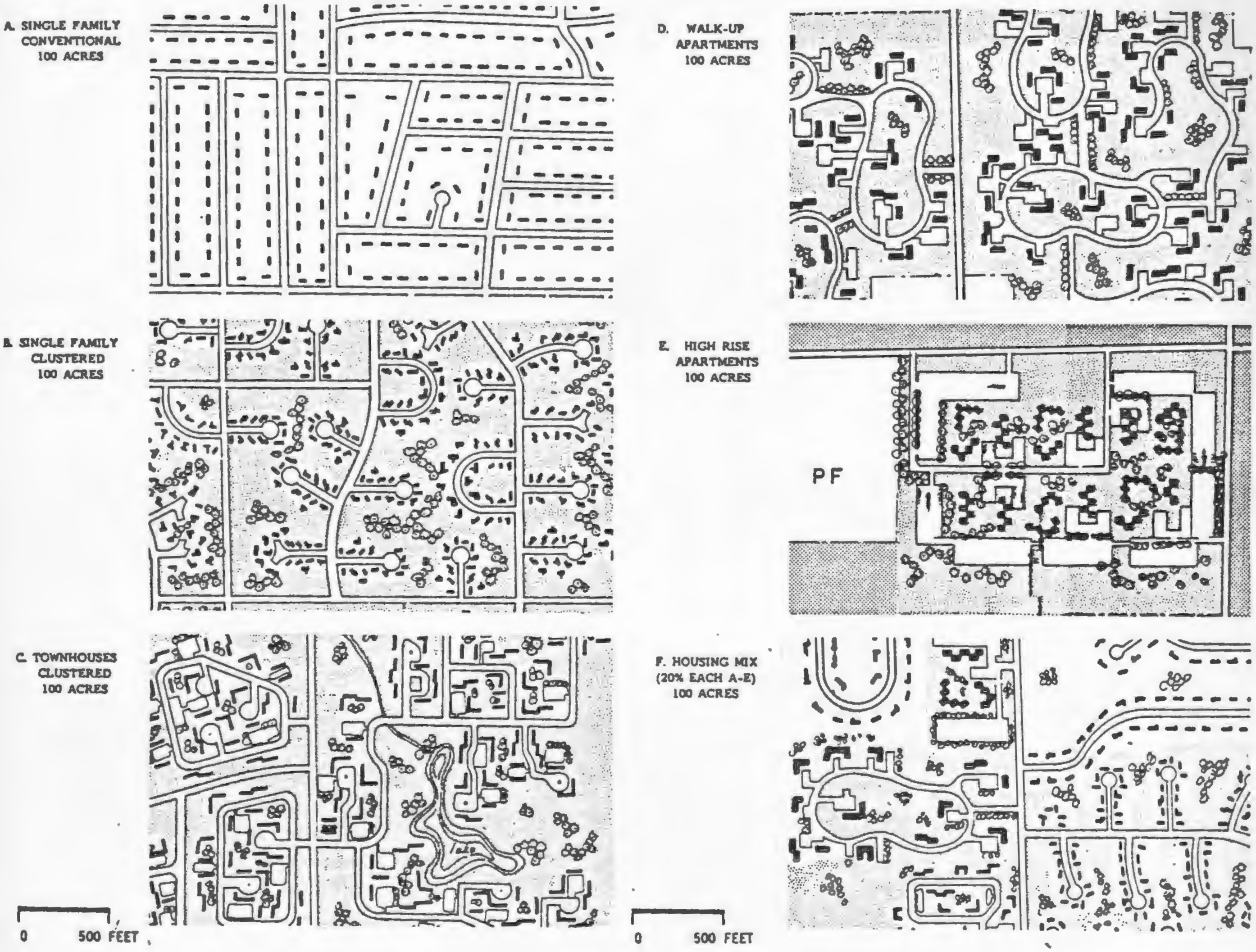
1. Significant regular bicycle traffic exists, and/or
2. Significant future bicycle traffic is forecast, and/or
3. Significant motor vehicle traffic is present on the roadway.



Journey from dwelling unit to selected destinations.

Walking distance is measured in miles.
Car or public transportation is measured in time.

FIGURE A
REPRESENTATIVE DEVELOPMENT PATTERNS



NEIGHBORHOOD PROTOTYPES - LEGEND