HOME ENERGY GUIDE

TECHNIQUES TACTICS & TIPS

# New Homes

Minnesota Department of Commerce Energy Information Center

**A new home is the most important purchase many of us will make. When we build a new home, we want our new home to:**

- **Provide a comfortable and healthy environment.**
- **Be efficient and economical in its operating expenses including energy bills and maintenance costs.**
- **Be durable and provide a good return on our financial investment.**

Quality control programs

Construction details that matter

Indoor air quality and moisture control

Questions to ask the builder

ENERGY STAR PARTNER

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An energy efficient home is designed to accomplish these goals. It is built on the principles of building science, which recognize that the home is a system consisting systems should designed to achieve the goals described above. We know, for example, that air tightness increases energy efficiency, comfort, and durability at the same time it requires that outdoor air be brought in to provide healthy indoor air and control moisture.

This guide gives new home buyers the background they need to begin researching and discussing with their builder the various options for achieving an efficient, durable, and healthy home.

## Quality control

Three important characteristics distinguish an energy efficient, high quality home: lower energy use, moisture control, and indoor air quality control. These qualities are interrelated. To ensure that all three qualities are present, the new home requires several key components, and these, in turn, require special attention to construction details. Designing, planning and implementing these details is important. It is also recommended that the energy efficiency of the new home is verified by the use of diagnostic tools like a blower door and infrared camera and that major mechanical systems including the whole-house ventilation be tested to make sure they are operating as intended. The following two programs include this type of verification.

### ENERGY STAR qualified homes program

ENERGY STAR qualified homes are independently verified to be energy efficient and incorporate one or more of the following features: building envelope upgrades and controlled air infiltration, high performance windows, upgraded heating, air conditioning and water heating systems, tight duct systems, and controlled ventilation. The program also includes emphasis on design that begins before the shovel hits the ground. The house plan is reviewed and compared to the standard code and site visits are made once construction is underway to make sure the building meets specifications once it is completed. There are a number of builders in Minnesota participating in the program (see additional resources section at the end of this guide for Web address).

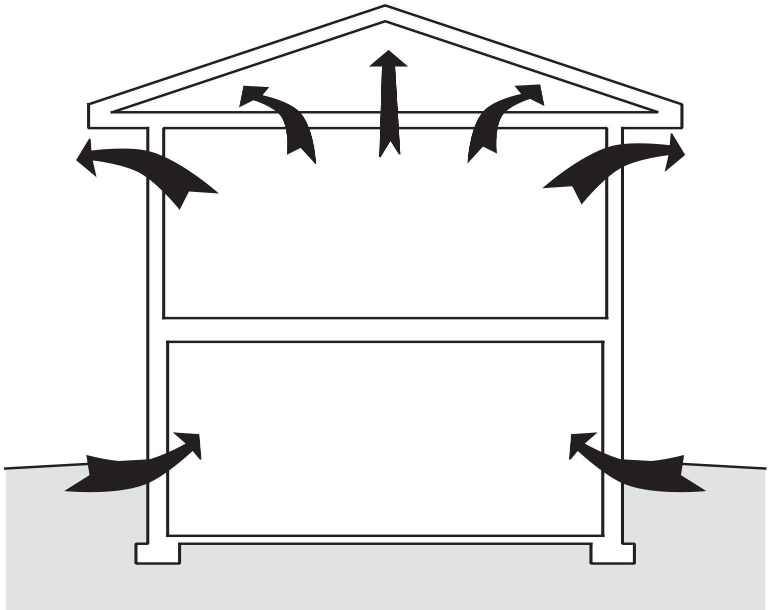


Figure 1:
During the winter, warm air inside the house will cause the house to act like a big chimney, drawing air in at the lower parts of the house and exhausting the warm and moistened air whenever there is an opening in the wall or ceiling.

### Health House Program

Health House is a national program of the American Lung Association. The program focuses on providing consumers and builders the resources to build healthier homes. In addition to energy efficiency, there is an overall emphasis on improved indoor air quality and resource efficiency. More information about the program and indoor air quality in new construction is available on the program Web site (see additional resources section).

## Continuous, interior side air barrier and vapor retarder

Air tightness is equal in importance to R-value. Insulation resists heat transfer, but most insulating materials–do not stop–air movement. Warm air moving through the insulation results in winter heat loss and unwanted heat gain in summer, which will increase year-round energy costs.

More important than the heat loss, however, is the moisture that the warm air carries into the insulation and into the building materials. Moisture substantially reduces the effectiveness of insulation and also can result in mildew and mold growth and the potential decay of the building structure.

Leaking air is also a major cause of ice dams on roof eaves. Warm air leaking up into the unheated attic through electrical openings and other gaps in the air barrier creates warm spots on the roof, starting the snow melt that eventually leads to damaging ice buildup along the eaves.

Movement of warm air from the heated space into the building envelope is the largest potential source of heat loss and moisture problems, and for this reason a continuous air barrier must be installed on the warm or interior side of the insulation (see figure 1). Since moisture can also penetrate by diffusion, a vapor retarder must be installed on the interior side of the insulation. In most new homes, the air barrier and vapor retarder are one and the same: a polyethylene sheet installed on ceilings and walls.

The critical requirement of the air barrier/vapor retarder is that it be continuous; any breaks result in loss of heated moist air and moisture penetration into the building envelope. Providing continuous coverage with an air barrier/vapor retarder requires attention to details. Electric wiring, plumbing, and other penetrations into the air barrier/vapor retarder are inevitable. The solution is to seal all these openings, using caulks and foams, gaskets and adhesives, blocking and tapes, or all of these, depending on the size and location of the penetrations. In particular, the special attention must be paid to the following:

- Areas difficult to insulate, described in the section above and also in the "Design Details" insets in this guide. These areas are also difficult to protect with a sealed air barrier.
- Electrical, plumbing, and telecommunication outlets and other penetrations into the exterior wall and ceiling air barrier.
- Tubs and showers located on exterior walls.
- Fireplace enclosures.
- Recessed light fixtures. These are a major source of air leaks. Talk with the builder about the importance of inspections or other quality control measures to ensure proper air sealing.
- Ductwork. It is preferable to have all ductwork run inside the insulated envelope and sealed throughout (see page 12)

## Full coverage, optimal thermal insulation

In Minnesota, with its long and cold winters, heating accounts for a major portion of a home's annual energy use. Keeping the same space cool in summer also accounts for a significant–and increasing–portion of home energy use, as air conditioning becomes more widespread. An energy efficient home, therefore, relies on having an outer structure–or thermal envelope–that is tight and well insulated, that reduces air flow and heat transfer between the indoors and outdoors in both summer and winter.

**Thermal insulation** reduces heat transfer. The ability of insulation to resist heat flow is expressed in terms of R-value: the higher the number the greater the resistance. The R-value of insulation varies according to the thickness of insulation and its material. The Minnesota Energy Code establishes minimum R- values for foundations (including the slab and slab edge), exterior walls, and the ceiling/attic floor. Various methods and techniques are available for easily achieving higher than the minimum R-values required by the code. Some of these options are described below; talk to your builder about these or other ways to achieve optimal thermal insulation.

Full coverage is as important as the insulation R-value. Any part of the house that is heated should be separated from the unheated space by an insulation barrier. Some areas needing special attention include:

- **Foundation walls.** R-10 rigid insulation on the exterior is recommended. Although it can be more expensive than foundation insulation installed on the interior, it will perform better with fewer compromises. New foundation systems such as ICFs and Integral systems can also be used to easily meet this recommendation.
- **Basement floor.** The Energy Information Center strongly recommends insulating the basement floor with one-inch thick rigid insulation, placed beneath the slab. Some heating systems use the basement slab for heat storage. In this case, two-inch thick rigid insulation surrounding the heat storage system is recommended.

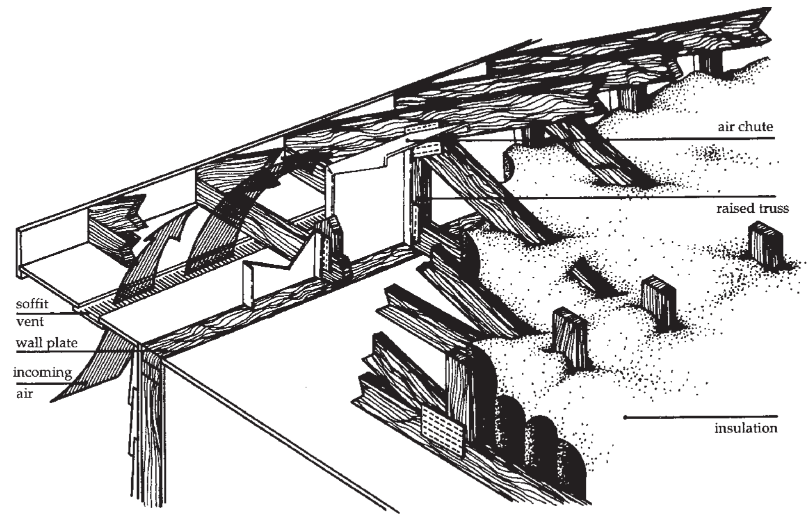



Figure 2:
During the winter, warm air inside the house will cause the house to act like a big chimney, drawing air in at the lower parts of the house and exhausting the warm and moistened air whenever there is an opening in the wall or ceiling.

- **Crawl spaces beneath heated spaces.** To control moisture, a polyethylene moisture barrier is required by code to be placed over the entire ground. It is recommended that this be extended four to six inches up the crawl space walls and be sealed to the wall. The walls of the crawl space should be insulated like any other foundation wall with rigid insulation placed on the exterior walls (see foundation wall insulation, above).
- **Attic insulation** should extend to the outer edge of the outside wall. A true full Energy Heel Truss is recommended which will allow for a full depth of insulation to extend to the outside of the wall (see figure 2).
- **The rim joist** where the exterior framing meets the floor joists is a critical area to insulate and air seal, and it is often a major source of heat loss. The key to good thermal performance is to seal for air leakage at the rim board area. Spray foam to the interior surface of the rim joist (figure 3) has been proven to work well as an insulator and air seal system. Insulating on the exterior with a bump-in of the rim board (figure 4) or using a manufactured rim board product with built-in insulation can also be effective.
- **Architectural details** such as cathedral ceilings, cantilevered floors, and bump-outs–are described in greater detail in the insets in this guide.

Figure 3

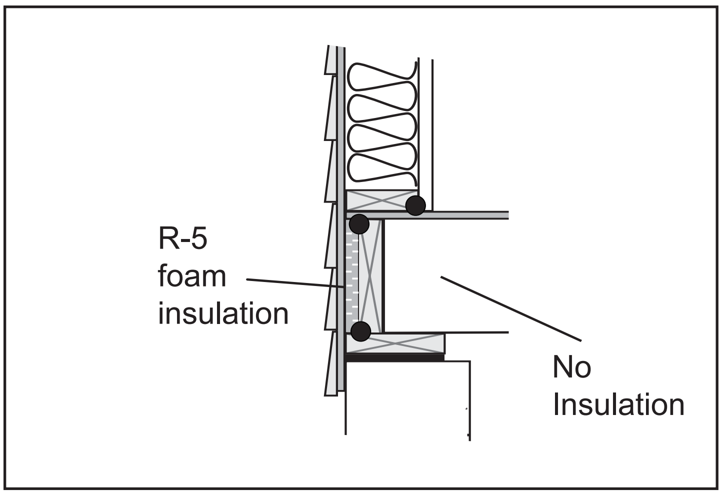



Figure 4

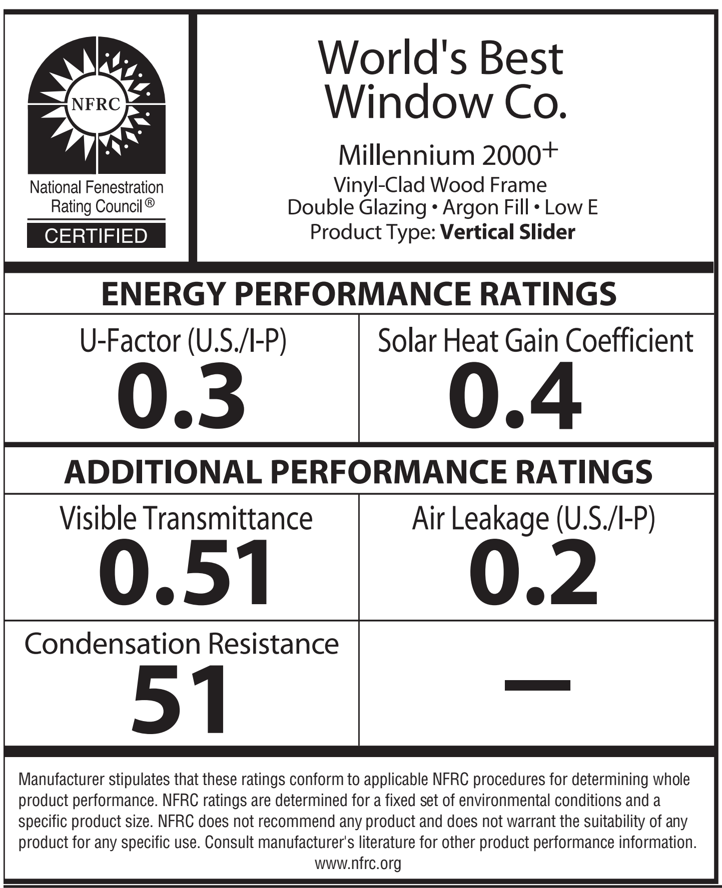



Figure 5

## Weather barrier

Insulation and the building framework must also be protected from exterior wind and water penetration. Water driven into the structure can affect durability, and wind can drastically reduce the effectiveness of the insulation. A number of materials that are impervious to water and air can be used, including modern “house wraps” that are placed around the exterior of the building between the sheathing and siding and some rigid foam insulations. Some products/materials can serve multiple purposes. A spray closed-cell foam insulation, for example, may serve as insulation, an exterior air barrier, and an interior air barrier as well. Ask your builder what kind of barrier he plans to use and that he follow the manufacturer’s installation recommendations.

## Energy efficient and condensation resistant windows

Window performance has improved dramatically in recent years. Low-e coatings on glass panes, gas fillings and insulating spacers between panes, and improved framing materials all reduce heat loss in winter and heat gain in summer. In addition to increased comfort and reduced energy loss, a further advantage of these high performance windows is less moisture condensation: greater insulating ability results in a warmer temperature for the windows’ indoor surface, resulting in less condensation.

The best way to select windows for your new home is to look for the label issued by the National Fenestration Rating Council (NFRC). The NFRC label will provide the consumer with consistent ratings on window, door and skylight products (see additional resources Section). Figure 5 shows a typical NFRC label.

- U-Factor. The U-Factor or (U-Value) measures the rate of heat loss. The lower the number, the better its insulating value. U-Factor ratings vary between 0.20 and 0.60. Look for a U-factor of .30 or less.
- Solar Heat Gain Coefficient (SHGC). The SHGC is a ratio of how much solar heat gain can come through a window, where 1 is the maximum amount and 0 is the least amount. A SHGC of 0.50 means that 50 percent of the available solar heat is coming through the win-

dow and will provide a good year-around balance. Select skylights with a SHGC of 0.55 or less. If summer heat gain and the impact on cooling is a concern, a SHGC of 0.40 on west and east facing windows is recommended.

- Visible Transmittance. Measures how much visible light comes through the product. Ratings are between 0 and 1; the higher the number, the more light is transmitted.
- Air Leakage. Measures the cubic feet of air passing through a square foot of window area. The lower the number, the less air will pass through cracks in the assembly. The AL is an optional rating; manufacturers can choose not to include it on their labels.
- Condensation Resistance (CR) estimates how well the window will resist condensation. (CR is rated on a scale of 0 to 100 – a higher CR number means the window is less likely to form condensation.) The CR is an optional rating and is not meant to predict condensation but rather is a tool to for comparing windows and their potential for condensation formation.

Window installation is an important factor in building durability. Because water intrusion has the potential to create serious damage to a building, correct installation of windows with the appropriate flashings is vital. Ask that your builder follows the installation recommendations of the manufacturer. See the video available on both the Consumer and Builders CDs for a tuutorial on how these details could typically be accomplished.

Doors also have improved in efficiency; metal and fiberglass doors with cores of insulation now account for about half of all doors in newly constructed homes. Metal and fiberglass doors provide better insulation and security than patio sliding or French doors. Glass patio doors have considerably less insulating value than insulated wood or steel doors. If you plan to have glass doors, ask your builder to use doors that have an NFRC low U-value rating.

## Effective ground moisture/soil gas control

Except for structural errors, moisture damage is the nation's leading cause of problems in buildings. And in Minnesota, these moisture problems often begin with a damp or wet basement. Studies show that 10 gallons or more of water vapor per day can evaporate into a house through the basement walls and floors.

The Energy Information Center recommends the following measures:

- Perhaps the most important step is to select an appropriate building site. A site with a high water table or poor drainage patterns presents substantial obstacles to building and maintaining a dry foundation.
- The Minnesota Building Code requires that landscaping be appropriately graded to direct rain water and melting snow away from the foundation. Backfill always settles after a year or two. It is important to start with a generous slope of at least six inches over the first ten feet from the foundation wall.
- A high quality, durable coating–termed waterproofing–should be applied on the below grade portion of foundation walls. This provides better protection from moisture penetration. Although it may not be needed in well-drained soils, it is much less expensive to apply while the foundation is being built then later as part of a repair.
- Use gravel as backfill around the foundation. Cover it with a low permeability soil or hard surface to divert runoff away from the foundation. Porous backfill gravel or sand should be used against the foundation walls to promote drainage to a channel of coarse rock or drainage tile located outside the foundation footing. A drainage mat product can be used in place of–or in addition to–the backfill gravel or sand. Drainage mats made of corrugated fiber or plastic material creates a clear drainage path directing water to the drain tile.
- The concrete slab floor should be insulated with 1 inch of rigid insulation underneath the slab. In addition, there should be three to four inches of washed aggregate underlying the insulation and slab.

### Do you need a basement?

With so many of our housing problems related to moisture and foundations why build a basement when you don't have too? Not too long ago basements were used primarily for storage and the mechanical equipment.

More recently, basements have been converted to living space under the premise that it is relatively inexpensive space. Given what we know about potential for moisture problems, this may not be an accurate assumption. Consider if it would be less expensive to extend the living space upward or horizontally.

A "safe room" similar to what is built in other parts of the country can be added to replace the basement storm shelter. Storm protection can be provided by a safe room, an area of your house built to withstand Tornados. These safe rooms are common in those areas where there is no ability to build basements such as Texas and Oklahoma.

cussed with your builder or heating subcontractor.

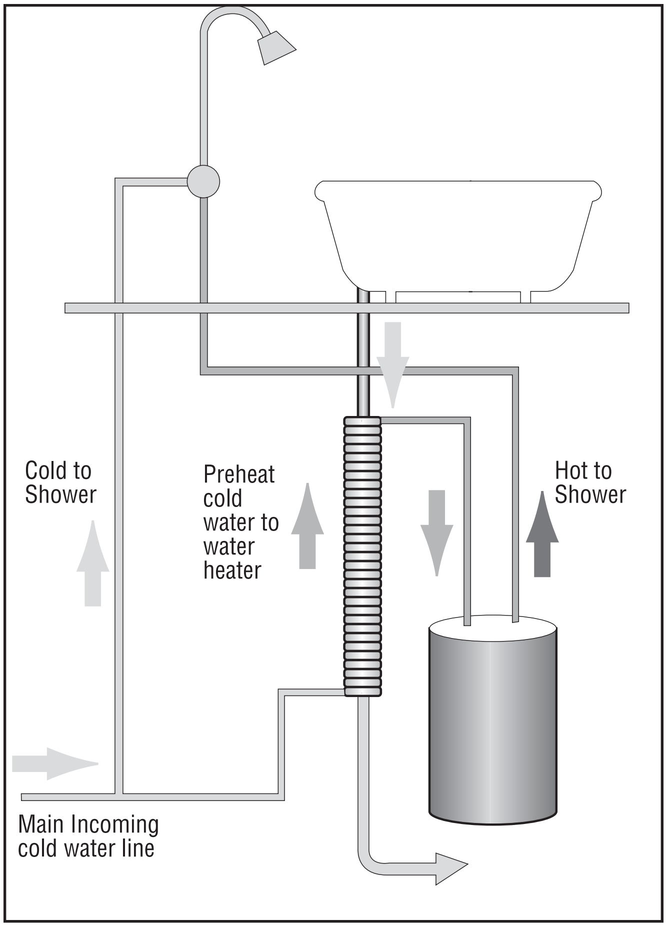



Figure 6
The GFX must be installed vertically; it is best if the drain is close to the water heater.
**Source:** Doucette Industries, Inc.; York, PA

- Heated slabs, with heat pipes or cables either embedded in or below slabs, should be protected on the sides and bottom by R-10 insulation.
- Many homes in Minnesota are now constructed on a concrete slab (slab-on-grade), with no basement. Heating system ducts should not be installed in the ground below a slab. There have been numerous failures of this type of system which can be very expensive to remedy.

## Water heating options

Water heating can easily account for more than 20 percent of energy costs in a modern energy efficient home. Because of concerns about backdrafting of atmospheric water heaters and the extra cost of power vented equipment, some builders install electric resistance water heaters. This solution may be unsatisfactory to some homeowners because of increased operating costs and slower recovery times (see sidebar, "Comparing Fuel Costs" page 11). The options and features discussed in this section can reduce domestic water heating costs and should be discussed with your builder or heating subcontractor.

An efficient water heater, as judged by its Energy Factor (EF), is a concrete way to lower monthly energy costs. The EF takes into account both the efficiency of heat transfer into the water and the 'standby heat loss' of the storage tank. An EF of .64 or higher is recommended for gas water heaters and .93 for electric. Check the yellow and black Energy Guide tag found on all new water heaters. The tag gives the estimated yearly cost of operating the unit and shows how the particular model compares in energy use to similar models. Another important piece of information is how much hot water the tank can provide. The ability of a water heater to meet peak demand for hot water is indicated by its "first hour rating."

### Conservation measures.

No matter what fuel you use, water conserving measures and equipment can pay big dividends. The installation of water efficient appliances such as ENERGY STAR clothes and dishwashers will reduce the cost of domestic water heating, as will simple measures such as insulating hot-water pipes and installing low-flow showerheads.

A Gravity Film Heat Exchanger (GFX) is a relatively unknown but very cost effective conservation measure. The GFX is a vertical, counterflow heat exchanger that extracts heat out of drain water and uses that heat to preheat the cold water entering the building. The GFX is a simple and inexpensive device that can reduce the energy needed to produce hot water by 25 to 40 percent. The unit replaces about five feet of vertical drain line, is very compact and has no moving parts (see figure 6).

### Plumbing manifold.

Manifold plumbing systems are control centers for hot and cold water that feed flexible plastic supply lines to individual fixtures. The system has the potential for offering installation cost advantages over traditional residential water supply systems.

Plumbing manifolds can be installed more quickly than rigid plumbing systems with fewer fittings and without the need for piping tees and elbows. The systems permit several fixtures to be used simultaneously without dramatic pressure or temperature losses. By downsizing supply piping, water velocity is increased and delivery of hot water to fixtures is faster. Heat loss in the piping may be less than a copper system because plastic has better thermal insulating properties.

Because these systems are relatively new, costs can vary greatly (for more information see additional resources section).

## Gas water heating

Although power-vented and direct-vented natural gas water heaters can be more expensive than electric resistance water heaters, the additional equipment expense will often be offset by lower operating costs. A major difference in the types of natural gas (or propane) burning equipment is how the exhaust gases are vented from the house. The following describes the various types.

**Atmospheric vent.** These are the standard gas water heaters. They use room air for combustion and exhaust. Flue products are expelled through a chimney, which depends upon the natural buoyancy of the combustion products to exhaust properly. While the water heater itself may be cheap using this older appliance may cause significant additional installation expense in a new home.

**Power-vented.** These are similar to atmospheric models in that they rely on room air for combustion, but they feature a re-engineered power assisted exhaust that allows venting through a sidewall (see figure 7). No chimney or chase is required.

**Atmospheric direct-vent.** Sometimes referred to as sealed combustion, these units use out-side air for both combustion and exhaust. They are not affected by other exhaust systems in the house. Like a power-vented appliance, they do not need a chimney, which allows for greater installation flexibility.

**Power direct-vent.** Powered direct-vent models (also sometimes referred to as sealed combustion) combine the features of power and direct vent models. Only outside air for both combustion and exhaust is used. It uses PVC plastic pipe as a venting material and can be place up to 40 feet from a sidewall allowing for flexible installation.

**Water-space heating combinations.** High efficiency boilers can provide hot water throughout the year. Considerable savings in overall equipment costs and overall operating costs are likely. Only a unit specifically designed to do this should be used.

**Recommendations.** New homes with atmospheric-vented appliances may require expensive additional makeup air for protection against backdrafting. Gas water heaters that are power-vent, direct-vent, or power direct-vent are inherently safer; the Energy Information Center strongly recommends that they be considered. Also look for an Energy Factor rating of .64 or higher.

**Figure 7:** Power vented water heaters can be vented through a sidewall or vertical vent. **Source:** CenterPoint Energy Minnegasco

## Electric water heating

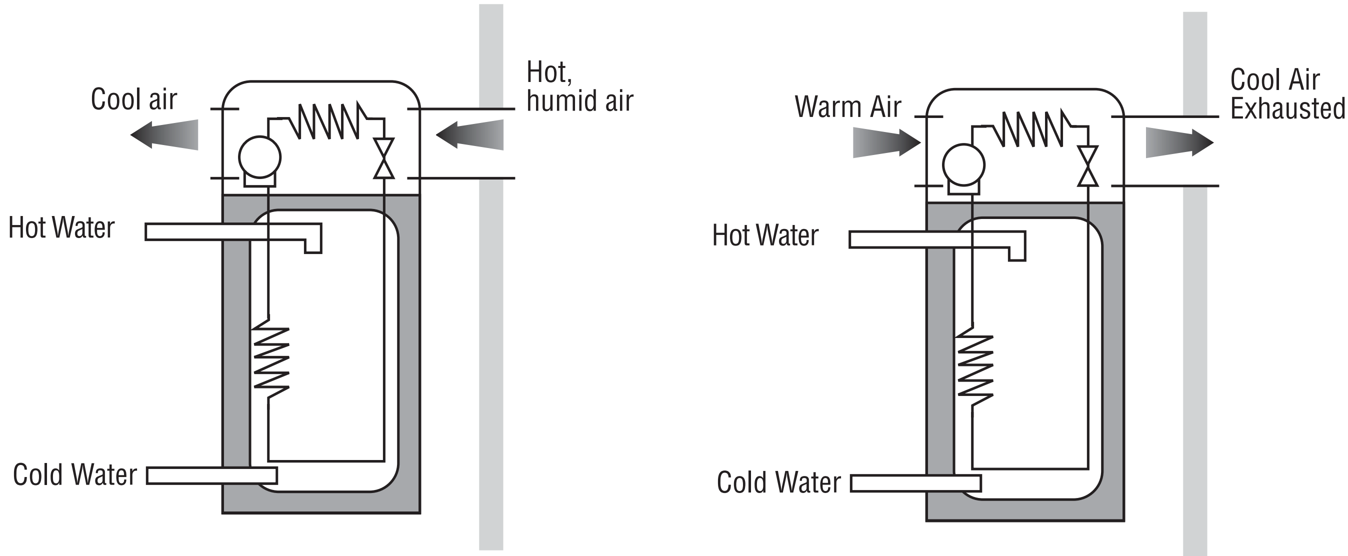
Although they have a low initial cost, electric resistance water heaters can have a high operating cost. In addition to the conservation items already presented, the following options should be considered.

**Off-peak electric water heating.** "Storage heating" is an inexpensive and efficient method of electric water heating. Many utilities offer low cost off-peak night electric rates for water heating. Water is heated at night, storing all you need for daily use. Make sure that you have adequate water heater storage capacity if you choose this option. Larger homes may need up to 160 gallons.

In the same manner, interruptible electric water heating allows the utility to temporarily interrupt electricity to the water heater during times of peak electric usage – usually for a few hours on the hottest or coldest days of the year.

Some utilities offer incentives for their customers who install off-peak storage heaters or control devices for interruptible service. Check with your local utility to learn what is available.

Figure 8




**Summer:** Hot and humid outside air is drawn in past the unit and cool, dry air is fed into the house ventilation system.

**Winter:** Warm house air is drawn from the ventilation system to the HPWH and cool air is exhausted outside.

## Typical household hot water flow rates

Faucets
.75 gallons to 2.5 gallons per minute

Low-flow showerheads
1.2 gallons to 2 gallons per minute

Standard showerheads
2.5 gallons to 3.5 gallons per minute

Clothes washers and dishwashers
1 gallon to 2 gallons per minute

**Air-source Heat Pump Water Heater (HPWH).** The heat pump water heater takes heat from the surrounding air inside the house and transfers it to the water in the tank. Although they may cost $800 - $1,000, typical Energy Factors are 1.9 to more than 2.0. Other benefits are free dehumidification and a reduced cooling load.

The HPWH works by taking heat out of its surroundings, such as the basement. A practical application for a HPWH in Minnesota would be to integrate it into the mechanical ventilation system, which is required in all new homes. In winter the HPWH recovers energy from stale air before exhausting it to the outside. In summer, the ventilation airflow is reversed, and the HPWH recovers energy and removes humidity from outdoor air as it enters the house. These systems are common place in Scandinavian countries and show great potential for the Minnesota climate (see figure 8). As this product is not currently available it remains an entrepreneurial opportunity.

**Ground-source heat pump systems.** Homes with adequately sized ground-source heat pump systems (sometimes called geothermal energy) can add a desuperheater water heater. This is an attachment to the heat pump that makes use of the compressor waste heat to pre-heat water in an extra tempering tank. A desuperheater water heater can provide 60 percent of the hot water requirements during the cooling season and 40 percent during the heating season. While it is economical during the air conditioning and heating seasons it does not contribute towards water heating during the spring and fall when the compressor is not operating. An electric resistance water heater is usually used to store the hot water produced and provide water when the ground source heat pump is not operating.

## Solar water heating

Solar hot water heating is a viable and cost effective option for households with high hot water demands. Although the initial cost is higher than conventional systems, ($3,500 to $5,000 installed), the fuel is free and environmentally friendly. For an effective solar water heating system, the home must have good solar exposure (a south facing roof that has no shade). Solar water heaters will generally pre-heat water in a separate tempering tank. During the summer, the solar system may provide all the required hot water. In winter, it may provide about one-third to one-half of the total. There are only two types of solar hot water systems that are appropriate for the Minnesota Climate, the closed loop heat exchanger and drainback systems. Both of these types use antifreeze for freeze protection during the winter.

The Minnesota Building Code requires that solar collectors and solar water heating systems sold or installed in the state must bear a certification label from the Solar Rating and Certification Corporation. A complete listing of SRCC certified equipment is available on the Web (see additional resources section).

### Tankless water heaters

Tankless water heaters (also called instantaneous or demand units) have a heating device that is activated by the demand for water when a hot water valve is opened. Once activated, the heater delivers a constant supply of hot water for as long as the rate of flow is high enough to keep the heater on. When located adjacent to the faucet, a tankless heater becomes an instantaneous" supply. Unlike "conventional" water heaters, tankless water heaters heat water only as it is used, or on demand. Efficiency is improved because "standby loss" is eliminated. The output of the heater, however, limits the rate of the heated water flow.

Demand water heaters are available in propane (LP), natural gas, or electric models. Although they are made in a variety of sizes for different applications, there are not many suppliers and installers of this equipment in Minnesota. One reason may be that the cost of these systems can be up to 3 times the cost of a conventional storage water heater.

Sizing is an important consideration. The units are labeled for the amount of hot water provided at a given inlet water temperature. To determine the size needed, list the number of devices you expect to use at one time and add up the flow rates. It makes sense to use low-flow showerheads and water-saving faucets (see sidebar Typical household hot water flow rates).

In some situations additional plumbing work will be required. Gas units require a larger flue pipe and gas supply than a typical water heater and in some instances may exceed the supply capacity of the home's gas system. Electric units need heavy gauge wire and because of the additional demand, the electrical service coming in to the home may need to be upgraded. Also, because the high water hardness found in many areas of Minnesota can rapidly 'lime-up' an instantaneous unit, a water softener is highly recommended.

## Space heating options

Space heating is the prime energy user in a Minnesota home. Reducing this energy use and its cost is the principal reason–along with increased comfort–for building an energy efficient home. An important factor in achieving maximum efficiency is the selection of an efficient heating system. Many consider the choice of a heating system before the house plans are finalized (see sidebar "How to Compare Fuel Costs, page 11). Consider putting that decision off till the plan is done and then make an assessment of the heating load. A good efficient home will likely need a small heating system.

### Combustion heating systems

A combustion (fuel burning) furnace or boiler requires air (called combustion air) for proper operation (see water heating section for a description of the various types of combustion appliances). For this reason, it is extremely important to buy a direct vent or sealed combustion furnace. This type of furnace brings air from outdoors directly into the combustion chamber without mixing it with indoor air, and it discharges all flue gases directly to the outdoors. A chimney is not required so you will have greater freedom in where to place it and save chimney construction costs. The air tightness of a well insulated home also makes it possible to buy a smaller size furnace than otherwise would be needed. An additional advantage of a forced air heating system is that its ductwork can be used by a central air conditioner and the required mechanical ventilation system.

The Annual Fuel Utilization Efficiency (AFUE) for a furnace is like the miles-per-gallon label on a new car. This rating estimates how much of the fuel used actually goes into heating the home, based on average use. The Energy Information Center recommends an AFUE of 92 percent or greater for forced air furnaces and 85 percent or greater for boilers. Look for models with an ENERGY STAR label.

Choosing the appropriate size furnace also is important: oversized furnaces, because they cycle on and off more frequently, are less efficient. Your builder's HVAC subcontractor should provide a good estimate of what your annual heating and cooling needs will be.

Annual energy costs also are affected by the amount of electricity a fuel-burning furnace uses to circulate air. The AFUE rating does not account for this energy use. Variable rate furnaces use considerably less electricity–as much as 50 percent less–than other forced-air furnaces. Features include microprocessor controls, which automatically adjust air flow to achieve maximum efficiency.

There are two sources of information to help consumers evaluate the electrical consumption of furnaces. The American Council for an Energy Efficient Economy (ACEEE) estimates the average amount of electricity used by each model in its directory and the Gas Appliance Manufacturers Association (GAMA) has been noting the electrical efficiency of furnaces and has developed a guideline for efficiency (see additional resources section). The GAMA guideline is most useful if the furnace fan operates to distribute air from the ventilation system.

## Electric heating systems

Coefficient of Performance (COP) measures the efficiency of electric heating. A COP of 1.0 means that the heat energy the appliance delivers is the same as the electrical energy it uses. Although all electric heating systems operate at nearly 100 percent efficiency and therefore have a COP of at least 1.0, this rating does not take into account the energy used to generate and transmit the electricity.

Baseboard electric heaters, radiant ceiling and wall panels, in-floor radiant heating, and electric furnaces all operate at 100 percent efficiency (COP 1) and, with the exception of electric furnaces, are easily zoned to provide different levels of heat in different rooms. At current prices of electricity, however, they also are probably more expensive to operate than oil, natural gas, or propane furnaces. In some areas of Minnesota, electric utilities provide discount rates for energy used during off-peak hours (usually later at night and in the early morning). Customers can take advantage of these rates if they have a backup fuel source such as fuel oil or propane or have an electrical thermal storage system. These systems consist of heating elements and some type of heat storage unit (such as rock, water, or ceramic materials).

Heat pumps use electricity to operate a refrigeration cycle to move thermal energy from one area to another. Refrigerators and air conditioners use the same principle. The only difference is that heat pumps are designed to operate in "reverse cycle" to fulfill both heating and cooling needs. There are two basic types of heat pumps for homes: ground-source and air-source.

**Ground-source heat pumps** (sometimes called "geothermal energy") appear to be the most practical heat pump for the Minnesota climate. Ground-source heat pumps use the relatively constant temperature occurring eight to ten feet below the ground as a source for heat and a sink to absorb heat for cooling. They can be a good option depending upon the electric costs in your area, heat load demand, and particular soil type. The heating efficiency of ground- or water-source heat pumps is rated by their COP, and their cooling efficiency by their Energy Efficiency Ratio, or EER. The most efficient of these pumps has a COP of 4.1 and an EER of 16 or higher; again, look for ENERGY STAR qualified equipment.

**Air-source heat pumps** extract heat from the air and can also be used for heating and cooling although when in heating mode the efficiency will drop considerably as the outdoor air temperature approaches freezing. In our climate it is best to consider air-source systems as an auxiliary heating system. As the temperature and the efficiency of the heat pump drops, a point is reached when the heat pump is turned off and a system (usually a combustion heating system) is switched on. This is referred to as the "set point" and is determined by the cost of electricity, the efficiency of the heat pump, and the cost of the main heating fuel. Consumers with air-source heat pumps should be willing to monitor these factors and adjust the set point accordingly.

The heating performance of air-source heat pumps is rated by the Heating Season Performance Factor (HSPF), a ratio of the estimated seasonal heating output by the seasonal power consumption for the average U.S. climate. The HSPF of the more efficient pumps ranges from 7.7 to 10. The cooling performance of air-source heat pumps is rated with a Seasonal Energy Efficiency Rating. The Energy Information Center recommends you look for an ENERGY STAR label and size the air-source heat pump to meet your air conditioning load.

# How to Compare Home Heating Fuel Costs

## Step one - Determine the cost of fuel per unit of energy

To make a meaningful "apples to apples" comparison, you first must convert to a standard unit of measurement. A common measure of energy is one million British thermal units (MMBtu). Table 1 shows the amount of fuel required to provide one MMBtu from common residential heating fuels. The conversion number is then multiplied by the fuel cost per unit (gallons, therms, kWh). The result is the MMBtu cost for each type of fuel. The table uses an average statewide fuel cost; use your anticipated fuel cost for greater accuracy.

Table 1 - Cost of heating fuels on a per MMBtu basis

| Fuel type | Units per MMBtu | Average unit cost | $ per MMBtu |
|---|---|---|---|
| Natural Gas | 10 Ccf | $1.004 per Ccf or therm | $10.04 |
| Electricity | 293 kWh | $0.085 per kWh | $24.90 |
| Propane | 10.9 gallons | $1.56 per gallon | $17.00 |
| Heating Oil | 7.2 gallons | $1.73 per gallon | $12.46 |

## Step two - Divide cost per MMBtu by the efficiency of the equipment

The efficiency of the equipment must be taken into account when comparing various options. Table 2 shows a few examples but it is best to use the efficiency of the particular equipment you are considering.

Table 2 - Costs of fuels based on equipment efficiency

| Fuel Type (Equipment type and efficiency) | Cost per MMBTU (Including efficiency) | Annual Cost (From Step 3) |
|---|---|---|
| **Natural Gas** | | |
| (Furnace with 90% AFUE) | $11.15 | $780 |
| (Water Heater with .64 EF) | $15.69 | $314 |
| **Electricity** | | |
| (Resistance heating) | $24.90 | $1,743 |
| (Ground source heat pump with 3.2 COP) | $7.78 | $544 |
| (Water heater with .93 EF) | $26.77 | $535 |
| **Propane** | | |
| (Furnace with 90% AFUE) | $18.88 | $1,321 |
| (Water heater with .64 EF) | $26.56 | $531 |
| **Heating Oil** | | |
| (Furnace with .85 AFUE) | $14.66 | $1,206 |

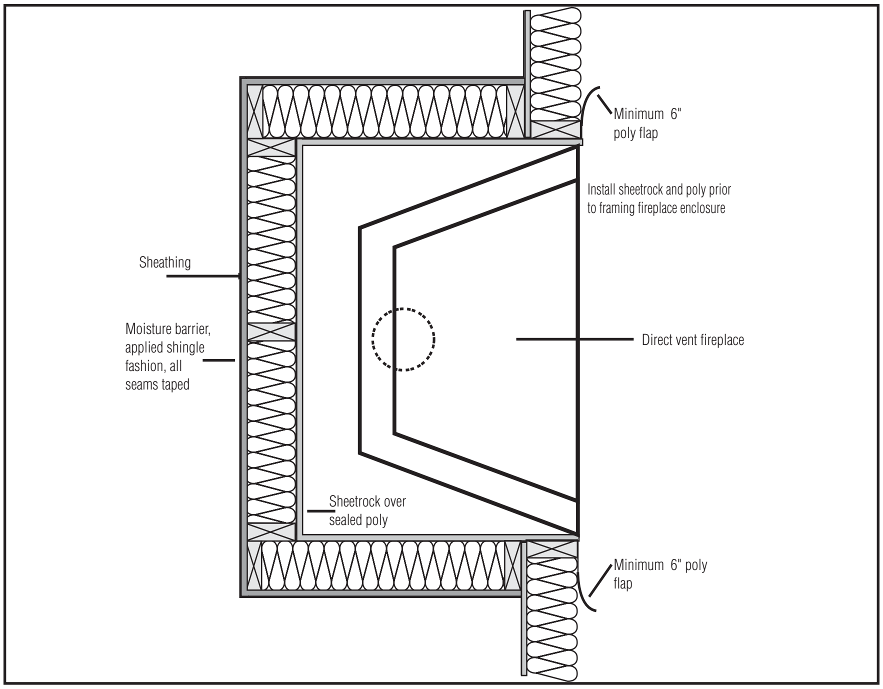
## Step three - Multiply the result from step two by the annual MMBtu fuel requirement

The far right column of Table 2 shows annual costs for both space and water heating using statewide annual averages of 70 MMBtu for space heating and 20 MMBtu for water heating. This information is provided for general comparison purposes only. For greater accuracy, substitute your estimated annual MMBtu requirement.

## Design Details: Bump-outs for entertainment centers and fireplaces

Another area where major air leaks or cold spots can occur is a framed fireplace cavity on an exterior wall. Unless properly sealed, the interior studs of the cavity will be warm as compared to the adjacent gypsum board.

The illustrations below show how to solve this problem.




## Building Technology: Insulated Concrete Forms (ICFs)

ICFs are forms for poured concrete made from polystyrene foam that stay in place as a permanent part of the wall system. The forms are either pre-formed interlocking blocks or separate panels connected with plastic ties. Although all ICFs are identical in principle, the various brands differ considerably in their shape and components. Once the forms have been poured with concrete, drywall, siding, and stucco or brick can then be attached directly to the surface with appropriate fasteners.

ICF systems can be used for above and below grade walls, but have a significant advantage in below grade applications. The R-value of a typical ICF system runs up to R-18 and above. It is extremely important that ICF below grade applications are thoroughly waterproofed. The current building code specifies how this should be accomplished. Ask your builder and local building code official to ensure that the ICF is water proofed properly. It is also a good idea to check on your builder's experience and track record with ICFs.

ICF systems are light, easy to install, and recognized in the Minnesota building code. They can provide a well-insulated, extremely quiet and comfortable below grade living space, which can fully take advantage of all of the square footage in a new home. More information about this type of building system can be found on the Insulating Concrete Form Association web site (www.forms.org).

## Space cooling options

Just as heating costs are reduced in an energy efficient home, so, too, are cooling costs. Higher insulation levels and increased air tightness of an energy efficient home keep the house cooler in summer as well as warmer in winter. To reduce summer heat gain, consider specifying a low solar heat gain coefficient for east and west facing windows (see page 4). The orientation and strategic placement of trees and other landscaping can greatly reduce summer heat gain and lower your cooling costs. Research indicates that deciduous trees should be avoided on south facing windows but should used to shade windows on the east and west (see page 18). Our Saving Energy with Trees Home Energy Guide has additional information including a list of recommended species (see additional resources section for details).

If you decide to cool your house with air conditioning, you can either have a central system to cool the whole house or window or wall units that cool one or more rooms. Split units or high velocity units also are available for homes with hot water or electric heating, but these systems are also more expensive than the standard forced air unit which can use the furnace ductwork. For maximum efficiency, the air conditioner capacity should match the cooling load (it is important not to oversize). On room or wall units, check the Energy Guide label for the energy efficiency ratio (EER): the higher the number the better. The Energy Information Center recommends a rating of (11 is the best in room units 18 SEER for whole house systems) or higher. Look for an ENERGY STAR label on both window and central air conditioner systems.

## Duct systems

Typical ducts for forced air heating and cooling systems are so leaky that 20 percent of the energy used to condition the air is wasted. Good tight duct work will improve comfort and energy savings. This is true even if all of the air leaks are within the home. Duct leakage causes poor distribution. Energy is wasted because of excessive fan run times and uneven heating and cooling. This is most obvious in the summer when leaking ducts spill a lot of cool air in the basement and lower floor, leaving some second story rooms with insufficient cooling.

Many new homes in Minnesota use the heating duct system to deliver air from the mechanical ventilation system. Sealing the duct work will ensure that the ventilation system performs as intended. The Energy Information Center recommends that duct joints are sealed with a UL listed duct mastic or tape. Even better, duct tightness should be verified by a field test such as that offered by the ENERGY STAR program (see Quality Control, page 1).

The location and size of the ducts is also critical. Ducts should not be run through non-conditioned areas such as attics, crawlspaces, and garages. The best duct work is sized properly with minimal runs and smooth interior surfaces. In tightly constructed homes with high levels of insulation and high performance windows the expense of running ducts to the perimeter may not be necessary.

Talk to your contractor about the benefits of duct sealing and how the mechanical contractor will seal the ducting to prevent leaks and provide good distribution. Fact sheets about duct sealing, location, and sizing are available from the ENERGY STAR Web site.

## Managed mechanical ventilation

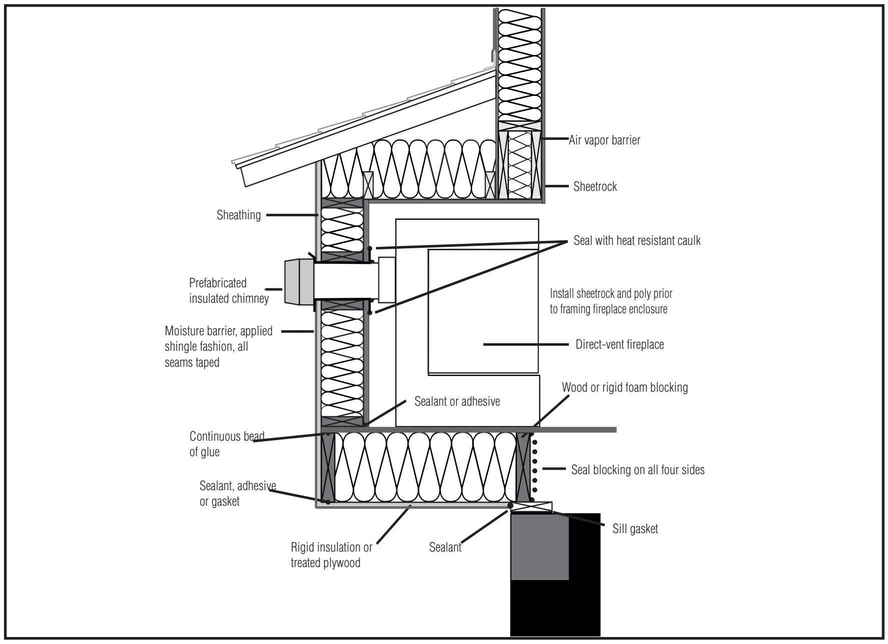
All new homes in Minnesota must have a mechanical ventilation system to deliver and exhaust air from all rooms of the house. The system is needed to exhaust pollutants, moisture, and odors from inside the house to the outside, and to bring in outdoor air to mix with the indoor air.

It may seem illogical to seal the house up tight and then provide for fresh air, but in Minnesota it is not practical to rely on opening a window for ventilation year round. New homes in Minnesota are "built" tight to ensure comfort and keep monthly energy bills as low as possible, especially during the winter. "Ventilating right" with controlled ventilation is equally necessary to ensure that the proper amount of fresh air is brought indoors in all seasons and that unwanted moisture and pollutants are expelled.

There are a number of choices for supplying ventilation and makeup air. Following is a description of the various types of ventilation systems and the conditions in which they should be used.

## Design Details: Cantilevered floors over Garages

Air leakage tests in new homes shows that there is substantial air leakage and heat loss through rim joists separating the house and an attached garage. This is one area where attention to detail is very important. The drawing below shows the recommended solution of sealing all penetrations in floors and walls separating the garage and house.




## Building Technology: Structural Insulated Panels (SIPs)

SIPs are high-performance building panels for floors, walls and roofs. The panels are made using molded expanded polystyrene or polyisocyanurate rigid foam insulation sandwiched between two structural skins of wood composite panels, such as plywood or oriented strand board. The wood panels provide the structural strength—no wall studs are used in the panels. The panels lock together for tight construction, and a variety of R-values are available.

The prime advantage to SIPs is that they result in a structure that is strong, predictable, and extremely energy efficient. Since SIPs are completely filled with insulation, they usually have more R-value compared with the traditional wall systems of stud framing with fiberglass insulation of the same thickness. In addition to the increased insulation value, air infiltration is greatly reduced.

Although the material cost is somewhat greater than conventional frame construction, SIPs can save on labor costs because a typical building envelope can be erected simply and quickly. In considering SIPs it is important to verify that your builder has experience building with this type of product and that all bids fully consider the cost of building with this system. More information on this building system is available from the Structural Insulated Panel Association (www.sips.org).

## Design Details: Skylights

Skylights are a weak area in the thermal envelope; their insulation value is low and they create breaks (They create details that must be tended to assure continuity of the air barrier) in the air barrier. Their location at the top of the thermal envelope makes condensation problems and potential air leaks even more serious. But they are a great source of natural light. Care must be taken to install the skylight so that it is sealed tightly to the air barrier/vapor retarder. Designing and installing the skylight so that snow is shed readily helps prevent problems with snow melt. Look for skylights with an NFRC overall U-value of 0.55 or less, and a shading coefficient of 0.5 or less. A South facing Clearstory window would provide almost as much light and true solar gain over the heating season. Clearstories use standard windows so they may offer much better thermal performance and less risk of condensation than a skylight. Skylights will add to your summer time need for air conditioning and that energy expense may exceed the lighting savings.

## Design Details: Fireplaces

A direct vent gas fireplace is fully compatible with an energy efficient home.

Open hearth or conventional fireplaces were popular in the past but since conventional fireplaces require large amounts of combustion air, they significantly affect the air supply in the home and make it essential to have only direct vent combustion furnace and appliances.

## Design Details: Cathedral Ceilings

Builders can use a number of techniques to allow for added insulation in cathedral ceilings. The Energy Information Center recommends two options: the "scissors truss" or supplementing insulated rafters with rigid insulation. The scissors truss allows plenty of room for insulation and ventilation in the space separating the roof and ceiling. If the design does not allow for a scissors truss, roof rafters or truss can be fitted with R-38 batt insulation and an inch of rigid insulation added on the underside of the rafter or truss. Regardless of the method used, the two important features are maintaining a clearance of one or two inches under the roof deck for required ventilation and maintaining a tight air barrier to prevent warm, moist air flow from the living space.

### Balanced ventilation

Balanced systems use power fans both to expel indoor air and its pollutants and to bring in fresh air to supply basic, round-the-clock ventilation. A variety of balanced ventilation systems are available and described below. The department recommends a balanced system as the most effective and easily understood method for supplying round- the-clock ventilation. In most instances, these systems will be the most available, effective and easily understood equipment.

**Central heat recovery ventilator (HRV).** Often referred to as an air-to-air heat exchanger, this is the most common ventilation system. It consists of an intake fan, exhaust fan, and a duct system. It employs a heat recovery system that reduces indoor heating and cooling loads by transferring heat from or to the exhaust air. The efficiency of the heat recovery system can be 70 to 90 percent. This system can be run continuously, or it can be controlled by timers or a dehumidistat.

**Energy recovery ventilator (ERV).** The main difference between an HRV and an ERV is the way the heat exchanger works. In an ERV, a certain amount of water vapor is transferred along with heat energy, while in the HRV, only heat is transferred. Transferring water vapor across the heat exchanger core is very desirable. In winter, household humidity stays more constant because some of the moisture from the exhaust air is transferred to the less humid incoming winter air. In the summer, the water vapor in the incoming air is transferred to the drier air leaving the house. If you use an air conditioner, an ERV generally offers better humidity control than an HRV. ERVs have been on the market for a while, and are beginning to become recognized for the benefit of humidity control. Although they cost more, the Energy Information Center strongly recommends this option.

**Central intake and exhaust fans.** These systems are similar to the heat recovery ventilator without the heat recovery feature. The initial cost is significantly less than that of an HRV, but will not provide the long-term energy savings of an HRV or ERV or the humidity control advantages of an ERV.

### Exhaust only systems

Exhaust only systems use fans to remove moisture and pollutants from the house, but do not use fans or other mechanical means to bring in outdoor air. Because replacement or makeup air comes from the outdoors by relying on infiltration leaks, they are not considered to be "balanced" systems. Exhaust only systems do not provide humidity control and must only be used in homes that have sealed combustion appliances.

**Operation and control.** Whatever system is selected, it is important that the home owner understand the ventilation requirements and operate the system so as to provide the needed amount of fresh air. All controls should be accessible and easy to understand. They can be automatic or operated manually, but a system that allows a combination of automatic and manual controls is preferable. Make sure your builder explains the system and its controls and that you understand how to do the required routine maintenance (see additional resources section for more information on maintaining the home and its systems). During the first months after a home is constructed, the ventilation system should be operated continuously at the highest rate of operation possible to ventilate the extra moisture and gasses emitted from construction materials, paints, carpets, and other new furnishings. After the first year, the ventilation system should be operated whenever the home is occupied.

**Installation recommendations.** Although ventilation systems can use the same duct system as the furnace, it is strongly advised that the exhaust air have separate ductwork. Recent research has found that the most effective system with a forced air furnace is a balanced ERV with separate exhaust ducts from the kitchen and bath areas with the fresh air being supplied into the supply side of the heating and cooling ductwork. It is always a good idea to locate exhaust grilles high on walls and run the ducts down the wall and the output from the fan out the rim joist. This avoids breaks in the ceiling air barrier, keeps air from rising through the duct when the system is not running, and prevents condensation from forming inside the duct in the attic and dripping back down through the grille. Ventilation system components should be installed to minimize noise and vibration transmission. Ask your builder to provide a written certification that all components of the system and the system operation have been tested to assure it is functioning in the manner intended.

## Renewable energy options

With rising fuel costs there is an increased interest in renewable energy systems that do not rely on fossil fuels or power plants. In general, renewable energy systems such as photovoltaic and wind are expensive compared to conventional sources. In most cases, it is usually best to spend money making the house and its appliances as energy efficient as possible. There are, however, a few opportunities that should be considered in planning for your new home as outlined below.

### Passive solar

Passive solar design integrates a combination of building features to reduce the need for mechanical cooling and heating and daytime electric lighting. Passive solar design is not new, but what is new are building materials, methods and design software. The basic concept is fairly straight forward: use south facing glazing and thermal mass to capture the heat of the sun in the winter and build in shading to keep out the sun in the summer. To be successful, a passive solar structure must be well designed. Because there are numerous subtle details that must be well executed, the Energy Information Center recommends that you hire a design professional. A good place to start is the AIA Minnesota Web site, the department's Renewable Energy CD, and the U.S. D.O.E. Energy Efficiency and Renewable Energy Web portal (see additional resources section for theses Web addresses).

### Solar electricity

In some situations, it may cost $25,000 or more to connect your property to the local electric utility. If your electric needs are modest, you may be able to install a renewable energy system. Keep in mind that although renewable electric systems are expensive ($8,000 to $10,000) per kWh), they may last for several decades so what you are doing is paying for all of your electricity in advance.

Because of the expense it is important to carefully analyze your electric load. It is always going to be more cost effective to purchase more efficient appliances than it is to purchase additional panels. For information to help you do research about these systems, contact the Energy Information Center and request a copy of our Renewable Energy CD.

Even if you are on the grid, you may want to con-

### Zero emissions building

The Science Museum of Minnesota has built a zero emissions building on its grounds in downtown St. Paul. The 1,000 square foot building is designed to produce all of its annual energy needs and includes number of renewable and energy saving features including: a photovoltaic roof, ground source heat pump, energy efficient windows and tight construction, and passive solar design elements. See the Science Museum of Minnesota Web site for more information and hours of operation (www.smm.org/sciencehouse).

## Minnesota's Energy Code

For some time homes in Minnesota have been built on the principle of "build tight and ventilate right." Builders here recognize that the home is a system, consisting of the building structure, the mechanical systems, and the occupants. The Energy Code takes into account the need for air tightness to ensure comfort and energy efficiency, and also the need for mechanical ventilation to control moisture problems and provide proper amounts of fresh air for the occupants.

The result is that new homes in Minnesota are first class in energy efficiency and durability as compared to the rest of the U.S. New home buyers should be aware, however, that they have many options for going beyond code requirements and achieving even higher levels of energy efficiency, comfort, and durability.

sider getting some minimal electrical power from the sun. At present, the state has a rebate for grid-connected solar electric systems. You may also want to consider a solar electric system that can be used as part of the roofing system. These systems, called building-integrated-photovoltaics, or BIPVs, are a mixture of PV modules and conventional roofing with the roofer installs. A solar contractor makes the necessary electrical connections and supervises the work. The systems can integrate well with the structure, but are not necessarily less expensive than installing separate PV modules. As with any system, you should carefully check the warranty.

## Efficient appliances and lighting

Home appliances and lighting are much more efficient than those of 10 years ago, and efficiency pays. Owning and operating a new appliance or lighting is like buying on the installment plan: the purchase price is only a down payment. The rest of the cost is paid through gas and electric bills, month after month, for as long as the appliance and lighting are used. These monthly energy costs add up. For example, running a refrigerator over its typical lifetime of 15 to 20 years typically costs three times as much as the purchase price.

In the case of lighting, an efficient compact fluorescent lamp may cost more than a standard incandescent bulb, but it pays for itself several times over in energy savings and length of life. About one-fourth of the lamps installed in the average home use about three-quarters of the energy use. For that reason, it is important to choose ENERGY STAR lamps and fixtures for high lighting use areas such as the kitchen, bath, and living room.

The easiest way to choose energy efficient appliances is to look for an ENERGY STAR qualified product. The ENERGY STAR label means that the product is among the most energy efficient and will help the environment. A list of qualified products is available from the ENERGY STAR Web site. Our Appliances Home Energy Guide also contains additional information on features to look for when purchasing major home appliances.

## Low toxicity materials and furnishings

The new home built to the standards described in this guide assures, to a considerable extent, a healthy indoor environment. Installing and operating a mechanical ventilation system and selecting sealed combustion or power vented combustion appliances greatly reduce the threat of carbon monoxide (CO) buildup. Mechanical ventilation combined with other measures to control moisture (i.e. a continuous vapor retarder and air barrier and foundation water proofing and other measures to control ground moisture and gases) reduces the source of mold growth and helps prevent radon entry.

Other indoor pollutants, however, particularly volatile organic compounds (VOCs) can come into the home on products and furnishings. VOCs are chemicals that become a gas at room temperature. They are found in such products as particle board, plywood, paneling, and pressed-wood products. Some carpeting, synthetic fabrics, paints, solvents, pesticides, cleaners and disinfectants, air fresheners, and dry cleaned clothing contain VOCs. These sources of VOCs may be too potent to be adequately diluted and dispersed by the ventilation system.

The best prevention is to avoid bringing these materials into the home. Home buyers concerned with these issues should insist that their new home be "Health House Certified" through the American Lung Association's Health House program (see quality control, page 2). More information on VOCs, radon, and other home pollutants is also available from the Minnesota Department of Health from the Web site listed in the additional resources section at the end of this guide.

## Selecting a builder; questions to ask

Higher quality probably translates into higher costs, but a builder experienced in energy efficient construction may be able to build your home for a lower cost than a less experienced builder could. Also explore other options for reducing the costs; for example, ask your local utility if it offers rebates on more efficient appliances, and ask your lender about energy efficient home mortgages.

Throughout this guide the new home buyer has been advised to ask a number of specific questions regarding the components of an energy efficient home. All of these questions are good to discuss and you may, depending on the response of the builder, decide to select another builder. Below are suggestions for other questions to ask and factors to consider before selecting a builder.

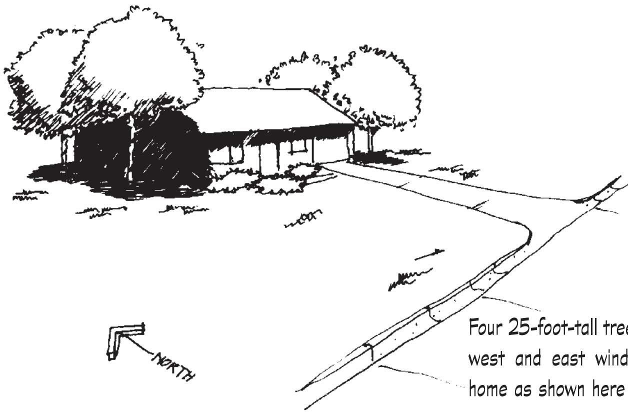
- Chose an ENERGY STAR partner builder and specify that they build an ENERGY STAR home. As explained earlier this program has both design and quality control components that will ensure lasting energy efficiency and building durability.
- Consider building your new home to be “health house certified” through the America Lung Associations Health House program.
- Ask your builder what kind of quality control is provided. Will the builder involve a qualified house performance specialist to verify that your new home will perform as it was designed?
- Ask how long the builder and company have been in service, will they provide references, what after-sale services do they offer, and do they provide a guaranteed third-party warranty and what specifically does it cover? (Third-party refers to those outside the company that the builder hires to perform specific jobs.)
- Ask for a description of the features included in the base price, along with a description and cost of the upgrade options you’ll want to be sure to include now that you’ve read this guide.
- Contracts you sign should clearly spell out what the builder is providing as standard inclusions and what you are paying for as upgrades.
- The range of prices in new homes generally reflects differences in location, features, and quality of construction. If a builder’s prices seem out-of-line, ask for an explanation. Higher prices should reflect better quality materials, finishing, features, and service.
- Check to make sure the builder is licensed.

### New home warranties

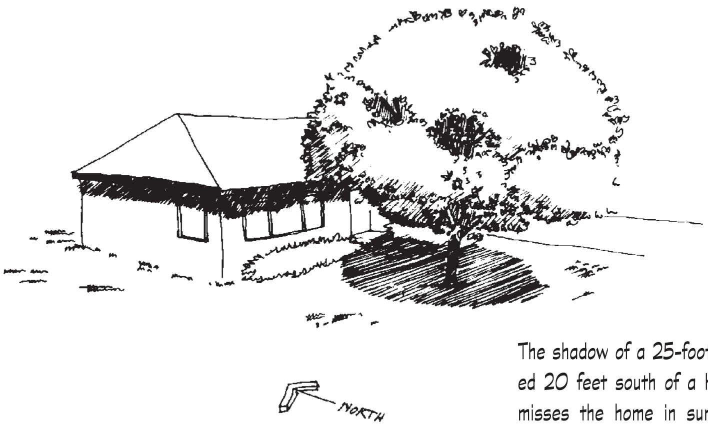
Minnesota law requires builders to warrant that the new home will be:

- Free of major construction defects for 10 years. “Major construction defect” means damage to the load bearing portion of the home, which vitally affects use of the home for residential purposes. It does not include damage caused by flood, earthquake, or other natural disaster.
- Free for two years from mechanical defects caused by faulty installation of plumbing, electrical, heating, and cooling systems due to noncompliance with the state building code.
- Free for one year from defects caused by faulty workmanship and defective materials due to noncompliance with the state building code.

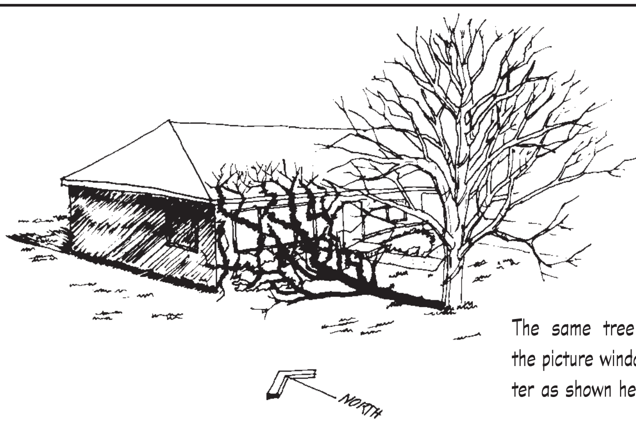
Some builders enroll in private new home warranty programs that cover liability for certain defects. Although the cost of these plans can add to the cost of the home, they may provide protection to the consumer and can be helpful to the new builder in establishing credibility.




Four 25-foot-tall trees effectively shade the west and east windows of this one-story home as shown here at 3 p.m. in July.




The shadow of a 25-foot-tall tree located 20 feet south of a home completely misses the home in summer as shown here at 3 p.m. in July




The same tree detrimentally shades the picture window throughout the winter as shown here at noon in January.

This tree shading an air conditioner still allows good air circulation.

## Energy Saving Landscaping for New Homes

Strategic planting of trees can help improve the overall energy efficiency of your new home. The object is to use trees to shelter the home from the harsh winter winds while maximizing solar heating. In the summer, trees can be used to reduce unwanted heat from the sun.

In winter, a significant amount of solar energy is available through south facing windows, less through east and west windows. In summer, about half the unwanted heat in a home comes from sun shining through the windows. Because of the angle of the sun, nearly twice as much of the sun's energy strikes the east windows in the morning or the west windows in the afternoon as hits the south windows.

The following are the most critical actions for planting for energy conservation:

**Shade west and east windows.** Give highest priority to planting shade trees due west of west windows. Planting shade trees due east of windows is second priority.

**Avoid trees south of windows.** Contrary to intuition the worst place to have a tree from an energy-saving perspective is on the south side of the home. In summer when the sun is high in the sky at midday, the shadow of a tree falls directly under the tree and entirely misses a home to its north. In winter, the shadow of the tree will fall on the house throughout most of the day.

**Shade air conditioners.** An air conditioner runs more efficiently if it is in a cooler environment. It is best to locate air conditioners away from south windows and shade them with trees.

**Create a windbreak.** A home on a site of a quarter-acre or so should have room for a windbreak along its west and/ or north side. The idea is similar to the traditional farmstead shelterbelt, only on a smaller scale.

**Increase tree canopy cover.** Smaller residential yards just do not have space for large dense evergreen trees whose spread may reach thirty feet. However, remember the canopy of tall trees throughout the neighborhood also provides significant shelter.

Our Saving Energy with Trees Home Energy Guide contains more details on these strategies and includes a list of recommended species.

## Additional resources

This section provides the Web site addresses for the resources mentioned in this guide. In addition, we provide other references useful for planning, designing and building your new home.

### Quality control programs

- ENERGY STAR New Homes: www.energystar.gov (click on "find local home builders" under the "new homes" column). The ENERGY STAR Web site also provides additional information about topics discussed in this guide including lists of qualified heating and cooling equipment, appliances and lighting fixtures. The site also has information concerning duct sealing, placement and sizing.
- American Lung Association Health House: www.healthhouse.org.

### Windows, building envelope, and general building science

- Department of Commerce Building & Energy Industry Library CD: available from our Energy Information Center (energy.info@state.mn.us). The disk includes "best practices window installation video" and useful building design information.
- National Fenestration Rating Council: www.nfrc.org (click on "get product ratings").
- University of Minnesota Extension Service: www.extension.umn.edu (click on "environment" and then "energy").
- Structural Insulated Panel Association: www.sips.org.
- Insulating Concrete Form Association: www.forms.org.
- Builders Association of Minnesota: www.bamn.org.
- Energy & Environmental Building Association: www.eeba.org (see "bookstore" to order Builders Guide for Cold Climates and other publications).
- Building America: www.eere.energy.gov/buildings/building_america.

### Water and space heating

- American Council for an Energy Efficient Economy: www.aceee.org > consumer resources
- Gas Appliance Manufacturers Association: www.gamanet.org (click on "Product Certification" and then "Product Directories").
- Toolbase Services – The Home Building Industry's Technical Information Resource: www.toolbase.org (use search feature to learn more about "plastic plumbing manifolds").
- Geothermal Heat Pump Consortium: www.geoexchange.org

### Home maintenance and general energy conservation

- Department of Commerce Consumer Energy CD: available from the department's Energy Information Center (energy.info@state.mn.us). The disk contains the entire Home Energy Guide series, the "best practices window installation video," and more. Many of these publications are also available from our Web site.
- Home-Smart – A helpful guide for homeowners (www.home-smart.org)
- Family Handyman Magazine, Home Service Publications: www.familyhandyman.com

### Renewable energy and indoor air quality

- Department of Commerce Renewable Energy CD: available from the department's Energy Information Center (energy.info@state.mn.us).
- Solar Rating and Certification Cooperation: www.solar-rating.org (click on "ratings" for directory of certified solar collectors).
- U.S. DOE Energy Efficiency and Renewable Energy Web Portal: www.eere.energy.gov
- AIA Minnesota – A Society of the American Institutes of Architects: www.aia-mn.org.
- Minnesota Department of Health: www.health.state.mn.us (click on "mold" or "radon" in far left column).
- Science Museum of Minnesota Science House: Zero Emissions building: www.smm.org/sciencehouse

Minnesota Department of Commerce

Suite 500
85 7th Place East
St.Paul, MN 55101-2198
www.commerce.state.mn.us

## Energy Information Center

Twin Cities:
651-296-5175

TTY: 651-297-3067

Statewide toll free:
1-800-657-3710

This information will be made available, upon request, in alternative formats such as large print, Braille, cassette tape, CD-ROM.

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MINNESOTA DEPARTMENT OF COMMERCE

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## Minnesota Home Energy Guides

This guide is one in a series of publications designed to help Minnesotans save energy in their homes. Copies of the titles listed below are available by calling or contacting the Minnesota Department of Commerce.

**CD-ROM** containing all of the Home Energy Guides as well as several other publications of interest to homeowners, builders and contractors.

**Appliances** advises consumers on what to look for in energy efficient appliances and includes information on efficient operation and maintenance of refrigerators, freezers, washers, dryers, dishwashers, cooktops, ovens, and home office equipment.

**Attic Bypasses** explains how to find those “hidden air passageways” and fix them to prevent costly heat loss and damage to roofs, ceilings, walls, and insulation.

**Basement Insulation** discusses options to improving basement comfort, many not even involving insulation. It also provides details on exterior basement insulation, special foundation products and recommendations on interior insulation.

**Caulking and Weatherstripping** describes how to identify sources of air leaks, lists various types of caulk and weatherstripping, and provides illustrated how-to-apply instructions.

**Combustion and Makeup Air** describes the causes of dangerous combustion air problems and tells how to install an outside combustion air supply. It also tells how to test your home for combustion air problems.

**Home Cooling** tells you how to cool without air conditioning, and provides information on buying and operating energy efficient air conditioners.

**Home Heating** describes proper maintenance techniques and helps you become an educated shopper if you are buying a new heating system.

**Home Insulation** helps the homeowner evaluate the benefit of added insulation, providing information on buying and installing insulation.

**Home Lighting** looks at new technologies for residential lighting, identifying four basic strategies and providing examples for putting them into practice.

**Home Moisture** describes symptoms of moisture problems, lists common indoor and outdoor causes, and discusses preventive and corrective measures.

**House Dianostics** explains what it entails and helps you decide if you need these services.

**Ice Dams** describes what causes ice dams and how to fix them.

**Indoor Ventilation** describes the types of home mechanical ventilation systems that are available, the amount of ventilation air needed, and how best to operate and maintain the system.

**Low Cost/No Cost** addresses the often overlooked energy saving tips for all areas of your home.

**New Homes** discusses a wide range of options for increasing energy efficiency beyond the normal building code requirements. Subjects covered include insulation, ventilation, air-vapor controls, heating and cooling, windows, doors, and appliances.

**Saving Energy With Trees** describes how to use trees and shrubs for long-term energy savings, and lists trees appropriate for energy-savings.

**Water Heating** helps you determine whether to buy a new water heater or improve the old one. It explains the efficiency of different types of water heaters and provides installation tips.

**Windows and Doors** helps you decide whether to replace or repair windows or doors and gives a good summary of energy efficient replacement options.

**Wood Heat** offers advice on purchasing and installing a wood stove, with special emphasis on safety.