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USING NATURAL RESOURCES
IN LOCALIZED DESIGNS
FOR ENERGY CONSERVATION

by

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July, 1980

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INTRODUCTION

Years ago mankind did not have the technology to utilize fossil fuels for energy to the extent it has today. They had to rely on other techniques to provide energy for food preparation and heat. Their culture, land use, and in particular, building design, evolved from this need. Buildings were designed to minimize heating and cooling needs through the use of localized natural resources, site orientation, internal layout and choice of building materials. Because builders lacked advanced building materials, technology and research, they had to rely on their knowledge of the area's climate and their common sense.

The Industrial Revolution and subsequent technological advances made available an abundance of fossil fuels and the ability to utilize them to mechanically heat and cool buildings. The need and ability to use natural resources to heat and cool a building fell into disuse. Buildings were designed to accommodate other desires such as style, usually with total disregard to the structure's ability to minimize heating and cooling needs.

World events such as the OPEC oil embargo created shortages and initiated a continuing upward trend in energy costs. The problem of diminishing supplies, oil in particular, is slowly being recognized. Our dependence on fossil fuels, especially on imported oil, has threatened our national security and economy. Rising energy costs are responsible for a considerable portion of the inflation rate. In some areas of the country, winter means a choice between freezing and starving. The need for finding alternative energy, especially clean renewable energy sources is finally being recognized, although mobilization to combat the energy problems has been slow.

Suspicion that the energy problem is a myth generated by the oil companies to further their profits has reduced public support of energy conservation programs. In many cases, indecision and a lack of leadership has caused delays. The lengthy debate over and delay in passing a National Energy Act is a prime example of this inaction. Local communities have been slow to react, possibly awaiting action by the federal government. The lack of a data base and dissemination of accurate information has retarded alternative energy development. Institutional, social and economic factors have played out their roles in delaying mobilization. The complexity and sheer size of the existing energy inefficient infrastructure slowed activity. It is generally not feasible or energy efficient to tear out the infrastructure and replace it with more effective designs.

In simplistic terms, we do have certain options that could begin resolving at least part of the energy problem. The following is not meant to be a discussion of all available options, rather it is to provide examples of measures that could be initiated quickly.

First, we need to mobilize at all levels of government. Federal action is useful and necessary, but the local communities can't afford to wait for the federal government to respond. This causes too much lag time. Additionally, many options can be initiated at the local level, such as development of local decentralized energy resources, changes in land uses, community education and development of community efforts to conserve energy.

Secondly, the conservation of energy has been labeled as an energy resource in itself. It can reduce energy consumption significantly enough to equal a new energy source. There are many ways to conserve energy.

Examples include more efficient design of transportation modes, buildings and land use configuration, weatherization and retrofitting of existing buildings, and institutional changes.

Another option would be to develop alternative energy resources to their fullest. This would take the longest to implement and is the most complex; effective and comprehensive development needs an extensive research base requiring a considerable financial and resource commitment.

The concept of using natural resources in a localized design to minimize the need for mechanical heating and cooling of buildings fits into all three of these options. Although government action is not required, it can assist and encourage development, particularly in the public sector. The use of natural resources is a conservation measure as well as being considered an energy resource. It can be implemented at all levels from the federal government to the individual.

The definition of natural resources for the purpose of this paper is limited to landscaping materials, climate and site characteristics. In addition, building design will be briefly discussed because an effective design can maximize the benefits available from utilizing natural resources.

Various aspects of the localized use of natural resources for energy conservation will be discussed. Chapter one will document the historical uses of natural resources in localized design. Chapter two will summarize the current use of natural resources to illustrate what can be done. A design process for project planning will be detailed in chapter three. Implementation techniques available to communities will be discussed in chapter four. Chapter five will summarize the information presented.

This is not intended to be a definitive manual on how to use natural resources to maximize energy conservation. The paper is designed to discuss relevant concepts and illustrate the types of things that can be done. Ideally, the information presented will motivate readers to pursue the concept and implement ideas designed to meet their specific needs.

CHAPTER I

HISTORY OF THE USE OF NATURAL RESOURCES IN LOCALIZED DESIGN

Historically and today in some primitive areas, vernacular buildings were constructed using locally available materials. Vernacular buildings are designed to be responsive to local conditions and can be identified by region. For example, the location of a building could be identified by its design characteristics.

These buildings or shelters were built to reduce the range of local climate variations. For example, in areas of hot days and cool nights, a building was constructed of heavy masonry. The thermal lag characteristics of masonry absorb the heat of the sun but delays transferring it into the building interior. The time delay is dependent upon the type and thickness of the masonry. During the hot daytime hours the building interior is kept cool; as the colder nighttime temperatures develop, the masonry gives off the stored heat and warms the interior. The building is comfortable and the need for mechanical heating and cooling is reduced.

Localized building is illustrated by two communities in West Africa.¹ The communities are located next to each other but with dramatically different climates. One community is in a hot, arid climate, the other in a tropical rain forest. Building materials and designs are completely different. The community in the hot, arid region is designed to minimize the impact of heat and the diurnal cycle and adjust the flow of air to provide comfortable ventilation. Their building material is clay. The community in the rain forest uses wood and thatch building materials.

The community is designed for protection from insects and animals, to temper climate conditions and to provide adequate ventilation.

The Eskimo snow houses provide an excellent example for tempering the effects of the exterior environment to provide a liveable interior.² The construction requires only available snow and ice, simple tools, two people and two hours. Its comprehensive design makes use of every possible concept to increase interior liveability. This includes details such as the placement of a section of ice in the wall to permit light penetration and a tunnel entrance design that allows only the essential amount of air to enter. With exterior temperatures at -60 degrees F, interior temperatures at the sleeping shelf level are 45 degrees F.

These are just a few examples. There are many cases that demonstrate ways to use the sun, wind, and other climate characteristics to their best advantage. The common concept in all these examples is that the buildings are designed for the local region. This includes maximizing the use of natural resources to improve the interior environment.

In most countries building design has evolved away from utilizing natural resources. Buildings are usually constructed with little or no regard to local topography or climate conditions. Houses originally designed for the southwestern United States, California or Florida, are built in the upper midwest or northeast. Houses that are adequate for one region are often inefficient and uncomfortable in another. Insulation requirements, building materials, window placement and size, site orientation and internal layout are all impacted by local conditions. In hot, arid regions, minimizing southern windows and increasing northern exposure may be vital to reduce cooling needs and increase internal comfort. In colder

regions, increasing southern exposure and decreasing northern exposure can significantly affect heating requirements.

Increased mobility and the development of and dependence on mechanical heating and cooling systems has contributed to inefficient designs. Mobility mixed styles and regional differences. Designs popular in one region were transferred into another region. Mechanical systems and cheap energy eliminated the need for localized design. Mechanical systems became a sign of development and advanced technology. Buildings without the modern amenities of central heating and cooling were considered old fashioned, out of date and undesirable.

Increasing energy costs and decreasing supplies have forced people to reflect on past practices. The time aged concepts are experiencing a resurgence under the label of innovative and energy conscious designs. Advanced technology and a more thorough understanding of concepts such as thermal lag are improving on old designs, but the main concept of using local natural resources to their fullest has remained unchanged.

However, change is gradual, even when it's simplified by utilizing old ideas. There has not been a sudden rush to construct vernacular buildings. People need to be reeducated to understand and accept the philosophy of localized design. Information needs to be disseminated on implementation of localized designs. People are hesitant to construct buildings using localized natural resources designs because it's a considerable financial investment and they lack confidence in the design or saleability of the building. The concepts appear unproven, not through lack of examples, but through lack of research and documentation. We've come to accept information only after it's been thoroughly tested. This is protection against being flooded by questionable information.

As a consequence of these circumstances, the use of natural resources is in a holding pattern. The concepts are being incorporated into building designs slowly and sporadically. There are examples here and there across the country but not en masse. Many designs are effectively incorporating the time-tried principles with newer building materials and techniques and the building performance is being documented. It is simply going to take time to document and disseminate the information and to convince people that localized designs should be used. Rising energy costs could spur development, and governmental programs to encourage efficient design could make the step forward easier.

FOOTNOTES

¹Richard G. Stein, Architecture and Energy. (Garden City, N.Y. Anchor Press/Doubleday, 1977) p.31.

²Ibid., 38

CHAPTER II

LOCALIZED USE OF NATURAL RESOURCES

A key concept behind energy efficient design is the effective localized use of natural resources. In the context of this paper, localized means the use of natural resources that are specific to a particular site. For example, the climate varies by site; for a design to be effective it must use the climate available to the specific site under development. Energy efficient design is also based on certain key principles. These principles are facts and must be utilized as they exist; it is not possible to modify their action.

This chapter is divided into six sections. The first summarizes basic principles that impact energy efficient design. The second discusses how landscaping can be an effective tool for maximizing comfort and minimizing the heating and cooling needs of a building. Section three illustrates how building design can maximize energy efficiency by utilizing the available natural resources. The possibilities for retrofitting existing buildings utilizing energy efficient design is summarized in section four. Section five presents the potential benefit of this design and section six is a summary of the chapter.

PRINCIPLES

The effective use of natural resources to conserve energy in buildings is founded on certain basic principles. It is sufficient within the context of this discussion to summarize in simple terms the effect of these principles rather than explain them in full detail.

HOT AIR RISES, COLD AIR SINKS

These are two main effects of this principle. In a system that is not hampered by barriers, the rising hot air and sinking cold air movement is seen in Figure 1.

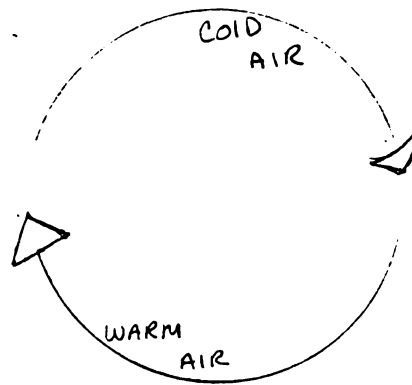


Figure 1

This is a principle behind efficient furnace operation; hot air ducts distribute heat and create an air circulation pattern, the cold air return ducts allow the sinking cold air to flow back to the furnace.

In general, this means that the air within a building and around a building will be stratified with the cool air at ground level. Since hot air is moving up within a building, this also explains why so much heat can be lost through the roof. This is important to remember when designing a building for heating and natural ventilation.

The second effect is the formation of cold air sinks or the trapping of cold air in a depression or against a barrier. Since cold air sinks, it will flow down a slope until it hits a depression or a barrier. If a building was constructed in a low area, cold air would accumulate in the depression surrounding the building. In colder regions this would be undesirable. In hot climates, this may be a very effective way to cool the building. If a building is built on a slope, it may form a barrier and trap cold air on the upslope wall of the house. However, as will be discussed later, this can be avoided.

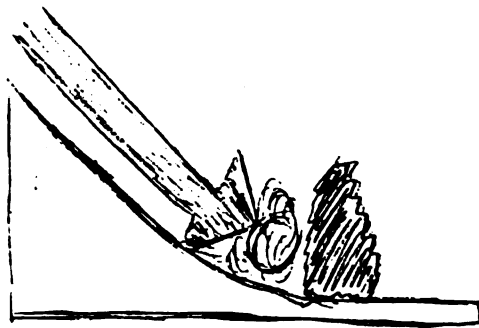


Figure 2

HEAT AND LIGHT IS ABSORBED BY DARK SURFACES,
REFLECTED BY LIGHT SURFACES

This effect can be easily experienced by touching dark and light surfaces exposed to sunlight. One example of the use of this principle

is the popularity of light colored clothing in tropical climates. This principle is extremely important to remember when designing a building, as it affects the choice of materials used. Choosing the most effective building materials, given local climate conditions, will use the available light and heat efficiently.

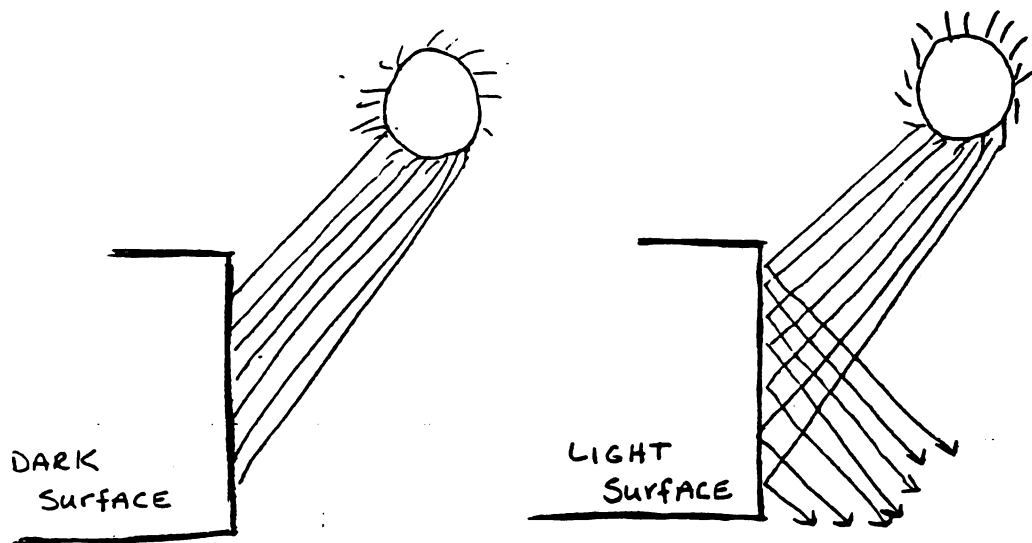


Figure 3

PRESSURE BALANCE

The pressure balance between the interior and exterior environments of a building affects the infiltration rate. For example, higher pressure within a building reduces infiltration rates while lower pressure causes air to be drawn into a building, increasing infiltration rates. Air infiltrates mainly through cracks in a building so the amount of air coming in is also dependent upon the structure.

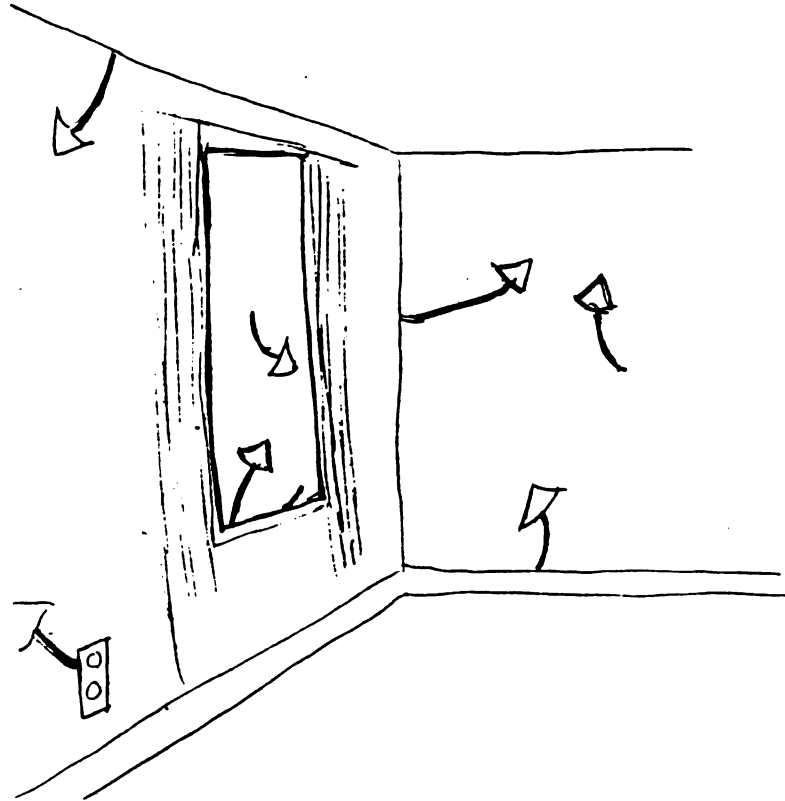


Figure 4

Pressurizing a building is done to avoid drafts and comply with air exchange rates. It is used mainly in commercial and industrial buildings. Fresh air is drawn in, heated, then blown out through the cracks. Lower internal pressure can be inadvertently caused in buildings by the furnace system. If a building is extremely tight, the furnace may have trouble getting sufficient oxygen to burn properly; it draws on the internal air supply enough to effectively lower the pressure and draw air in through cracks. This has become a problem in some new building construction where extensive efforts are made to eliminate cracks and tighten up the building.

DEAD AIR SPACE INSULATOR

Dead air is air that is trapped within a space and moves very little, if at all. It is a very good insulator. One common use is in double pane windows or when storm windows are added. The space between two panes of glass creates a dead air space, insulates the glass and reduces the infiltration of air through the glass.

Although less common, well selected trees and shrubs can create insulating dead air spaces around a building, reducing the internal heating needs.

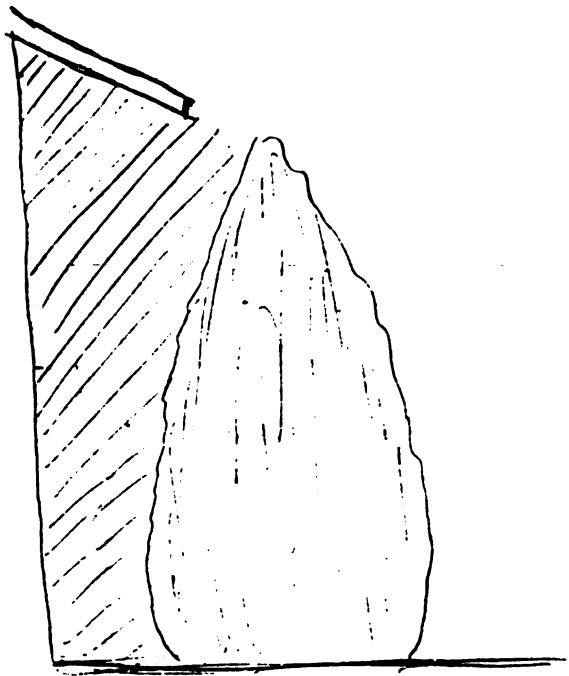


FIGURE 5

THE SUN'S PATH

There are two important principles involved in the path the sun takes. These are illustrated in Figure 6. During the winter months, the sun is lower in the sky, in the summer, it is higher.

The sun's path is important for designing buildings and landscaping because of the placement of shading devices. With correctly placed shading devices, the sun enters windows during the winter when the heat is desired and is cut off from entering by the devices during the summer when additional heat is not wanted. This principle can be used to reduce summer cooling needs.

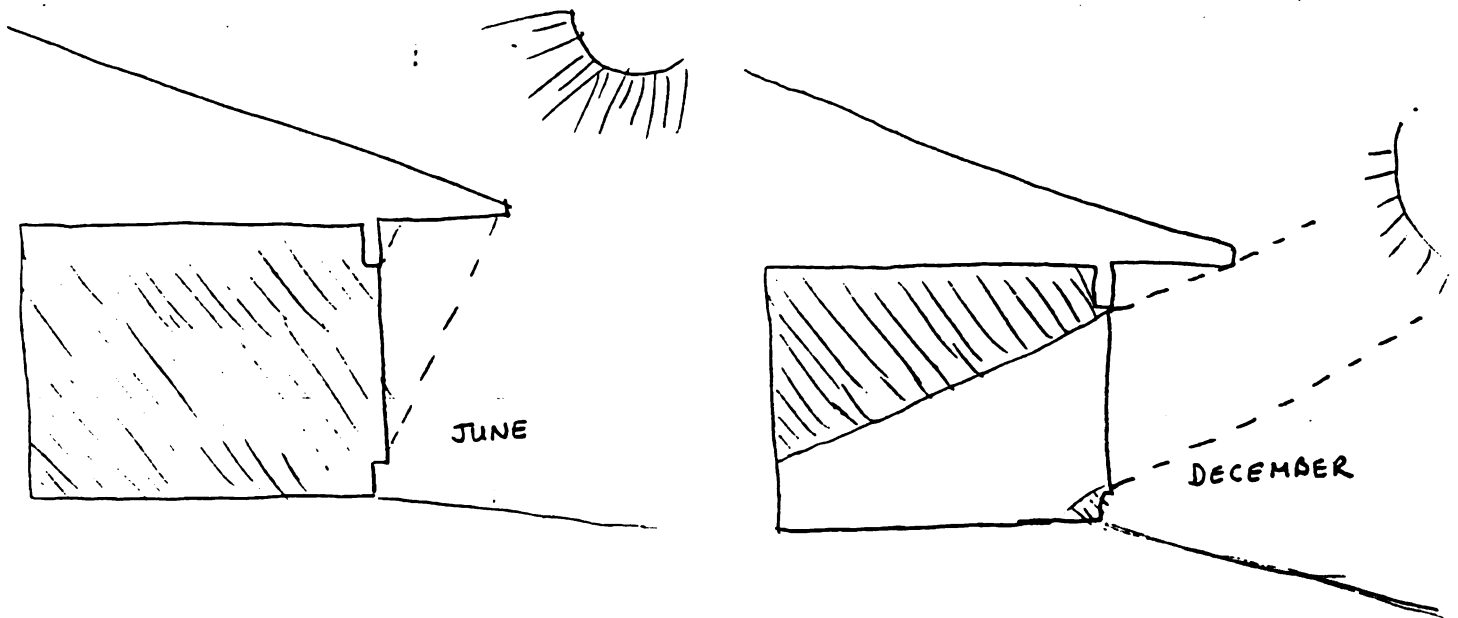


Figure 6

The second important principle is that the sun rises in the east, travels on a southerly path and sets in the west. This is very elemental but essential to maximizing the use of natural resources in building design. In colder climates, a building should be oriented to the south with the majority of glazing or windows located on the southern facade. The principle also governs the placement of shading devices as shading the north will do nothing for a building.

WINDBREAKS DIRECT AIR FLOW

A windbreak of trees, shrubs or other material directs the flow of air. This principle is used to decrease drafts and heating and cooling needs, and provide good ventilation. Windbreaks can direct air around or over an object. They can also direct air through an opening. Windbreaks will be discussed in more detail later.

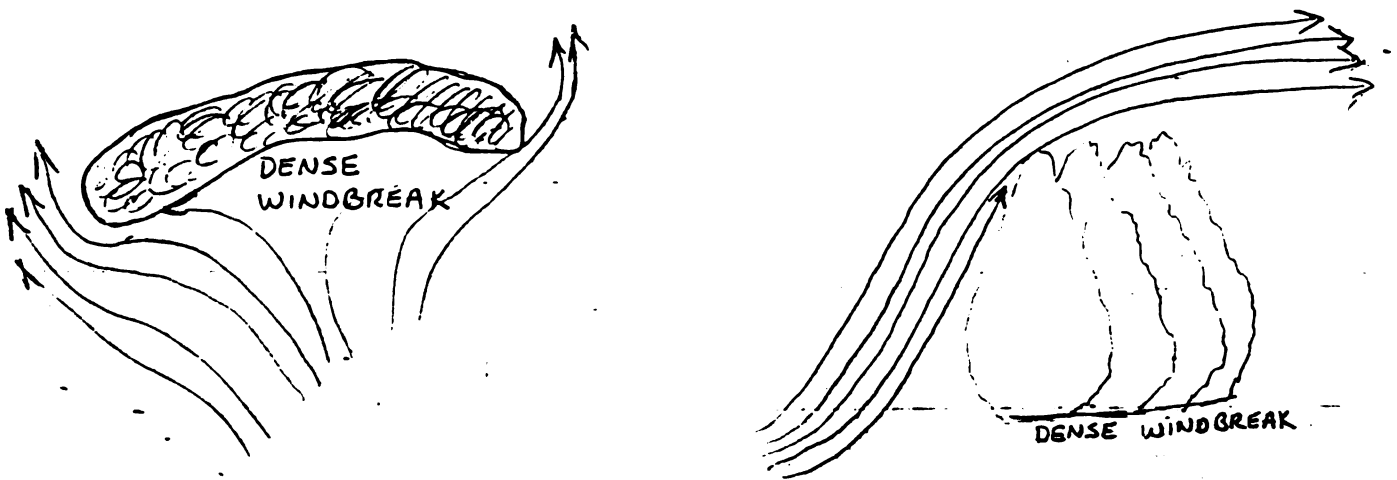


Figure 7

HEAT TRAVELS TO COLD

Heat moves toward cold surfaces. If you touch something cold, it feels cold because the heat is leaving you. If a hot surface is touched, heat is felt as it travels to the cooler person. Because of this, interior heated air is going to be moving toward the external colder air. During hot weather, air conditioned internal air will travel toward external hot air. This explains why heat travels out of a building through the exterior building shell.

LANDSCAPING

Landscaping can be a very effective tool for maximizing comfort in and around a building and for minimizing interior heating and cooling requirements. Landscaping is tied into the characteristics of the site, the building, local climate conditions, plant species suitable to the region and aesthetic considerations. For these reasons, it is not within the scope of this paper to detail specific plans for a site, rather to discuss possibilities and provide examples. Individuals wishing to implement ideas should apply the concepts to their specific location.

The following is a discussion of the resources available for landscaping, including the use of the sun and wind:

SUN

The sun is essential to the most effective use of natural resources. It provides heat and light which produces the energy for plant growth. Effectively used, the heat and light can provide a comfortable living environment while reducing the need for mechanical heating and lighting.

As discussed previously, the sun's path follows a southerly direction while traveling from east to west and is higher in the sky during the summer, lower during the winter. In a colder climate region the building and landscaping are designed to capture solar radiation during the winter and reflect it during the summer. This is accomplished by site orientation and the use of building and landscape components. Those will be detailed in subsequent sections. The important concept to remember is that the sun is a renewable, clean source of energy. It is waiting to be tapped and should be a focal point in an energy conserving design.

WIND

The cooling characteristics of wind are highly desirable in hot climates and during summer months in colder climates, but are not wanted during cold winter months. The solution is to capture the wind when it's wanted and direct it away or block it out the rest of the time. Fortunately, nature usually helps out, as the prevailing winds typically change direction with the seasons. This allows for the formation of windbreaks that divert cold winds during the winter but have no effect on the capture of wind during the summer. This will be illustrated in more detail under plants.

Winds not only cool, they ventilate. Ventilation is important to provide fresh air and take away stale, used air. This is evident in the desire to open windows on the first warm spring day to "air out the house." Internal room design, placement of windows and landscaping all have an impact on the amount of ventilation available to a building.

Air also has a good insulating quality, but only as dead air. Moving air transfers both hot and cool air, but air that is stagnant acts as a barrier to hot and cold flows. Air spaces can be created both in building design and with landscaping materials. A line of dense shrubs placed near a building will trap air and insulate the structure. The shrubs or small trees can also modify wind velocities next to a building. This reduces the impact of wind and infiltration on a building.

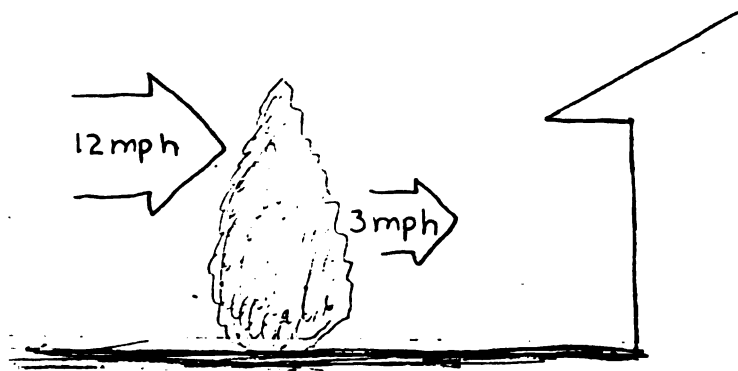


Figure 8

When planning a site development, it's important to remember that wind is a fixed characteristic of a particular locality. Although wind can be utilized advantageously by diverting or directing it using landscaping and building design, its direction and velocity is not within the dictates of an individual. Plans must be designed to this fixed characteristic.

PLANT MATERIALS

Plant materials have certain requirements for light, heat, water, nutrients and soil based upon their species. Because of the evolution and variety of species, there is a plant that will grow under almost any circumstance. Consequently, plants are very flexible and easily used for landscaping purposes. Unlike the wind, their location, height, density, etc. can be chosen to utilize sun, wind and other natural resources to increase

the effectiveness of a plan. However, it is important to choose plants to suit both design needs, and needs of the plant. Choosing a plant that requires a lot of sun and planting it on the north side of a building may thwart the plants efforts to survive and your efforts to create an efficient building design.

At this point, it is beneficial to discuss some of the useful properties of plants. For example, coniferous evergreens that branch to the ground retain their thick, dense properties year round. They are very effective windbreaks and create insulating dead air spaces. The trees cut down the velocity of air movement and divert air up and over the windbreak. They provide shade but because they are dense year around, evergreens also block desired sun during the winter. In cold climates, the most effective use of evergreens is to plant them to block the prevailing northern winds as seen in Figure 9. This does not hinder the cooling flow of air from the south-southwest during the summer.

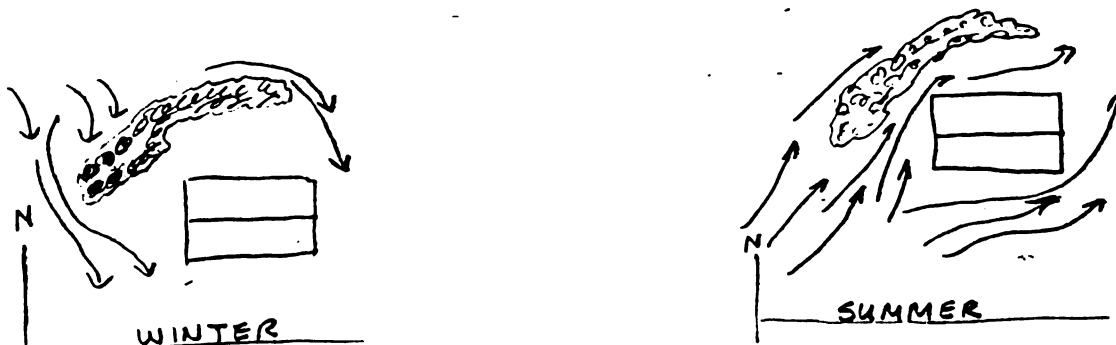


Figure 9

Deciduous trees lose their leaves during the winter months, allowing sunlight to pass through the branches and provide light and heat to the surface area below. This is essential to maximizing the heating value of the sun during the cold months.

In the summer, the tree's leafy crown shades the area below within a certain distance. The distance depends on the height and type of tree. The shade blocks the sun that would create excessive heating of a structure.

Just as important is the cooling effect of trees. The leaves intercept and absorb solar radiation. Also, the tree draws water up from the ground through its root system and evaporates it from its leaves, cooling the surrounding air. The temperature beneath a shady tree can be 15-20 degrees cooler than in a nearby treeless area.²

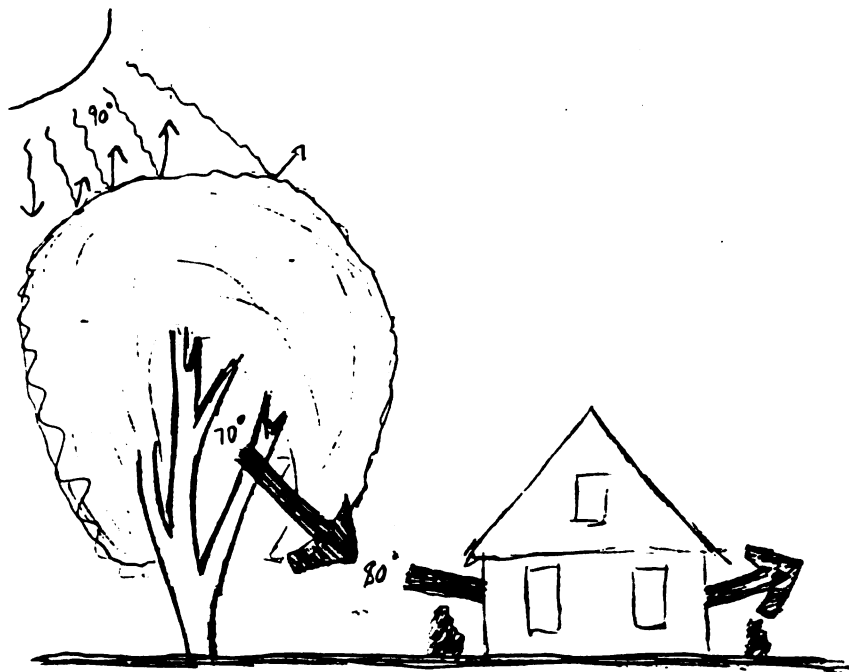


Figure 10

The most effective placement of deciduous trees is in a semicircle around the east, south and western perimeter of a building. South and west placement is actually the most important as heat builds up throughout the day. When the sun is in the east, the air is cooler, so shading isn't essential. As the day progresses, more and more heat builds, reaching a peak in late afternoon. The sun is lower in the sky as it sets, allowing the rays to get under many shading devices, penetrating and overheating the building. As the heat builds and the sun goes lower in the sky, shading is critical to prevent heat build-up and increased cooling needs. Well selected and placed deciduous trees can provide the necessary shade.

One problem with the use of deciduous and coniferous trees is that they need to be at a certain stage of maturity before they are effective. Saving existing mature trees when building on a site can solve this problem--providing the trees are in the right locations. Buying and transplanting large trees helps speed up the process, but this can be very expensive and there's a limit to how big a tree can be effectively transplanted. The best solution is to save existing trees when possible, transplant the largest trees that can be afforded and transplanted with success, plant additional trees as necessary and if shading is still needed, look into devices such as awnings, blinds, etc. Overhangs designed into a building can be useful on the south side but do little against the low sun in the west. Species selection also has an impact as there are fast growing trees that would provide shade sooner than other varieties. However, it's important to remember that a variety of species is needed. If a disease strikes one variety, it usually will not destroy the whole stand of trees if it has a mixture of species. Variety often improves the wildlife habitat and

can add to the aesthetic value of the site. It's helpful to remember that time moves fast and the trees will be providing benefits relatively soon. All too often people don't plant trees because they feel it's not worth it, given the long growing time.

Other forms of plants such as shrubs, bushes and vines perform many of the same functions as described above, only to a lesser degree. A shrub is too short to shade the vertical height of a building, but it can create insulating spaces and infiltration protection in the winter and cool the air along the lower portion of a building in the summer. Shrubbery can also be used in conjunction with trees to direct air flow. The following diagrams illustrate different combinations and their effect on a building.³

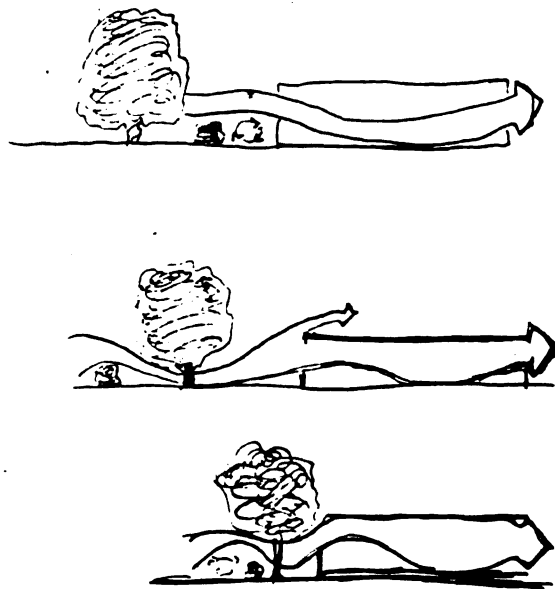


Figure 11

Vines on or right next to a wall can create a cooling or shading effect by absorbing and deflecting solar radiation. The following illustration details the effects of vines on a wall when compared to a bare wall.⁴

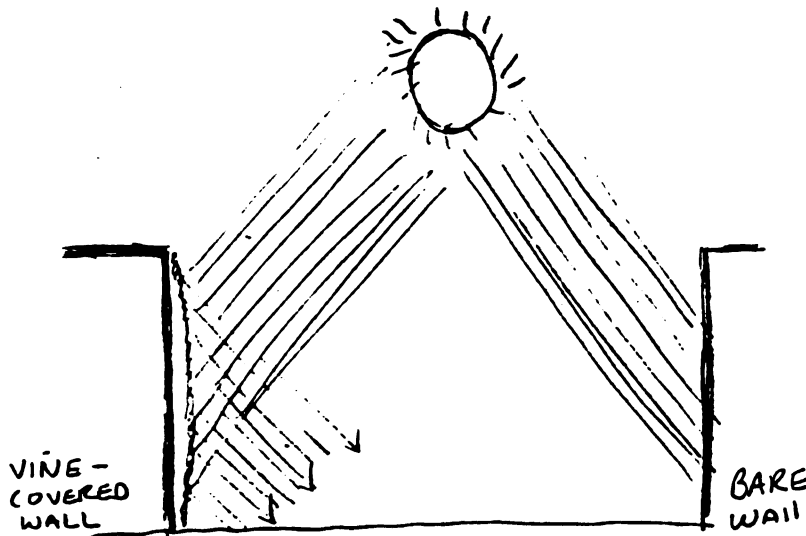


Figure 12

If the vines are mounted on a trellis a few inches from the wall, the temperature difference created by the vines will form a convection current, carrying heat up and away from the wall.

Plants are obviously a major landscaping component and their use can be extremely effective in maximizing comfort and minimizing mechanical heating and cooling needs. One point needs to be stressed. A haphazard plan is not likely to be very effective. A plan has to be developed to meet the needs of the site, the building, and the plants.

SLOPES AND BERMS

A slope is a natural characteristic of the site; a berm is a constructed mound of dirt that slopes. A slope has to be considered in the development of a site; a berm is chosen and placed to accomplish a specific goal.

Slopes can be a benefit or a hinderance, depending on the orientation, size and degree of slope. If a slope is gentle enough (building on a steep slope creates erosion problems) and orientated to the south, a building can be constructed in the slope. The north side of the building is, dependent upon specific design, covered with earth. Earth has some insulating qualities although wall insulation is still needed. The biggest effect of the earth on the north is the barrier to infiltration. North winds will strike the earth and be diverted, they will not pass through to the building.

If the north side of the building is not entirely covered by earth, it can form a barrier to cold air flowing down the slope. This can form a cold air sink, trapping the cold air against the building. In this case, a windbreak needs to be planted to divert the air around the building. The windbreak will also form an insulating space to protect the building. If the building is left to form a cold air sink, the air can permeate the shell of the building and increase the heating needs. It can also cause the depth of the frost line to increase, possibly creating structural problems.

A building built into a south slope has a large southern exposure designed into the building plan. This is to trap and utilize the incoming solar radiation. The effect of such a design is a building protected to varying degrees on three sides from prevailing winter winds but functioning as a solar collector on the southern side. In the summer, the earth helps to cool the building while the southern exposure, if shaded, will admit cooling summer winds.

A berm is limited only by expense and construction feasibility. It can be long and high and perform the same functions of a slope. It is more

difficult to integrate visually into a site, especially if the site is flat. Berms are often limited to partially covering the building, for instance, up to the window sills. This is easier to visually integrate into the design, allows more traditional placement of windows and points of egress and still provides insulating and infiltration protection for a portion of the building.

Berming and building into a slope can be very useful but it can present certain problems. Structural requirements and choice of building materials are affected by the weight and dampness of the earth. Ventilation of the building may be a problem in that cross ventilation may be difficult or impossible to achieve. Cross ventilation draws air through a building. Depending on design, some rooms of the building may be dark and closed-in with no windows or natural light. These are design considerations.

BUILDING DESIGN

Although landscaping is very important to the effective use of natural resources, building design can make a significant impact on energy consumption. A building design can either ignore the use of natural resources for energy conservation and comfort or it can be attuned to the utilization of available components. In recent times, designs have ignored local characteristics, but the trend is slowly reversing. Since there is a wide variety of possibilities, depending upon specific site characteristics, this discussion will focus on major design considerations and a sampling of examples.

SITE ORIENTATION

Site orientation cannot be overstressed. Typical examples of bad site orientation include placing a garage on the south side of a building and

orienting the front of a building to the north. This is usually done for convenience, ease of design or for no reason at all. In nearly all cases, a building can be effectively oriented on a site. Not all sites are ideal for energy conservation, and many land developments, such as subdivisions, plot out the land inappropriately for proper site orientation. However, with careful planning, even a poor site can usually be made to work effectively.

The key concept to remember about building orientation is to design the building to the land. For example, if there is a slope that faces south, make use of the slope rather than leveling out the land or building entirely on top of the slope. If the site is large enough, it's better to place the building closer to the north line rather than centering the building or putting it close to the south property line. This allows more efficient use of southern exposure. Orienting the building to the south means that major living areas and windows face south, capitalizing on southern exposure.

Proper site orientation should be tied into the actual building design. A building facing south is a step forward but without efficient design, it has comparatively minimal impact. Specific design possibilities are discussed in more detail below.

MAJOR DESIGN CONSIDERATIONS

Major design considerations include choice of building materials, window selection and placement, insulation and the arrangement of interior space. Many of these considerations have no or minimal impact on the cost of a building. In other cases, the payback period associated with energy conserving techniques is short, ranging from a few months to five to seven

years. Increasing energy costs will continue to lower the true cost and payback period of conserving measures. In addition, the value and demand of energy conserving buildings is increasing with a positive impact on the market value of the structure. There are many possible designs and combinations of conserving techniques; the following discussions focuses on key issues in buildings designed to utilize natural resources.

Choice of Building Materials

The choice of building materials centers on thermal qualities. A building acts like a solar collector; the sun's rays are either reflected or absorbed by the various building components. Drawing on the discussion of principles, remember that light surfaces reflect, dark surfaces absorb heat and light. Also, keep in mind the thermal lag properties of materials such as masonry.

The roof of a building is the surface most exposed to the sun, although the amount and intensity of exposure varies with the season, roof design and site location. Because the sun is higher in the sky during the summer, it strikes the roof more than in the winter. The color of the roof will affect how much solar heat is absorbed by the building, impacting summer cooling needs. Light colored shingles or roof surface will reflect solar radiation. The building absorbs less solar heat through the roof and is, therefore, utilizing a building material to minimize the impact of the sun. A dark colored roof has the opposite effect as it absorbs the solar radiation striking the surface.

The color of the building siding has somewhat the same effect, but the impact is mainly on the south side as it receives solar radiation

throughout the day. The north side receives little direct sunlight and the east and west receives light only during certain parts of the day. During the summer, shading is often needed on the side of the structure anyway so reflective surfaces aren't as desirable (except for certain climates such as the tropics). The color of the roof and siding should depend on the local climate.

Often the color and thermal components of a siding should be related. For example, in colder regions where solar heat absorption and storage is desirable, the south facade or entire wall structure may be dark and of sufficient thermal mass to collect, store and transmit heat to interior spaces. Thermal mass may be in the form of a block or concrete wall, a rock (such as field stone) or brick wall or wall of glass with containers for storing water. The glass allows the solar radiation to pass through and into the dark containers of water which store and transmit heat into the building.

Color and thermal components also can be significant in interior design. Light colored ceilings and walls reflect light within the rooms, reducing mechanical lighting needs. This reflection can also diffuse the light evenly over the room. Floors and walls that are masonry and dark can act to store and distribute heat within a room. A good example is the masonry hearth, common with fireplaces. The hearth collects, stores and distributes heat generated by sunlight or a wood stove or fireplace. Dark masonry floors can also be good collectors but are often undesirable because to be effective they can't be covered with wall to wall carpeting. The carpeting is often wanted for ease of maintenance, warmth and softness. It is

unlikely that all possibilities would be incorporated within one room, but various combinations can achieve energy impacts while satisfying the owner's needs.

Windows

The ideal use of a window is to maximize desirable heat gain in the winter, cooling ventilation in the summer, and to minimize heat loss in the winter and heat gain in the summer. The placement, size and construction of windows all impact their effectiveness. A well constructed window with weatherstripping, insulated double glazing and tight construction, reduces infiltration rates and winter heat loss, especially at night.

Window size is often decided by aesthetic values or cost; energy efficiency needs to be added to the decision making criteria. The size of a window affects how much heat is gained during the day and how much is lost at night. The larger the window, the more heat gained and lost. However, insulating shutters or even drapes can cut down on heat loss. Therefore, to attain high heat gain, large windows are needed.

This is further controlled by the location of windows. Large windows will not help gain heat if placed on the north side of a house; they will only contribute to heat loss. Large or several windows should be placed on the south side with no or small windows placed on the north. Windows on the east and west are generally smaller and fewer in number. These windows contribute heat gain but not as much relative to heat loss when compared to south windows. The best heat gain to loss ratio is with south windows, followed by west, east and north facing windows. An important design factor that needs to be tied into windows is insulation, as discussed in detail below.

Insulation

The term insulation usually brings to mind wall and ceiling insulation, but it can have a much broader definition. For example, when selecting windows, their energy efficiency can be significantly increased by using thermal or insulated shutters. Properly used, shutters allow for maximum heat gain by being left open during sunny days and minimize heat loss by insulating the window during cloudy days and at night. Insulated shutters can be made of a variety of materials, ranging from a wood frame with foam insulation as a core to multi-layer quilt fabric to foam beads that are blown into the air space between panels of glass on a double glazed window. The choice of shutters depends upon individual taste, cost, adaptability to the structure, and thermal performance. Thermal performance comparisons between types of insulated shutters has not been thoroughly documented but there is a significant difference between bare windows and a curtain or drape and between a draped window and one covered with an insulated shutter. As an example, one study indicates the use of shutters can result in a 28 percent savings in reduced heat loss.⁵

Wall and ceiling insulation is an important design characteristic in any house, but it is especially important when trying to utilize natural resources to conserve energy. This is critical because effective use of the environment requires that heat gained be retained in the building. If it is not trapped in the structure, the effectiveness of using natural site components will be significantly reduced. There are many different types of insulation available including varieties of foam, cellulose and fiberglass. They should be chosen based on performance,

cost, and suitability to the structure. Recommended R-values vary according to local or regional climate. Depending on the type of insulation, the R-value will generally indicate the thickness of the required insulation. The R-values refer to a material's resistance to heat flow and are listed for each type and brand of insulation on the packaging or by the contractor.

Interior Space

The layout of the interior space of a building depends on many variables including building use, convenience, privacy and aesthetics. For the purposes of this discussion, the structure will be assumed to be residential. Traditional plans group activity areas together. For example, the bedrooms are grouped together, the kitchen-dining room are together, etc. Usually these rooms are placed within the house with little regard for the site except perhaps for the main entrance. Considering the directions, specifically north and south, when planning the building layout can impact energy usage. Below are some key design points that are useful in an energy conserving design.

1. Put garages, storage sheds and utility or workrooms on the north side of the house. These rooms generally do not need the same level of heat as living areas and can perform as insulating dead air space. Their presence also reduces the infiltration impact on north winds. Placement on the north side also insures that they don't obstruct solar access on the south.
2. Put closets and hallways on the north side of the house or on exterior walls, but not on the south walls. For example, if a bedroom has a north exterior wall, locating the closet on this wall will insulate with air space and clothes.

Storage of clothes, spare blankets, pillows, etc. will insulate a space. Locating hallways on exterior walls will provide a buffer zone to living areas that need more heat. These ideas can not be used on a south wall as they will restrict solar access.

3. Place as many major living areas as possible on the south side. This is largely dependent on the configuration and dimensions of a building. Except in unusual designs it would not be possible to locate all rooms on the south, but all rooms so located will benefit from incoming solar radiation. The most important room would be the living room; a criteria to use in choosing room locations would be the extent of use. Heavily used rooms would benefit the most from incoming solar radiation and light. Also, rooms used more during the day would benefit from southern exposure.
4. Design a building configuration for minimal exposure. Large sprawling buildings have more exterior wall area that is impacted by the climate. Reducing exterior wall area reduces mechanical heating and cooling needs. A two story building would tend to be more energy efficient than a long rectangular building while providing the same internal square footage.
5. Plan double entrys as a buffer zone against incoming cold air. A person enters the building through one door, closes it and then enters the main part of the building through a second door. This keeps cold air from directly entering main living areas. These entrances can be totally within the building or extended like a small porch on the exterior of the building.
6. Open plans allow for greater circulation and penetration of solar heat and light. The fewer internal walls block off southern exposure, the easier it is for heat and light to penetrate the building interior. The better circulation patterns also reduce the potential for overheating or trapping excess heat in rooms receiving solar radiation.
7. Plan for zonal heating. For example, in a two story house, the heating system for the upstairs and downstairs is controlled by separate thermostats, allowing for different temperature levels based on need. Also, since heat rises, heat is likely to accumulate in the upstairs, requiring less mechanical heating assistance. A door may be desired at the bottom of the stairs to keep heat from rising into the upstairs too much.
8. Plan windows and interior walls for cross ventilation. A window draws air in most effectively when a second window allows a cross draft. Interior walls can block cross drafts, reducing the benefits of natural cooling winds.

9. Locate heat producing rooms on the north side of the house. Examples might include a kitchen where cooking produces heat or a laundry room where a washer and dryer produce some heat. In this way, the room meets some of its own heating needs, while being located in an area more likely to be cooler than in another part of a house. This location may also provide a cooler work area during the summer.

Implementation of many of these ideas is dependent on individual needs, desires, site characteristics and building configuration. They are important to remember when designing a structure because they are often no cost energy conserving measures that are easily implemented and can enhance the overall comfort of the structure.

Retrofitting Existing Buildings

Ideally, energy conserving ideas using natural components are implemented in new construction. This offers the widest range of options, the greatest possibility for conservation and is the easiest to implement. However, the number of the buildings that exist and the investment of financial and natural resources dictates that these structures not be ignored. Retrofitting can be accomplished on several levels depending on resources available and the extent that retrofitting is needed.

Landscaping can almost always be done to provide benefits. Small, low cost projects such as weatherstripping and insulating are possible as are major redesigning efforts. Often, when a house is remodeled or an addition built, windows and interior wall arrangements can be modified. Retrofit ideas cover a wide range of possibilities; they are usually constrained by the original building design, costs, structural requirements and owner's needs and wants.

BENEFITS

The most obvious benefit to designing buildings using localized natural resources is energy conservation. Saving energy helps the individual owner by reducing the operating costs of the building. This can be a considerable savings over the life of the building, resulting in a very good financial investment. It strengthens the local economy by reducing the amount of energy that is imported from outside the community, which keeps money in local circulation. Conservation also contributes to the health and strength of the national economy and welfare. Reduction of imported energy has the same effect nationally as in a local economy; it just has a broader base and effect. The overall national stability and security is enhanced as dependence on foreign actions are reduced. Conservation also conserves natural resources, stretching out the useful life of what exists.

One might argue that energy conservation of a single building would have little effect on overall energy consumption. This is true and the reason why conserving energy through natural resources and building design should become a standard practice rather than an exception. One building has little impact, but if everything possible was done to existing buildings and these concepts became standard practice with new building construction, the impact on energy usage would be highly significant.

An indirect benefit to utilizing these concepts is independence and comfort. An individual who isn't totally dependent on outside sources of energy is less affected by shortages and increasing prices. Although it may be a question of individual preferences, buildings relying on natural resources to provide a portion of heating, cooling and lighting needs enhances the comfort of individuals. Many people are adversely affected

by air conditioning, especially when they have to make rapid adjustments between air conditioned and unairconditioned spaces. A building that is naturally cooled eliminates the abrupt adjustments while still providing a comfortable environment. Being able to open windows also provides fresh air and allows outdoor sounds to enter a building. It is noted, however, that in congested urban areas exterior sounds may not be desired.

The appearance of a building can be greatly enhanced through the use of these concepts, especially with landscaping. Landscaping can beautify an area while conserving energy and providing restful, park-like spaces on the building grounds. For a homeowner, a landscaped lot can provide a peaceful haven, privacy and pride in the property. For workers in a building, landscaping can provide a picnic-like place for lunches, and creates an overall appealing nature to the building and grounds. Landscaping can attract people to a location, a drawing card to a shopping area, for example. It's important to remember that landscaping for energy conservation and beautification can be easily combined.

SUMMARY

A building does not have to be totally dependent on mechanical heating and cooling measures. It can utilize energy conserving techniques to meet some of the heating, cooling and lighting needs of a building. Many measures are low or no cost, others are simply related to modifying designs. To make all this possible, an effective plan should be comprehensive. Using one idea will do little relative to combining options. The site characteristics, local climate, landscaping and building design need to be tied together so that they complement each other. Although some of the concepts are based on rather complex principles, this doesn't mean an architect

or landscape design firm is needed. They are often beneficial, but many ideas can be implemented through the resourcefulness of building owners. These concepts need not be restricted to people with professional expertise or large financial resources.

FOOTNOTES

¹Gary O. Robinette, Plants/People/ and Environmental Quality, (Washington, D.C.: U.S. Department of the Interior, National Park Service, 1972) p.77.

²Kimball Hart, How to Cut Your Energy Costs, (Washington, D.C. U.S. News and World Report Books, 1978) p.66

³Gary O. Robinette, Plants/People/and Environmental Quality, (Washington, D.C.: U.S. Department of the Interior, National Park Service, 1972) p.76.

⁴Ibid., p. 96.

⁵National Solar Heating and Cooling Information Center, Passive Design Ideas for the Energy Conscious Architect, (Rockville, Maryland; Superintendent of Documents, Government Printing Office, 1978) p.43.

CHAPTER III

PROJECT PLANNING

The planning of a project, large or small, is critical to effective implementation. The degree of project success is often directly dependent on how well it is planned. A landscaping and building design program aimed at energy conservation can be particularly affected by inadequate planning. Although the building may be sound and the trees and shrubs may live, the program may not save any energy and, in some circumstances, may increase energy consumption. Trees and windows placed inappropriately may increase the impact of winter winds or the summer sun. Whether it is an individual designing a single site or a local government planning a community wide program, it's imperative to develop an effective plan for the specific location.

This chapter will be divided into two main sections. The first section will describe the planning process and how it relates to a landscaping and building design project. The second section will discuss the components of a site or community evaluation in more detail.

PLANNING PROCESS

The planning process can be broken down into five major steps:

- (1) formation of goals and objectives;
- (2) developing a data base;
- (3) plan development;
- (4) implementation of the plan and
- (5) monitoring

and evaluating the plan. Each will be described and related to a landscaping program.

GOALS AND OBJECTIVES

Goals and objectives are an aid to decision making. They help define the parameters of a project and refine and focus ideas to illustrate a specific problem and/or need. They are the foundation for determining the scope of work and the specific tasks that are necessary to develop a successful program. Additionally, they should be used to evaluate a program. If a program is effective, then it will meet or exceed the goals and objectives. Without the goals and objectives, there is no base from which to measure the program to determine its effectiveness.

It's important to know the distinction between goals and objectives before formulating them. A goal is a broad concept that describes the overall purpose of a project. An objective defines in measurable terms a specific task that needs to be accomplished to meet the goal. The following are examples as they relate to an energy efficiency project.

Goal: To Conserve Energy Through Landscaping and Building Design.

Objective 1: To reduce the impact of winter winds in a building through the use of a wind break.

Objective 2: To increase the amount of solar radiation reaching a building's interior through the appropriate design and placement of windows.

Objective 3: To decrease a building's cooling requirements by shading the building.

After formulating the goal, it is used to define the necessary objectives. It forces the designer to focus in on the most important issues or tasks. The objectives are then used to develop specific tasks that will work toward fulfillment of the objectives and successful completion of the project. For example, to accomplish the first objective, there are several tasks that need to be done. The site needs to be assessed to determine the feasibility of planting a windbreak. Climate and topographical conditions of the site need to be analyzed to determine the direction of winter winds. The type, number and location of trees and/or shrubs that will effectively screen out the wind needs to be chosen. The windbreak needs to be planted and maintained. Lastly, the windbreak should be evaluated to determine whether it is doing the job it was designed for or whether modification is needed. Successful completion of these tasks should mean that the objective has been meant and that progress has been made toward goal accomplishment.

Developing a Data Base

Once the goals and objectives are formulated, a list of necessary information can be developed. For a typical energy efficiency project utilizing landscaping and building design, a wide range of information is needed. The type, scope, and detail of the information needed will be dependent on project requirements. For example, the needs of a homeowner building a new structure on a site will differ from an individual developing a plan around an existing building. These needs also

vary from the requirements of a local government designing a community wide program. In the first case, the individual needs general climate data for the area and specific site data, such as topographical conditions and existing plants. The person can then use this data to design a structure and landscape the site for energy efficiency.

In the second situation, the individual requires the same climate and site data, but he also needs to assess the existing building to determine how to advantageously use the building and to pinpoint retrofit possibilities. The additional data defines the constraints that the existing building places on the design and illustrates how the building and site can be best utilized. The landscaping is then tailored to the existing circumstances or to possible modifications.

Informational requirements in the third case vary according to the type and scope of the project. The needs of a program for public building only differs from the requirements of a comprehensive community wide program. The basic climate data and site specific information for both types of projects is still necessary. For the comprehensive community wide project, the amount of information is increased due to the additional sites under development. If the sites are publically owned, then it is unlikely that data will be required on each building site throughout the community. The exception might be when policies or regulatory tools are being formulated. In this case, it may be necessary to inventory and assess areas by blocks, regions or topographic conditions as a base for developing policies or ordinances that encourage or mandate energy efficient design.

When collecting data, it must be tailored to meet the needs indicated by the goals and objectives. Information that doesn't aid in the design or evaluation of a plan is useless. Information that is in the wrong format or that is too general or too specific is also useless. For example, site specific information may be meaningless or difficult to use in a community wide plan, whereas, general community wide information may not be specific enough for an individual. Information is good only if it is useful to the person who needs it.

Develop a Plan

Most people like to start with this step rather than perform the background tasks. Jumping in without an adequate base will most likely decrease the effectiveness and increase the difficulty of a plan. With a solid understanding of the goals, objectives and tasks and a firm base of information from which to proceed, actually developing the plan can be reasonably easy. The data base may also indicate constraints and compromises that are necessary for the plan to be effective. "Wonderful" ideas may turn out not to be feasible or effective. A landscaping plan may be attractive but ineffective in providing shade or a windbreak.

Specific plan development is wholly dependent upon goals, objectives and specific site characteristics. There is no one plan that can be applied to all sites. An ideal plan would be one perfectly suited to a site. The key points to remember when developing an energy efficient plan are:

- (1) Develop goals, objectives and a data base based on a desire to conserve energy through the use of landscaping and building design.

- (2) Design a plan using this information in conjunction with energy conserving landscaping and building design principles.
- (3) Develop a plan that is comprehensive and designed specially for each site. Try to tie together all possible energy conserving techniques.
- (4) Develop a plausible plan--one that can be implemented given potential constraints such as existing conditions or financial limitations. In the case of financial constraints it may be desirable for a plan to be implemented in stages.
- (5) Remember that a landscaping program needs maintenance, particularly a community wide program; develop a plan that can be maintained, both physically and financially. Crews and machinery need to be able to get to a landscaped area before it can be maintained and someone has to pay for it. Maintenance requirements vary with the type and location of landscaping done. Considering these requirements in the plan development stage can avert problems later.
- (6) Develop a plan that fits into other community objectives and plans. It is wasteful to plant shade trees along a street when the street is scheduled to be widened, unless this is considered when the trees are planted. An energy efficient plan may also further the goals of another plan if tied together in the planning stage. Perhaps a landscaping program for energy can also benefit park development or city beautification programs. Building design principles can be tied into capital improvement programs to buy, build or remodel buildings and may affect site selection. The plan shouldn't be developed in isolation but rather it should permeate into other areas of city operations. It should be a comprehensive plan.

Implementation

In order for a plan to accomplish anything, it obviously must be implemented. Too often plans are developed and then stored, perhaps out of procrastination, lack of financial resources, an unworkable plan or in the case of a community, lack of political support. A well designed plan can avoid some of these problems, but not all. It is often advisable to develop an implementation plan. This doesn't eliminate all problems, however, it's a progressive step.

An implementation plan should address several issues, such as a work schedule, a listing of financial resources, and ways to tie the program into other, perhaps ongoing, activities. In the case of a community program, a plan for gaining public and political support should be developed. These issues will be addressed in two sections, one aimed at individual needs and one dealing with community programs.

Individuals

Individuals need to concentrate on developing a work schedule and a financial plan. The work schedule should be a reasonable assessment of how much work can be done in a given time frame. Factors affecting this include appropriate planting times for selected species, the construction season, financial constraints, and if the individual plans to do the actual work himself, how much time is available and how much work can be done during this time frame. Overestimating the amount of work and time can lead to discouragement, procrastination and project failure. A realistic work schedule gets the job done in acceptable doses without hardships.

Assessing the financial resources available for the project is important to the work schedule, project completion and the avoidance of financial hardships. A work schedule ideal in other ways will fall apart if the financial resources are unavailable. Additionally, trying to do too much at once may cause financial problems. Assessment may also include investigating different funding sources for assistance, depending on the scope of work planned and the financial need.

Community Programs

The work schedule and financial arrangements for a community program parallel the requirements for an individual. The exception may be in the scope and complexity of the plan. A community-wide program is likely to have more work, possibly be more complex and/or varied and be more costly. The implementation plan needs to reflect these specialized needs.

A community plan needs to put considerable effort into two areas that can spell success or instant demise. These are garnering political support and tying into other community programs.

Tying into other community efforts such as capital improvement, park development and beautification projects may be a method for getting a plan implemented that might otherwise have been bypassed in favor of ongoing activities. If a choice between projects has to be made, an ongoing project has a better chance of surviving a cut. If a landscaping and building design plan is integrated into another project (as it should be anyway) then it stands a good chance of being carried along with the ongoing project. This should also enhance the degree of success as the project will be more comprehensive and wide-spread.

Attaining public and political support is necessary to get and keep the program going. Without this support, the project will likely be shelved or, if there is a negative response, it will be totally dropped. It's important to start building this support from the initial steps of project planning. This accomplishes two things. First, potential problems are encountered and resolved early, making the project more acceptable from the beginning. Secondly, the public and political entities involved feel like the project is their's because they've

had an opportunity to contribute to the project formation. This builds and strengthens the support base, making it easier to pass the project through the political approval process and easier to implement once approved. Springing a new project on political figures and the public can create a negative response simply because no one has heard of the project and have therefore been unable to participate in plan development. This decreases the chances for project approval and tends to make implementation more difficult or even impossible.

Gaining the necessary input and support can be accomplished through a variety of methods. Public hearings is a standard method and is often required. However, this often does not draw a large response from the community. An awareness and educational campaign combined with public meetings, the involvement of community organizations and the public hearings is more likely to build a stronger and varied support base. This take time, effort and expense but is usually well worth the investment.

Monitor and Evaluation

The degree of importance of monitoring and evaluating the program varies with the scope and complexity of the project. The larger and more difficult a project is, the more important this process becomes. However, even the smallest project can benefit.

Monitoring and evaluating is a way of assessing and documenting the success and problems of a project. The process should pinpoint problems that develop and improvements necessary to increase the project's success. It would be difficult to know if and why a project succeeded or failed without monitoring and evaluation. If this information isn't available, improvements are difficult to ascertain and replication is

more difficult. Maintaining an unsuccessful project or one plagued with problems wastes resources and damages the reputation and credibility of the local government. Monitoring and evaluating a project also creates a data base useful to subsequent projects.

SITE OR COMMUNITY ASSESSMENT

A site or community wide assessment is a part of developing a data base for the planning process. Although touched upon in the previous section, it deserves a more detailed discussion.

The components of an assessment includes climate data and analysis, existing building design and orientation, existing landscaping and specific site characteristics. These will be individually discussed in the following sections.

CLIMATE

There are several climate characteristics that are relevant depending on what is being planned. For example, wind data is necessary to plan windbreaks and ventilation; solar angles and degree days' are necessary for building design orientation and planning for shade, and the temperature range and seasonal patterns give important clues to design requirements. For instance, temperatures and seasons that are typically hot all year or with very mild winters, require emphasis on providing shade and ventilation, whereas, cold climates necessitate greater attention to reducing heating requirements.

Since relevant data depends on geographic location and the goals and objectives of a plan, it is inappropriate within the scope of this

discussion to go into specific details. It is sufficient to say that collection of climate data is essential to designing an effective plan and that it needs to be localized as much as possible. For example, information on the community where the plan is to be implemented is far more valuable than state or regional information. In cases where topography (as with hills) may have an impact, microclimate data on the specific site may be very useful. Microclimate data focuses in on such a small area that variations caused by localized conditions are considered. This information is particularly beneficial when dealing with one specific site.

Information is available from several sources. Most solar publications give solar angles by latitudes and some classify the country by climate regions. Often wind and degree days data is given for major cities. Sources for information more specific to a location include airports and other facilities that utilize meteorologists, the U.S. Meteorology Service and extension services associated with universities.

Once the information is collected, analyze it according to the requirements of the goals and objectives. For example, if a windbreak is desired, the wind data should be analyzed to determine the best placement of windows and overhangs. It's important to note that the information is worthless unless it can be analyzed and used in the development of a plan.

BUILDING DESIGN AND ORIENTATION

The concept of landscaping and designing buildings for energy efficiency is not restricted to new construction. New construction is ideal because it allows maximum use of energy conserving concepts, but

in many cases retrofitting plans can at least approach the efficiency of a new building. Before retrofitting can begin, a thorough evaluation should be performed to analyze existing conditions. How is the building oriented on a site--is a garage on the south side or do living or work areas front the south? Where are windows located and how does the interior layout relate to the site and to the south? What is the building constructed of--is there adequate insulation and thermal mass in place? If not, can they be added without incurring structural problems or excessive expense? The entire building and site should be looked at as comprehensively as possible to determine what exists and what the potential is. Retrofitting always presents constraints and compromises because one has to work with present conditions and limitations. In rare cases, retrofitting may be so extensive that this doesn't apply. However, retrofitting usually implies work done on a facility within the form of the building.

Because of these limitations, it is especially critical to consider as wide a range of options and combinations as possible. The more the concepts are tied together, the better the plan will work, resulting in greater energy efficiency. For example, it is essential to tie together the placement of thermal mass with the placement of south-facing windows. The windows won't be as beneficial without thermal mass to store and transport heat gained through the windows. Thermal mass will be of little value if there is no heat source for the mass to absorb.

In a community program, building design and orientation take on a different scope of meaning. It is not always possible to evaluate each building individually, although that may be included as part of an energy audit program. If this isn't possible, a broad evaluation based on blocks,

neighborhoods or some other delination of the community will assist in plan development. This evaluation should be as detailed as possible within time and financial constraints. Potential information may include general orientation of a neighborhood or subdivision. What direction do most of the buildings face? Are there other buildings blocking solar access? If this is the case, south-facing windows will be worthless as a heat source. How energy efficient are the building designs, and what possibilities exist to improve efficiency? Weatherization programs will improve efficiency by better retention of the heat captured through building design. In a community program, it is difficult to impact a large number of individually owned buildings because the individual has to be willing and able to make changes. To encourage retrofitting in individually owned buildings, an incentive, educational and regulation program is necessary. These will be discussed in greater detail in the next chapter.

SITE CHARACTERISTICS AND EXISTING LANDSCAPING

This inventory and evaluation of existing site characteristics goes hand in hand with an evaluation of the building. The check list in Figure 13 gives a sampling of potential data that is useful in plan development. The purpose of inventoring and evaluating site characteristics is to utilize what exists and to determine all the possibilities for developing an energy efficient plan. For example, existing roads, slopes, plants, lakes, streams and other natural characteristics of the site are important in plan development. Existing roads, water bodies and slopes are generally going to have to be utilized in their present form without major restructuring. This might be a constraint or it might be

an asset; an evaluation is necessary to determine which category the characteristic fits into and how it can best be used in a plan. Because of a tree's slow growth, a mature tree should be used if at all possible. If it cannot be used in an efficient design and is a detriment to such a design, then consider cutting it down. The practice of routinely clearing a site before construction begins may make the space easier to work in but can be very wasteful of natural resources. This is especially true when trying to use shade trees and windbreaks. Utilizing what exists may make the windbreaks and shade trees effective years before new plantings could have a significant impact.

In a community wide plan, the idea is the same but with wider coverage. If time and money allow, the ideal method is to maintain a tree inventory and a detailed accounting of natural characteristics. Roads, topography and many other characteristics are illustrated on various maps of a community making the data readily available. This source doesn't usually contain information on specific resources such as trees, which is why a tree inventory is useful. The reasoning for collecting and analyzing this information is obvious. A plan incorporating tree planting and other landscaping can't be effectively implemented without knowing what exists and what needs to be added.

The key point again is to develop a plan that effectively conserves energy in a comprehensive manner and that makes the best use of available resources. To do this, information on what resources exist is necessary, hence the need for a thorough inventory and evaluation of the site and buildings.

SITE EVALUATION CHECKLIST

Figure 13

CLIMATE

- Lattitude and solar angles
- Prevailing winds for summer and winter
- Temperature ranges
- Seasonal temperature variations
- Climate classification (cool, temperate, hot-arid, hot humid)
- Unusual characteristics specific to a region (heavy fog, pollution or other solar inhibiting factors)
- Percentage of sun available (or percentage of cloudiness)

BUILDING ORIENTATION AND DESIGN FOR EXISTING STRUCTURES

- Orientation of the building on the site (N-S, E-W Axis or other)
- Window size and placement
- Existing thermal mass: amount and location
- Adequacy of existing insulation
- Internal layout
 - Location of main living areas, work/utility areas and garages, closets
- Building Materials

POTENTIAL FOR MODIFICATIONS

- Can windows be changed
- Can internal layout be rearranged
- Can insulation and thermal mass be added

EXISTING TOPOGRAPHY, LANDSCAPING AND OTHER NATURAL RESOURCES

- Roads in relation to the site
- Trees for potential shading/windbreaks
- Topography, including slopes
- Water bodies

CHAPTER IV

IMPLEMENTATION FOR COMMUNITY PROGRAMS

Even the best energy efficient plans will not conserve energy unless they are implemented. Implementation is, therefore, the key to insuring an effective program. It is also one of the tougher aspects of the planning process. This chapter will summarize various legal and planning tools that are available to a community to encourage or mandate that energy efficient plans be utilized in new and rehabilitation projects. In the second part of the chapter, educational and incentive programs will be discussed along with other community programs that could be tied into an energy conserving plan.

COMPREHENSIVE PLANS, POLICIES AND RESOLUTIONS

There are several planning tools available to a community to encourage, advocate or mandate energy conservation through landscaping and building design. Such tools include comprehensive plans, policies and resolutions.

Comprehensive plans are developed after a thorough study and analysis of a community. They are the basis or foundation for activities and guides the community according to formulated goals and objectives. A plan includes elements such as transportation, housing and land use. Other elements vary by plan and community. The key is that the comprehensive plan is, as its name implies, comprehensive, and it is designed to guide or direct activities. For these two reasons, energy conservation measures can and should be integrated into the plan. Since the plan is formally

adopted by the community government, this gives formal recognition and adoption to energy measures. It also insures that these measures are incorporated into community activities.

How energy conservation is addressed in a comprehensive plan depends on the community, goals and objectives and the plan itself. Provisions may range from broad statements indicating interest to a detailed listing of planning principles to utilize energy efficient concepts, to very specific statements addressing particular concepts, such as landscaping. Since the plan is designed to be the foundation for future action, it is desirable to incorporate provisions as strong and specific as possible.

Not all communities develop comprehensive plans. They may have segmented plans, each dealing with specific topics or the community may be so small that they don't have the resources for developing extensive plans. A community may rely instead on a set of policies and resolutions to direct activities. In some cases this provides greater flexibility for responding to issues. Instead of having to redo or amend a comprehensive plan, which is typically a long and involved process, policies and resolutions on individual issues can be quickly formed and adopted. This may mean more rapid utilization of the concepts.

In this process, policies are formulated and then adopted by resolution by the community governing body. The resolution may then be used as the initial step in enacting an ordinance or regulation. Resolutions express the opinions of the people adopting them, while ordinances are a part of the law. Obviously the ordinance will have greater impact, but the resolution is a first step in gaining community support and recognition of the concepts.

ORDINANCES

An ordinance is a statute enacted by a legislative body; in the case of a community, it is enacted by their governing body. Ordinances can cover a wide range of activities within a community. If a community has the legal right to enact an ordinance, it can address, through regulation and within legal bounds, activities associated with landscaping and building design for energy efficiency.

For example, some communities may have regulations on the placement of hedges in relation to the location of a building. If these regulations are a barrier to energy efficient design, then the ordinance can be amended to allow the needed changes and encourage energy efficient design.

An ordinance may be formulated to develop and maintain a comprehensive plan for planting and maintaining shade trees, windbreaks and other landscaping components. There are innumerable ways to develop and use ordinances to enhance energy efficient designs within a community. The use of ordinances depends on the community needs, goals and innovation.

The zoning ordinance is a standard and widespread use of an ordinance. Zoning is the regulation by a district under its police power of the height, bulk and uses of buildings, the uses of land, and population density. Community plans should serve as a rational base for the formation of the ordinance. The zoning ordinance gains importance in energy efficient planning mainly because of the regulation of the height, bulk and spacing of buildings. Buildings next to each other may impact the amount of sun that reaches a building, and in some cases can completely block out access to sunlight and ventilating winds. Zoning can be used to protect a person's access to the sun and wind. Since ordinances generally permit

existing uses, the ordinance has the most impact on areas yet to be developed. It is an important concept when planning subdivisions, planned unit developments or other large complexes. To provide specific examples, the following possibilities illustrate possible zoning provisions to protect solar access:¹

- 1) Reduce maximum allowable building height
- 2) Reduce minimum frontage requirements for lots on east/west streets so that lots are deeper and solar access is improved
- 3) Decrease side yard requirements and increase front and rear yard requirements for lots on east/west streets--the result is narrower buildings from front to back and increased solar access
- 4) Use zero lot line zoning to increase the size of south lot area under the control of the landowner.

Protecting solar and wind access is very important as the most carefully laid and implemented plans will fail should a new building go up that blocks the sun and wind from the existing structure. Integrating energy efficient design concepts into a zoning ordinance can further community use and support.

BUILDING CODES/STANDARDS

Building codes and standards were originally designed to protect the building's occupants. This includes standards to insure sound construction, fire safety, sanitary provision of water and sewer facilities and an occupant's health and safety. For example, standards involving the size and number of windows was originally put into building codes to insure that an occupant received enough light and ventilation. This was necessitated by high density construction that packed buildings together, cutting off a good portion of the available light and air. The

standards have evolved to incorporate new developments, such as fire alarms. Until recently, the codes did not consider energy efficiency design or standards. There has been recognition that the need for energy efficient design is here to stay and should be incorporated into building codes. Standards for the various building design components that impact energy efficiency are currently being developed, but as yet are not a part of the accepted codes.

A community adopts or develops the building code of their choice. In the case of energy efficient standards, this flexibility in code adoption gives a community the opportunity to develop energy efficient standards of their own and incorporate them within the framework of the building codes. Davis, California has developed standards suited for their particular climate and needs and the State of Michigan has developed a Michigan Energy Code formulating energy efficiency standards. These are just two examples to indicate that this can and is being done.

Using building codes in this manner can insure that buildings meet at least minimal energy efficient standards. The codes do not always insure the maximum energy conservation possible, but they are a start. Development of codes can also be used to raise the consciousness level of the community and their interest may bring on a greater demand for energy efficient buildings.

Specific standards depend on the local climate and needs, goals and objectives as developed within the community. Possible considerations include but are not limited to insulation standards, square footage and placement of windows, and type of building materials. When a thermal efficiency standard is developed, a building has design flexibility as long as the standard is met.

Building codes are an extremely useful and effective regulatory tool but they must be designed with extreme care. They need to accomplish the goal of energy efficiency while being workable, reasonable, enforceable, and cost effective. Energy efficient designs do not have to be costly, but hastily designed codes can increase building costs, mainly by mandating unnecessary procedures, or the use of more expensive construction material. Often thermal efficiency standards are useful in providing flexibility and in keeping the costs down.

PLAN REVIEW

Some communities use a plan review system. For example, a developer plans out a subdivision and then submits his plans to a community agency for review and approval. Approval must be granted before the developer can obtain necessary building permits. The review has to be based on a set of rules. If energy efficient design concepts are integrated into the rules, then the review panel has an ideal opportunity to insure that the concepts are well utilized. The rules can include a wide range of concepts, standards or codes and can address landscaping and building design. It is important to remember that the review must have a firm and rational basis in the rules for it to be binding and fair. Assisting builders and developers in designing their plans will help in gaining support and furthering the program. This can reduce their potential loss of time and money and can garner their support.

INCENTIVE/EDUCATION PROGRAMS

Mandatory regulations usually insure that goals are met and are therefore desirable. However, regulations may infringe on peoples' rights or their perceived rights, cause undue hardship, financial stress or may be impossible to pass. Whatever the reason, incentive and education programs can be useful in developing community support and encouraging desirable activities. They should be used even when regulations exist because of their value in gaining understanding and support for a program.

Incentive programs entice people into doing something by offering them something in return. The most widespread and popular incentive is financial. These generally include tax credits, rebates or the exclusion of certain improvements from property tax assessment increases. Incentives may also include grant programs or low interest loans. A well designed incentive program can be well worth the money spent and may cost less in the long run than the administration of a regulatory program. Unfortunately, these programs don't tend to have as rapid or widespread a response as do mandatory programs.

Educational programs strive to inform and educate people, thereby encouraging them to utilize the selected concepts. Generally, education programs work best when done in conjunction with incentive and mandatory programs. One problem is to effectively reach the massive audience in a community. Messages have to be targeted for various audiences and then disseminated to reach the specified audiences. For example, materials designed for adults may be wholly inappropriate in grade schools and vice versa. An effective educational program requires considerable time and

resources to design and disseminate the informational materials.

Educational programs generally don't have an instant impact, but may have a long lasting effect.

COMMUNITY PROGRAMS TO TIE TOGETHER

There are various types of programs that energy efficiency designs can be tied into. Two of the most obvious examples include capital improvement projects and landscaping programs.

Capital improvement projects may include building or renovating buildings, streets and other capital intensive and long lasting projects. They would not include maintenance type programs. Building design and landscaping can be incorporated into capital improvement projects; the effectiveness will depend on the type and extent of the project and how well the concepts can be integrated into the project design.

Landscaping programs may include a massive tree planting plan; shading and windbreak designs can easily be incorporated into the plans. Often the proposed costs of the original program are not increased; the energy efficient design concepts are simply integrated into the program plan. Again, the effectiveness depends on type and extent of the program and on how well the concepts can be integrated. Concepts introduced at the beginning design stages tend to be more effective.

FOOTNOTES

¹Martin Jaffe and Duncan Erley, Protecting Solar Access for Residential Development: A Guidebook for Planning Officials. Washington, D.C.: Superintendent of Documents, U.S. Government Printing Office, May 1979. p.50.

CHAPTER V

SUMMARY

The need exists to develop the energy potential of all renewable energy and conservation techniques, however small the contribution when compared to the total needs of the nation. As a nation, we can no longer wait for a miracle to happen, for a single source of energy to be developed that will meet all our needs, or for our resources to run out. We have to recognize that we have an energy problem and begin to resolve it. This will be a long and in some ways, perhaps, a painful process. The quicker we respond, the more likely we will be able to meet the challenge and resolve the problems with a minimum of pain and cost.

Communities and individuals should not and need not wait for the federal or state governments to act. There are resources that can be developed at the local level. One such program is the use of natural resources to reduce energy consumption and develop energy efficient communities. This type of program can be energy efficient, comfortable, aesthetically pleasing and can contribute to the overall stability and attractiveness of a community.

The key points to remember when developing a program utilizing natural resources in landscaping and building design are outlined below:

1. Develop goals and objectives. This refines and focuses ideas and needs, improving the chances for a successful project.
2. Assess the site and any surrounding features that impact the site. This will identify problem areas and the potential for energy efficient designs. It will also provide the data base necessary to formulate an effective plan.

3. Develop a comprehensive and site specific plan. To make natural resources work effectively, a plan has to be designed in conjunction with what is available. A comprehensive plan will tie together various concepts to improve the efficiency of the design. Concepts involving the use of natural resources generally work better when tied together in a package. For example, windbreaks and shade trees have to be appropriately located in relation to the structure. Thermal mass needs to be used in conjunction with site orientation and window placement.
4. Community programs should be integrated into other community plans and programs. This increases the comprehensiveness of the program and improves the program's effectiveness and chances for implementation.
5. Develop an implementation plan that is realistic in terms of available resources. An overly ambitious implementation plan may never get off the ground if the resources are unavailable. A plan carefully designed to match resources has a better chance for overall success.

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