For Builders and Designers

MONTANA guide to building

ENERGY STAR Solar Homes

- BUILDING ORIENTATION
- SOLAR ELECTRIC SYSTEMS
- PASSIVE SOLAR DESIGN
- SOLAR WATER HEATING
- COMFORT
- DURABILITY
- PERFORMANCE TESTING
- CERTIFIED ENERGY EFFICIENCY

Energy efficiency and solar energy are a natural combination. Don't be satisfied with less than a high-peformance solar home!

National Center for Appropriate Technology

Montana Solar ENERGY STAR Homes is administered by:

National Center for Appropriate Technology (NCAT)
P.O. Box 3838
Butte, MT 59701
Toll-free 800-275-6228
www.ncat.org

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www.northwesternenergy.com

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www.millionsolarroofs.org

ENERGY STAR Homes Northwest

ENERGY STAR Homes Northwest (ESHNW) promotes the construction of new homes built to an energy efficiency specification negotiated specifically for Idaho, Montana, Oregon, and Washington.

Natural gas-heated homes built to this voluntary construction standard reduce electricity use by about 20 percent and natural gas use by almost 40 percent compared to the state energy code. Homes with electric heat built to the ESHNW standard will save about 60 percent of electric use.

Homes achieving ENERGY STAR certification are independently verified, so your clients can rest assured knowing their new home will perform efficiently far into the future!

The ENERGY STAR Homes Northwest Program sponsors builder workshops on energy-efficient new home construction every fall and spring. These workshops offer the opportunity to learn from building science experts how to build an energy-efficient home. For more information, call (877) 298-2172.

To learn more, visit these websites:
www.northwestenergystar.com
www.energystar.gov

Solar Ready

Even if you choose not to install solar electric and solar water-heating systems now, a house should be designed so that these systems can be easily added in the future.

In order for a home to be "solar ready," you'll need to follow some basic guidelines during construction:

1. Provide sufficient roof area with an unobstructed exposure to the sun from 9 a.m. to 3 p.m.

For solar electric systems:

2. Provide a wire chase to connect the solar array, the inverter, and the electrical panel.

3. Provide a circuit in the breaker box for the solar electric feed.

4. Provide a vertical wall area to mount a four-feet by four-feet inverter panel, usually in a utility or mechanical room.

5. Install an electric service disconnect switch.

For solar water-heating systems:

6. Provide a pipe chase from solar collector area to the hot water storage tank location, near the conventional hot water tank.

7. Provide extra space for a future solar water storage tank, approximately four feet by four feet, immediately adjacent to the conventional water heater.

8. Make sure that the roof structure is sufficient for the weight of solar collectors.

Solar Water Heating

The average person uses 15 to 20 gallons of hot water a day. At 8 cents per kilowatt-hour for electricity, an average family of four spends between $400 and $550 a year to heat water! A properly sized solar water heater can cut those costs in half.

The challenge for solar water heating in northern climates is freeze protection. Systems that work in Montana include:

Draindown systems pump water from the hot water tank through the solar collectors, where it is heated by the sun and returned to the tank. Valves automatically drain the system when sensors detect freezing temperatures.

Drainback systems use a separate plumbing line, filled with fluid, to gather the sun's heat. These systems operate strictly on gravity. When the temperature is near freezing, the pump shuts off and the transfer fluid drains back into the solar storage tank.

Antifreeze closed-loop systems rely on an antifreeze solution to operate through cold winter months. Antifreeze solutions are separated from household water by a double-walled heat exchanger.

Typical Single Family House Electric Use

Space Heating	Hot Water	Cooking	Central Air Conditioning	Electric Consumption kWh/Year
Gas	Gas	Gas	None	7,192
Gas	Gas	Electric	None	10,884
Gas	Electric	Electric	Central	11,626
Electric	Electric	Electric	None	20,257
Electric	Electric	Electric	Central	20,999

Grid-Connected Solar Electric

Solar electric systems—also called photovoltaic or PV—generate electricity directly from the sun. PV offers a reliable source of electric power, decreased dependence on outside energy sources, and increased energy security. PV systems are reliable, non-polluting, and require little maintenance.

A grid-connected, or net-metered, PV system is connected to the utility grid through a special meter that turns backwards when the house produces more electricity than it needs. The utility grid serves as storage, eliminating the need for batteries. Off-grid systems also are available, but they require batteries for energy storage.

For NorthWestern Energy electric customers, net metering allows solar electricity generated during sunny times of the year to offset electric use at other times. Other utilities have net metering policies that limit this ability to "bank" solar energy generated to a monthly or quarterly basis.

Net-metered PV systems usually consist of a photovoltaic array, an inverter, wiring, and switches. The array is typically made of rigid panels made of individual photovoltaic cells. Solar shingles and other building-integrated solar cells are appearing in the marketplace. A solar electric system produces direct current (DC) electricity, which is converted by an inverter into alternating current (AC) electricity at the utility's voltage and frequency. The AC electricity is fed into the household's main electric breaker panel.

How much elctricity (kWh/Yr) will a PV system produce?

	1-kW	2-kW	3-kW	4-kW	5-kW
Missoula	1428	2857	4285	5713	7142
Great Falls	1651	3302	4953	6603	8254
Billings	1689	3378	5067	6756	8445
Helena	1590	3180	4770	6359	7949
Kalispell	1403	2805	4208	5611	7013

Passive Solar and Solar Tempering

Passive solar and solar tempering refer to heating and cooling a house with non-mechanical systems that utilize natural forces such as the sun and wind. Passive or "integrated" design utilizes the relationships between building components such as south-facing windows and thermal mass. Windows should be oriented within ten degrees of true south.

Window Orientation	
Degrees off True South	Percent Solar Gain
22.5	92%
45.0	70%
67.6	36%

- Even small deviations from due south can cause significant increases in unwanted heat gain in the cooling months.
- Southeast orientation is better than a southwest orientation in climates like Montana.
- A rectangular building footprint with the long axis in the east-west orientation is best for passive solar designs. This maximizes southern exposure and minimizes east and west exposures.

In our climate, spring tends to be cool and fall tends to be warm and sunny. Overhangs and other shading devices are often designed as a compromise with intermediate-sized shading devices that permit greater sunlight in the spring and then assume that unwanted fall solar gain will be reduced with window shades or deciduous trees and vines.

Thermal mass, usually a concrete slab floor or masonry walls, can be used to store solar heat for use when the sun does not shine. Thermal mass also minimizes overheating in the space when the sun is shining.

Solar tempered designs are the simplest and least expensive solar design strategies because they do not require thermal mass.

- South glass should not exceed 7 percent of total floor area in a house without added thermal mass.
- This strategy can satisfy up to 20 percent of a home's space heating energy needs.

Passive solar designs can provide over half the space heating energy but require added thermal mass that can also add significantly to the cost of the house.

- Typical designs include south windows totaling 7 to12 percent of floor area. Thermal mass prevents overheating and stores heat for use when the sun is not shining.
- A common rule-of-thumb is that 5.5 square feet of uncovered and sunlit floor mass is required for each square foot of south glazing.
- The windows, shading devices, and thermal mass must be carefully designed if a passive solar home is to achieve maximum comfort and energy performance.
- Insulating even very energy-efficient windows can significantly increase the effectiveness of passive solar strategies.

The surface area of thermal mass is more important than its depth. Beyond four inches in depth, the effectiveness of masonry thermal mass decreases significantly.