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## EC80-2053 Planning an Energy Efficient Home

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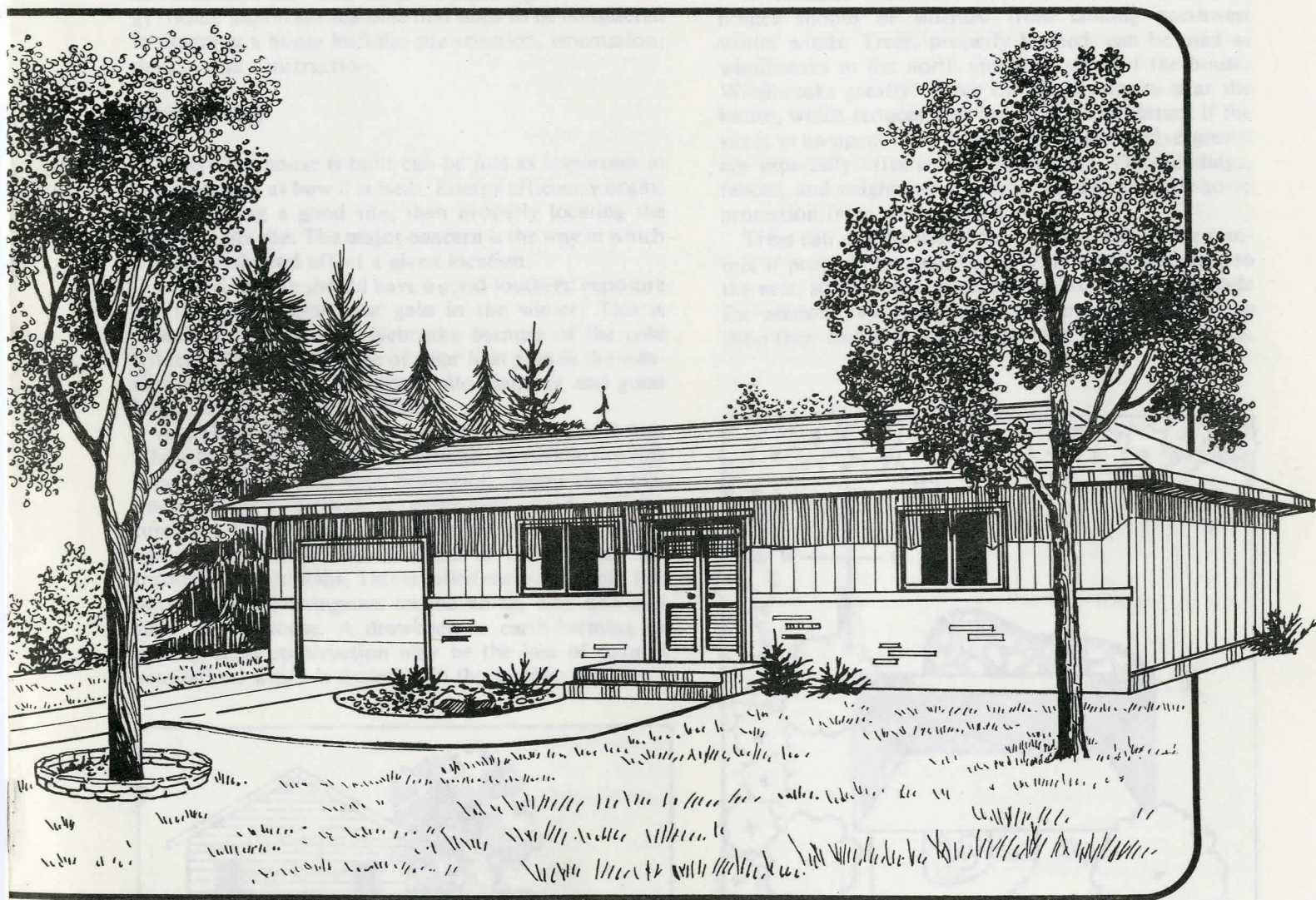
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# Planning an Energy Efficient Home



EXTENSION WORK IN "AGRICULTURE, HOME ECONOMICS AND SUBJECTS RELATING THERETO,"  
THE COOPERATIVE EXTENSION SERVICE, INSTITUTE OF AGRICULTURE AND NATURAL RESOURCES,  
UNIVERSITY OF NEBRASKA-LINCOLN, COOPERATING WITH THE COUNTIES AND THE U.S. DEPARTMENT OF AGRICULTURE  
LEO E. LUCAS, DIRECTOR



# PLANNING AN ENERGY EFFICIENT HOME

by

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Extension Specialist (Housing and Interior Design)

Planning to build a new home? Shopping for a new house? With energy costs sky-rocketing, energy conservation has become an important consideration in design of today's dwellings.

There have been a variety of "energy-saving houses" built in recent years. Many have been constructed under the sponsorship of utility companies, building manufacturers, or universities. These experimental houses have demonstrated the value of good planning to save energy. Some important features that need to be considered in planning a house include: site selection, orientation, design, and construction.

## Site Selection

**Where** the house is built can be just as important in saving energy as **how** it is built. Energy efficiency begins with selecting a good site, then properly locating the house on the site. The major concern is the way in which the **sun** and **wind** affect a given location.

Ideally, the site should have a good southern exposure for maximum solar heat gain in the winter. This is especially important in Nebraska because of the cold winters. The disadvantage of solar heat gain in the summer can be reduced by proper site planning and good house design and construction.

Additional savings can be gained by a house built into a hillside or partially into the ground. Earth can provide some insulation and wind protection. Below the frost-line, soil has a relatively constant year-round temperature. If a hillside is not available, earth can be pushed against the side of the structure to reduce heat loss through exterior walls. This is called earth-berming. It is particularly advantageous on the north, west and east sides of the house. A drawback to earth-berming or underground construction may be the loss of natural ventilation, which is desirable in the warmer seasons.

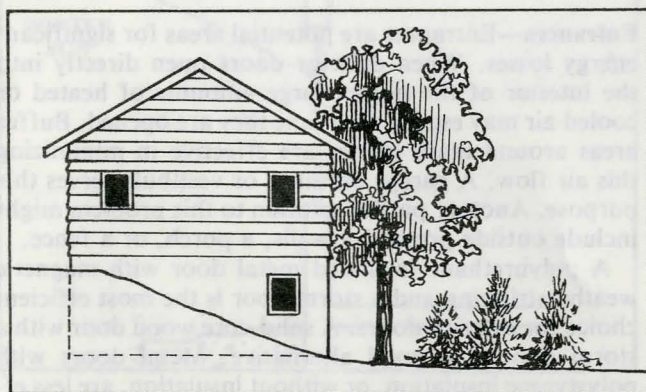


Figure 1. House built into south slope hill.

Careful planning is needed for underground construction or earth-berming. Proper construction techniques, waterproofing and planned drainage are all needed to prevent moisture problems. It is best to work with a professional experienced in this type of construction.

## Wind Protection and Shade

In climates with cold winters, such as Nebraska, homes should be shielded from chilling northwest winter winds. Trees, properly located, can be used as windbreaks to the north and west sides of the house. Windbreaks greatly reduce the wind velocity near the house, which reduces heat loss. This is important if the site is in an open, rural area, or on a hilltop. Evergreens are especially effective as windbreaks. Out-buildings, fences, and neighboring houses can also provide some protection from winter winds.

Trees can also be useful to provide shade in the summer if properly located. Large deciduous trees, close to the east, south and west sides of a house provide shade for windows, roof and walls. In the winter, these trees drop their leaves to allow solar heat gain in the house.

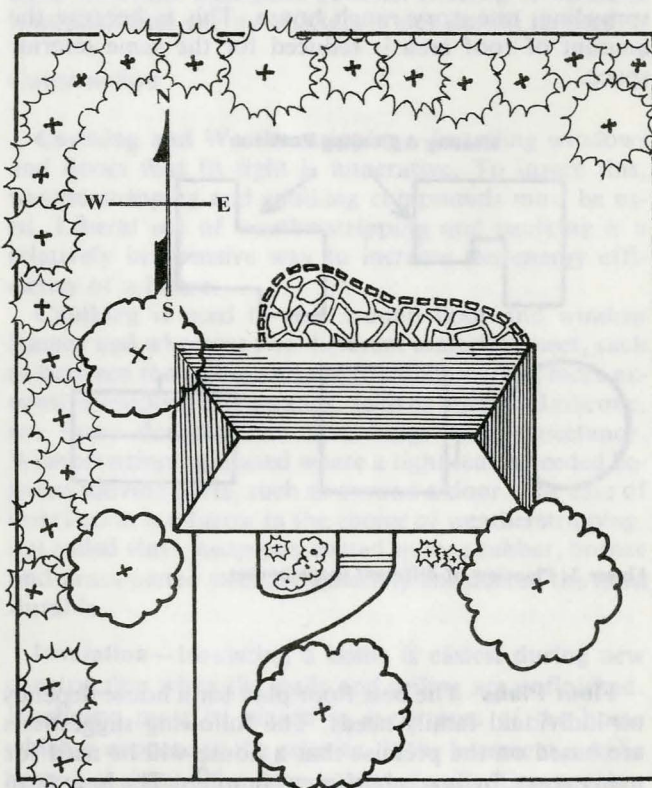


Figure 2. Plan view of house with windbreak and shade trees.



More detailed information on planting and locating windbreaks and shade trees, and landscaping for energy efficiency, is available from the Cooperative Extension Service Office in your county.

## Orientation

The long or main axis of the house should run east/west. This places the longest sides on the north and south, and gives the house maximum southern exposure—a benefit in the winter. It also limits the western exposure of the house, which reduces summer heat gain from the late afternoon sun.

Garages and other unheated areas of the house should be on the north or west sides of the house. These can serve as a buffer from cold winter winds.

## Design

**Size and Shape**—Before selecting a house or floor plan, carefully analyze present and future space requirements. A house should be only large enough to meet your needs. Generally, the larger a house, the more energy it takes to heat and cool it.

The shape of a house can also contribute to energy efficiency. Reducing the amount of exterior wall area or roof area can reduce the amount of winter heat loss.

The most energy efficient shape is a circle. This is because a circle has the greatest interior area, when compared to exterior diameter or perimeter, of any geometric shape. The next best alternative is the square plan. Both are more efficient than a long rectangular, L-shaped, or other spread out design. Generally, a multi-story house will cost less to heat and cool than a sprawling, one-story ranch house. This is because the amount of roof area is reduced for the same interior space.

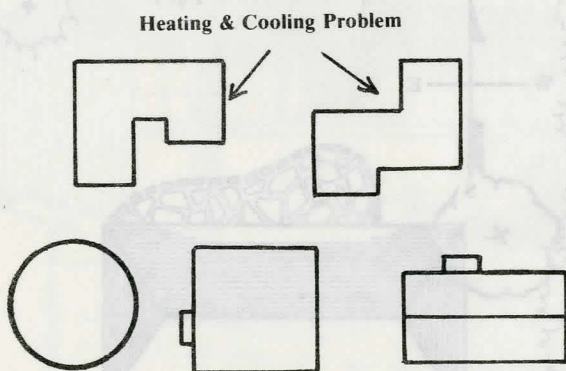


Figure 3. Planview of different shape houses.

**Floor Plans** - The best floor plan for a house depends on individual family needs. The following suggestions are based on the premise that a house will be used for many years, by several different families. The long term benefits of energy efficient arrangement are given critical consideration.

An "open" plan which has as few partitions as possible is desirable for main living areas such as family room, kitchen and dining area. This allows good heat distribution. In contrast, infrequently used areas, such as bedrooms and bathrooms, should be designed with doors that can be closed when the rooms are not in use. Locating these rooms in the same area of the house would allow the entire wing to be closed off. This is known as "zoning" a home.

Limited use areas such as formal dining room or formal living room require extra energy for heating and cooling. Rooms designed for multi-use may be more desirable, from the standpoint of energy efficiency. If a limited use room, such as a dining room, is desired, it is best planned so it can be shut off. This way the room is only heated or cooled when in use.

Location of different rooms in the house should be considered when evaluating different floor plans. Areas used frequently during daylight hours should be oriented to the south. Infrequently used spaces and those requiring little or no heat are best on the north (Table 1). Rooms that are sources of heat, such as kitchens and laundry areas, might also be located on the north or east.

Bedrooms not used during daylight hours should be oriented to the north. Whenever possible avoid placing a bedroom on the west side of the house. The afternoon sun in summer can heat the room to uncomfortable temperatures requiring air conditioning to cool it before bedtime. The west side is also a poor choice for family/living areas that are frequently used in the late afternoon and early evening. Outdoor living areas, porches, or rooms used only in the summer are best located on the north or east sides, away from the afternoon sun.

Table 1. Suggested location for the different areas in a house.

Space	Suggested Location			
	N	S	E	W
Bedroom	x		x	
Family/Living		x	x	
Kitchen	x		x	
Play Space		x	x	x
Work/Hobby	x	x	x	x
Storage/Garage	x			x
Bathroom	x			
Laundry	x			
Eating/Dining		x	x	

**Entrances**—Entrances are potential areas for significant energy losses. When exterior doors open directly into the interior of the house, large amounts of heated or cooled air may escape each time they are opened. Buffer areas around main entries are effective in minimizing this air flow. A garage entrance or vestibule serves this purpose. Another partial solution to this problem might include outside protective walls, a porch, or a fence.

A polyurethane insulated metal door with magnetic weatherstripping and a storm door is the most efficient choice for exterior doors. A solid-core wood door with a storm door is a good alternative. Metal doors with polystyrene insulation, or without insulation, are less effective than a solid-core wood door. A tight-fitting storm door is recommended with all types of doors. The



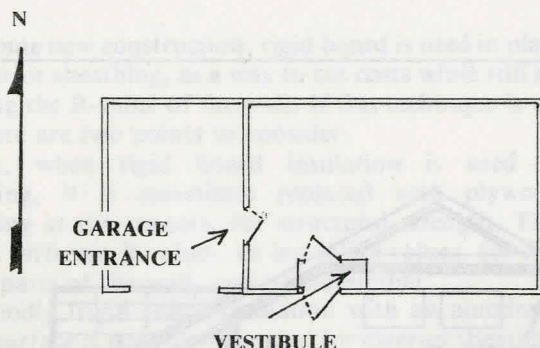


Figure 4. Vestibule and Garage Entrance. Vestibules reduce energy loss by providing two doors (only one of which is open at any moment) separated by a small unheated or uncooled air space.

storm door creates a dead air space, which increases the insulation values and reduces air infiltration.

**Windows**—It is often assumed that a house with a large amount of window area uses more energy than one with less window area. This is frequently true. However, a house with windows that are well-designed, well-located, and used properly can actually save energy.

In the winter, the south side of a house receives the most intense sun. In summer, the sun's rays are most intense on the southeast and southwest. To gain needed heat in the winter, the south side should have the largest window area.

To avoid excessive heat gain in the summer, southern windows should be shaded by a roof overhang or other means of exterior shading. The key is to stop the sun before it enters the house through the windows. It is many times more effective to stop the sun with an exterior projection or shade than with interior draperies, shades, or window film.

Due to the change in the sun's angle from winter to summer, a properly constructed overhang shades the window in summer, yet allows the winter sun's warmth to enter the home. In Nebraska, a general rule of thumb for a typical one story house is that a southern overhang should be a minimum of 30 inches wide.

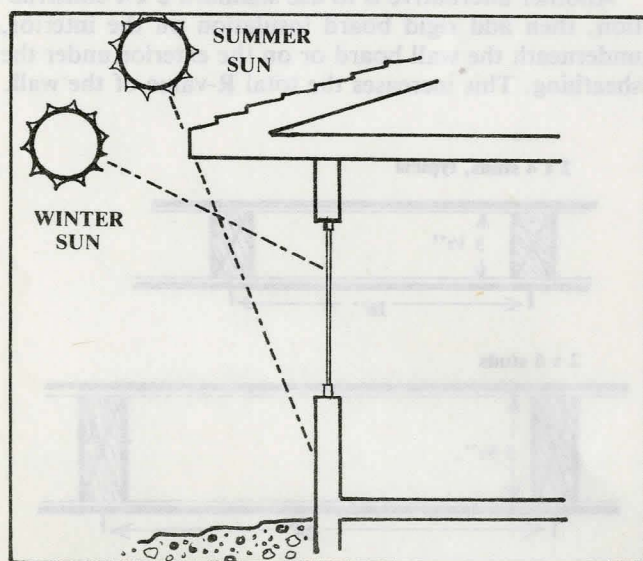


Figure 5. Window with overhang blocking out high summer sun and allowing low winter sun to enter.

If the overhang of the roof is insufficient, an awning or operable shutter can shade the windows. As previously discussed, deciduous shade trees are also effective.

Northern windows should be kept to a minimum in size and number. They receive no direct sunlight and are a particular source of winter heat loss.

Windows should be planned to take advantage of natural ventilation, which can help reduce the need for summer cooling. Windows on opposite sides of the house will give cross-ventilation. It is generally best to have some window area on all sides of the house, to take advantage of natural breezes.

In many of the energy efficient research houses, the total glass area has been reduced to eight or ten percent of the home's total square footage. This dramatically reduces heat loss and air infiltration through and around windows.

Reducing the window area can also reduce the amount of natural light available. Therefore, well-planned, energy-efficient lighting will be needed. Generally, the energy cost for additional artificial lighting is more than offset by the energy savings from reduced heat loss through the windows.

In Nebraska, all windows should have three layers of glass, double glazed window with a storm window, or triple glazed. The layers of glass and dead airspace increase efficiency. Wooden, insulated metal or plastic frames are preferred.

To summarize, windows can add to the efficiency of a house if well planned. The total window area should be in relation to the total floor area. There should be some window area on all sides of the house for ventilation, but the greatest window area should be on the south side, for winter heat gain. Summer shading of windows is needed, and energy-efficient styles should be used.

## Construction

**Caulking and Weatherstripping**—Installing windows and doors that fit tight is imperative. To insure this, weatherstripping and caulking compounds must be used. Liberal use of weatherstripping and caulking is a relatively inexpensive way to increase the energy efficiency of a house.

Caulking is used to seal around door and window frames and wherever two different materials meet, such as between the siding and the foundation. The more expensive caulking compounds, such as butyl and silicone, are more durable and have longer life expectancy. Weatherstripping is used where a tight seal is needed between moving parts, such as around a door. The ease of installation is a factor in the choice of weatherstripping, but rolled vinyl, neoprene-coated sponge rubber, bronze and brass-plated steel are generally considered the most durable.

**Insulation**—Insulating a home is easiest during new construction when the walls and ceiling are unfinished. Insulation must be placed in every area of the home which is exposed to the exterior. If the basement is to be heated, it should also have insulated walls. Concrete is a poor insulator, therefore, basement walls should be insulated to at least the frost line, approximately three feet



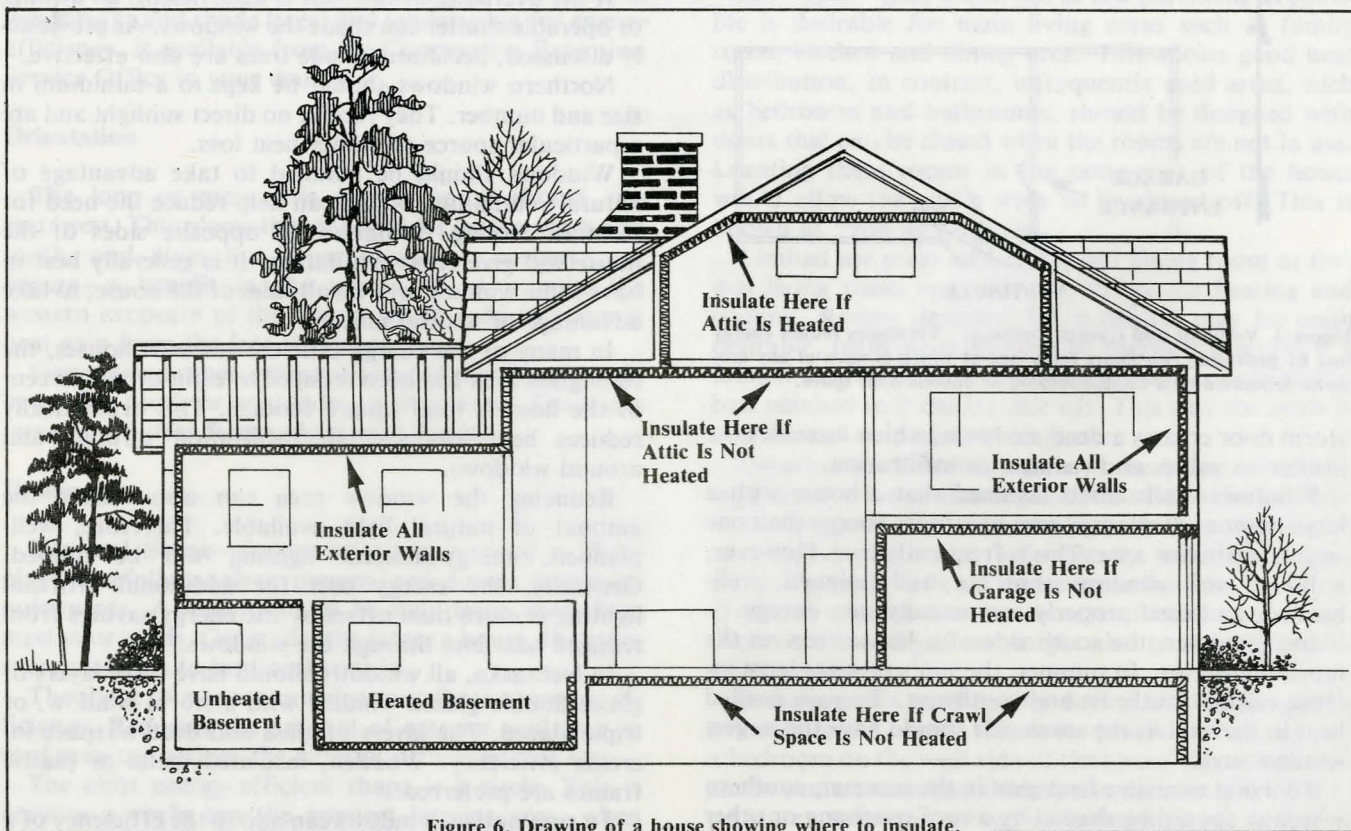


Figure 6. Drawing of a house showing where to insulate.

(.9 m) below ground. No insulation is needed between two rooms within a house if both are kept about the same temperature.

The value of insulation is measured in R-value. "R" stands for resistance to heat. The recommended R-values for Nebraska homes are:

**Ceiling - R 30 - 35**

**Walls - R 18 - 22**

**Floor - R 20 - 25 (Above an unheated space)**

A key factor in proper insulation is to install a vapor barrier to protect the insulation from moisture. Blanket and batt type insulation may come with a partial vapor barrier attached, usually of kraft paper or foil. The vapor barrier is always installed facing the inside of the house, on the warm side of a wall, floor or ceiling, directly behind the sheet rock or paneling.

To insure adequate vapor protection, the entire wall, ceiling or floor should be covered with 4 to 6 mil polyethylene plastic sheeting in addition to any vapor barriers attached to the insulation. Blanket and batt type insulation are typically stapled to wall studs or ceiling joists. The staple can puncture the vapor barrier and allow moisture to seep through. Also, the studs are frequently not fully covered by attached vapor barriers. The plastic can further serve as a barrier to air infiltration.

Do not overlook hot water pipes and heating ducts

that pass through **unheated** areas of the home such as a crawl space or unfinished attic. These should have insulating material wrapped around them.

**Framing**—In traditional building construction 2 x 4 studs spaced 16 inches (40.6 cm) on center are used for the wall framing. A fairly new technique is to use 2 x 6 studs spaced 24 inches (60.9 cm) on center. This creates a wider wall cavity for more insulation.

Another alternative is to use standard 2 x 4 construction, then add rigid board insulation on the interior, underneath the wall board or on the exterior under the sheathing. This increases the total R-value of the wall.

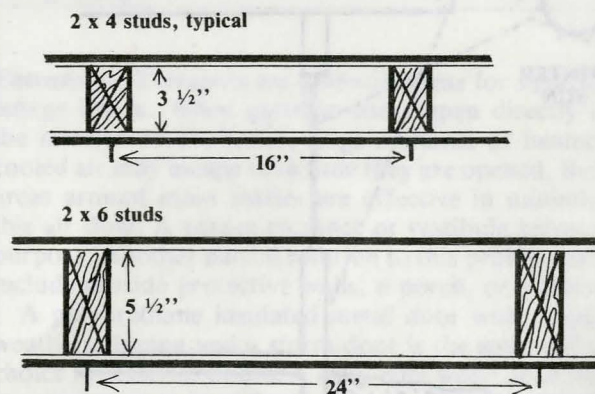


Figure 7. Drawing of wall (in plan) with 2 x 4's 16'' c.c. and 2 x 6's 24'' c.c.



In some new construction, rigid board is used in place of exterior sheathing, as a way to cut costs while still increasing the R-value of the wall. If this technique is used, there are two points to consider.

First, when rigid board insulation is used as sheathing, it is sometimes replaced with plywood sheathing at the corners, for structural strength. This creates different R-values, or insulative values, for different parts of the wall, and is undesirable.

Secondly, rigid board insulation with an aluminum outer surface is not recommended for exterior sheathing because of potential moisture problems. Even with an interior vapor barrier, some moisture may seep into the wall. The aluminum facing on the sheathing may effectively trap the moisture in the wall. This moisture will fill the air spaces in the wall insulation, and cause it to lose its effectiveness. Also, the moisture can lead to problems of mildew, rot, and structural damage.

More detailed information on insulation and vapor barriers is available from the Cooperative Extension Service Office in your County.

### Summary

Energy conscious design can provide substantial energy savings in homes. It involves choosing the right site and properly locating the house to take advantage of the sun and wind. The home's shape, floor plan, exterior features, and interior characteristics all contribute to energy efficiency.

To plan the best house for you and your family, as well as an energy efficient house, may require some trade-offs. A house must be functional and meet the requirements of space and layout for your type of lifestyle as well as be energy-efficient.

Further, it is not always possible to use all of the principles of energy efficiency. For example, the best site for

energy efficient orientation of the house may be farther from your place of work, requiring more energy use in commuting. Or, a more energy efficient shape of house may not allow you to zone your floor plan and thus reduce your total heat load.

This publication is a guide to some of the important basic principles of planning and building an energy efficient house. It should help you make the decisions necessary to have a house that is both energy efficient and suited to your lifestyle.

There are many other considerations in building for energy efficiency. Selecting energy efficient appliances, using fluorescent lighting, carpeting, insulative interior window treatments, automatic setback thermostat, flow restrictor devices to reduce hot water consumption, attic fans, fireplaces, or wood stoves that use outside air for combustion, and many more.

How much energy can you save? What will it cost? There are no simple answers to these questions. However, the University of Nebraska Cooperative Extension Service has a computer program called "HOUSE" which will help you answer some of these questions.

The "HOUSE" program is helpful in evaluating the cost-effectiveness of the different ways to increase the energy efficiency of a particular house or house plan. This program can evaluate an existing or proposed house for anticipated energy costs, and areas of energy loss, and make recommendations for the improvement of energy efficiency. Contact your local County Extension Agent for more details.

This publication was prepared with the assistance of Ardis Hutchins, former Extension Housing Specialist.

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