Building Siting Considerations

WORKSHOP IN

THE PRACTICAL ASPECTS OF

SOLAR SPACE AND DOMESTIC WATER HEATING SYSTEMS

FOR

RESIDENTIAL BUILDINGS

MODULE 2

BUILDING SITING AND ARRANGEMENT

SOLAR ENERGY APPLICATIONS LABORATORY

COLORADO STATE UNIVERSITY

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INTRODUCTION

The regional climate and microclimate should be taken into consideration to properly orient a building at a particular site. In many urban areas there is little freedom to optimize the building site on a given plot of land. However, when new developments are being planned or new houses are being built in suburban areas, consideration to siting can help to minimize energy uses for heating and air conditioning. Proper orientation of the building on the lot regardless of location and landscaping can reduce energy uses for space conditioning.

OBJECTIVES

The purpose of this module is to acquaint workshop participants to general considerations in designing and planning the layout of new buildings to minimize energy use for heating (and cooling) the building space. The participant should be able to:

1. Recognize the factors which should be considered to properly orient a building at a given site to optimize energy use for space conditioning.
2. Recognize design features of the building to minimize heat losses in the winter and heat gains in the summer.

SITING AND LANDSCAPING

To minimize energy use for space heating it is desirable to design and orient a building for the greatest southern exposure during the winter

to maximize solar heat gains. However, to minimize heat gains during the summer, it is desirable to minimize the southern exposure. A compromise is obviously needed to optimize heat gains for the year and the optimum dimensions of a building is dependent upon local climatic conditions.

While heat gain is one consideration to building orientation, heat loss is another. Buildings with large northernly exposure can expect to experience large heat transmission and infiltration losses during the winter, hence it is advantageous to minimize wall areas to the north, or to shelter the north sides with wind breaks. In cool and temperate regions of the country, rectangular-shaped buildings with ratios of east-west to north-south lengths from 1.1 to 1.3 will maximize heat gains and minimize heat losses in winter.

Heat losses and gains through windows are much larger than through walls. Therefore it is important that the ratio of window area to wall area be examined. Usually building codes will apply to govern minimum window areas in relation to the total wall area of a building.

The use of trees or wind breaks such as fences and earth berms can assist in reducing heat losses. Trees can also be used to shade south facing walls and windows to reduce heat gains in the summer. Buildings located on the south slope of a hill are obviously more sheltered from north winds than are buildings which are on the west or north slopes and may require less heating energy. Fences and other external structures can be used to deflect winter winds over or around buildings to decrease infiltration heat losses. In summer, ventilation and circulation of air within a building are of primary concern and doors and windows should be located to encourage summer ventilation.

Some suggestions for site modification and landscaping to conserve energy use in buildings for heating and cooling are listed below and shown on Figures 2-1 and 2-2.

1. Plant deciduous trees toward the south side of the building to decrease summer heat gains. As the leaves fall in the autumn, the trees will allow solar heat gains through windows on the south side of the building.
2. Coniferous trees planted on the north side of the building will provide shelter from north winds. The row of trees may extend from the north-west to north-east around the building.
3. Fences of the proper height will provide wind shelter.
4. Patios may be used to temper indoor temperatures.
5. Earth berms placed strategically on a site will direct wind flow over a building. Berms should be provided with ground cover.

BUILDING DESIGN

ROOM ARRANGEMENT

Because the total floor area of a building is needed for functional living, arrangements of rooms within a building are usually governed by individual tastes. From the viewpoint of energy conservation however, there are some variations in room arrangement which may serve the occupants as well as reducing heating loads.

Space which is not occupied for many hours of the day, such as mechanical equipment rooms, corridors, closets and utility rooms can be maintained at a lower temperature and located on the north side of the building as shown on Figure 2-1. If the layout of the lot is suitable, a garage on the north side of the building is also an excellent buffer

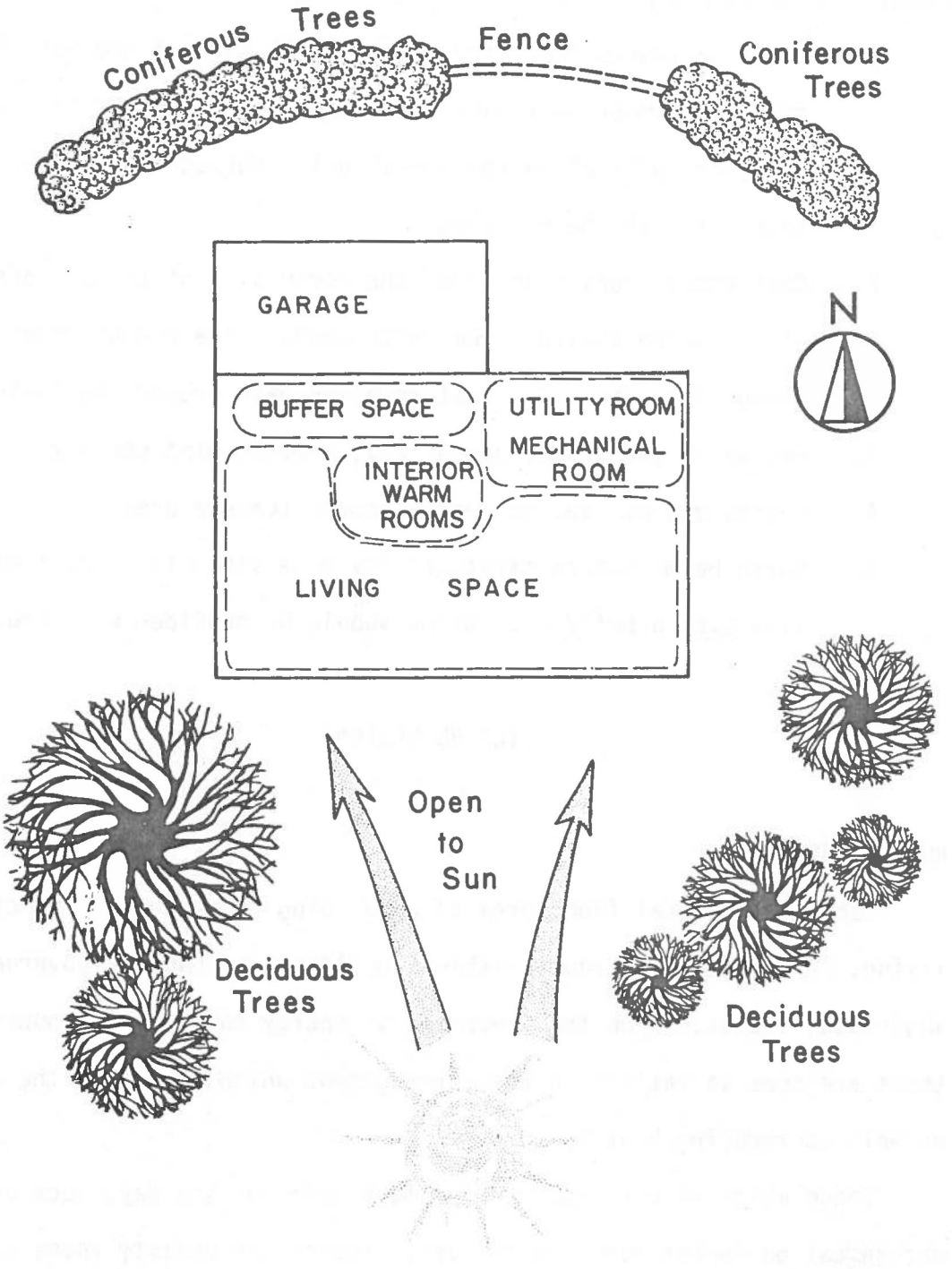

Figure 2-1. Siting, Landscaping and Room Arrangements

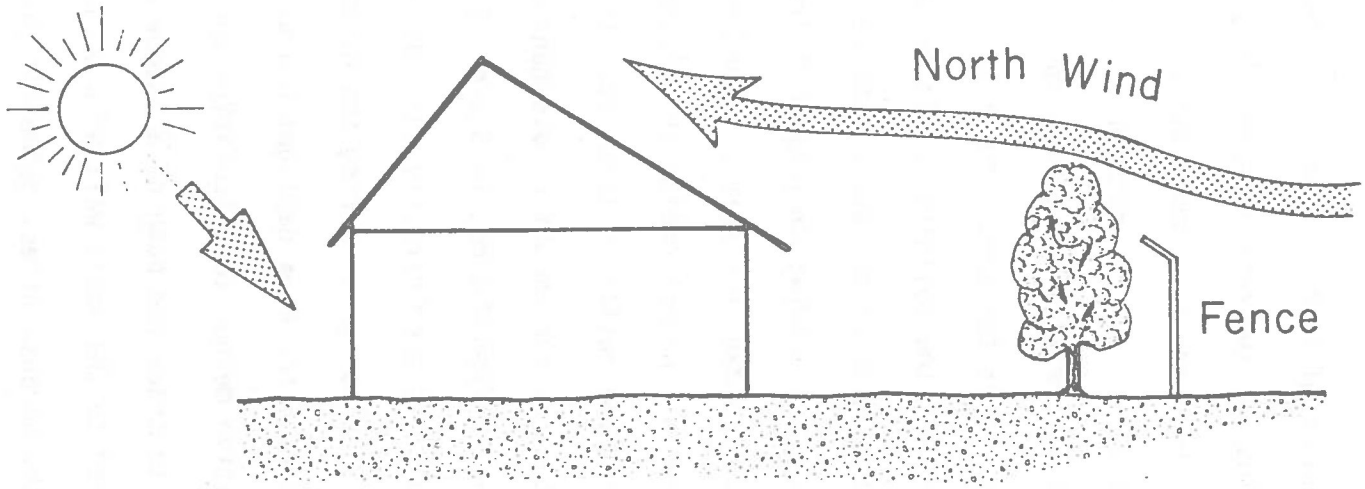

Figure 2-2. Sheltering a Building with Trees or Fence

for the living space from the north winds. Living space should be located along the south side of the building.

WINDOWS

A large amount of heat is lost from a building through windows. To minimize heat losses, two or more panes of glass with dead air space should be installed. The type, size and shape of windows should be based on location in the wall. On the west and south sides, it may be advantageous to use glass with a reflective surface to shield out the intense summer sun, but during winter the same windows will reduce heat gains. Windows on the north side of the building should be double glazed and small. If the window area exceeds 10 percent of the wall area there can be greater heat loss through the windows than through the insulated walls.

Overhangs, as shown in Figure 2-3, and wingwalls can reflect or shade windows effectively. Proper design and placement can block the sun in summer and allow penetration of solar rays into the building during the winter. To determine the amount of overhang desirable, calculate the position of the sun from 9 a.m., to 3 p.m. For effective shading, the summer sun should not beam directly into the room during those hours, and for effective solar gains during the winter, the sun should penetrate into the room during the same daylight hours.

An alternative method to calculating sun positions for different times of the year is to trace the path of a shadow cast by a horizontal beam (or staff) nailed to the south wall of a building. The staff can be of any length, because direct geometric proportioning can be used to determine the desired overhang length.

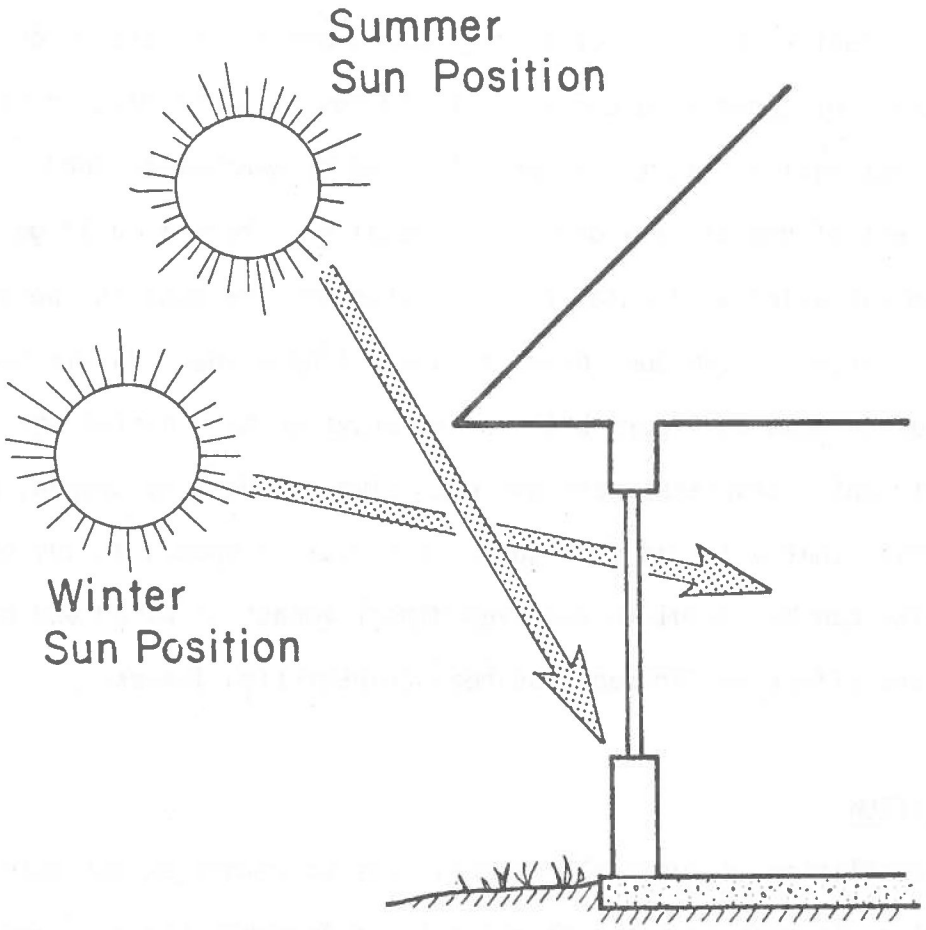

Figure 2-3. Window Overhang

Windows are primary sources for heat losses from air infiltration. Tightly fitted windows are a prime requisite for good construction. The type of window selected will determine how tightly they can be installed. Sliding panels must be loose enough for operation and will allow more infiltration than hinged panels.

DOORS

Controlling heat losses through doors and cracks around doors is important for conserving energy in buildings. To minimize infiltration, doors must seal as tightly as possible and be weatherstripped. Regardless of how tightly doors are installed, there is a large amount of cold air which will enter the room whenever the door is opened, and is intensified if the door opens to prevailing winds. An air lock, or vestibule, shown on Figure 2-4, can be provided to minimize the volume of cold air which displaces warm air each time the door is opened, provided of course, that only one door to the air lock is opened at any one time. Wingwalls can be useful in reducing direct impact of winds and storm doors are effective for reducing heat transmission losses.

VENTILATION

Ventilation is desirable in buildings to remove excess warm air and to replace it with cool air to maintain comfortable temperatures in the building. Except for open doors and windows, forced ventilation is not usually provided in residential buildings. One exception is attic fans installed to keep the attic air cool during the summer. By ventilating the attic, there will be less heat gain into the rooms from a warm ceiling.

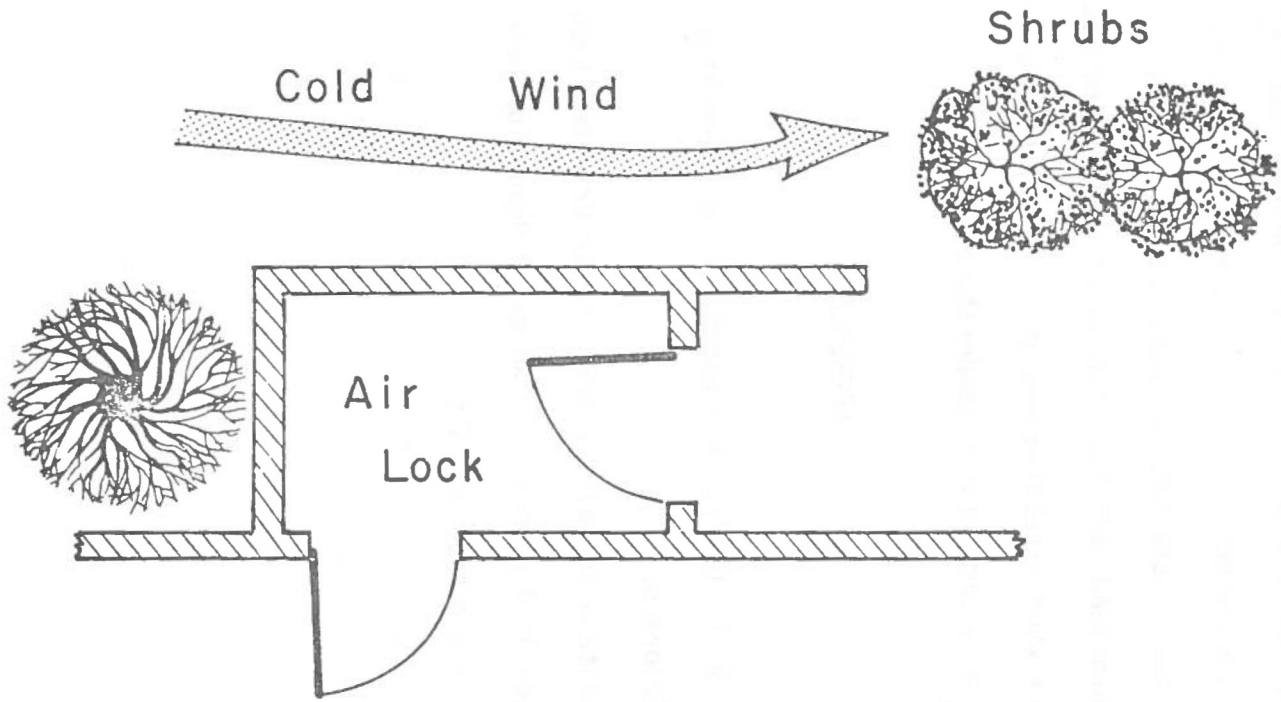

Figure 2-4. Air Lock (Vestibule)

If an attic fan is provided, a ceiling fan may be considered to circulate cool outdoor air into the building and exhaust warm room air to the attic.

Depending upon the building design, options may be provided for opening high level windows to draft out warm air. Buildings designed with high ceilings may create natural ventilation, to a limited extent, if openings are provided near the high point. A problem with high ceilings exist in winter when excessive heating is necessary to keep the lower living levels to a comfortable temperature.

REFERENCES

1. Crowther, R. L. (1977) Sun Earth. A. B. Hirschfield Press, Inc., Denver, Colorado.
2. Arizona State University (1975) Solar Oriented Architecture. ASU College of Architecture, Research Report prepared for AIA Research Corporation and NBS.