Passive Solar Building Design Guidelines and Recognition Program

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Prepared by

City of Santa Barbara
Community Development Department

Purpose of These Guidelines

These guidelines provide guidance to property owners, architects, contractors and others who may be interested in creating a passive solar building to save energy and create a more comfortable home enviornment. The guidelines include techniques for designing passive solar buildings that use solar energy. The guidelines have the following goals:

- Encourage passive solar designs compatible with the surrounding neighborhood and preserve the City's historic and visual resources
- Implement the Solar Recognition Program to publicly recognize effective and aesthetically designed passive solar buildings which voluntarily comply with these guidelines.
- Promote early design consideration for integration of passive solar energy system concepts in new structures and additions.

How to Use These Guidelines

Are the guidelines mandatory or voluntary?

These guidelines are voluntary. They are not intended to prohibit, restrict or condition the use of any passive solar energy techniques or to mandate passive solar techniques. The City encourages thoughtful consideration of these passive solar guidelines to achieve the goals listed above. Applicants who follow these guidelines can qualify for special recognition from the City Council.

Are the guidelines for residential buildings only or for all uses?

The guidelines and the Solar Recognition Program are for all uses, including both residential and commercial.

Are the guidelines citywide or for certain neighborhoods or zones?

These guidelines and the Solar Recognition Program can be applied citywide.

Are there also guidelines and an award recognition for active solar energy systems?

Yes, visit the Planning and Zoning Counter at 630 Garden Street or www.santabarbaraca.gov/Resident/Home/Forms/design_guidelines.htm to obtain a copy of the City's Solar Energy System Design Guidelines and Recognition Program.

Introduction

While solar energy systems such as photovoltaic installations are a great alternative to using fossil fuels for energy, the most sustainable energy technique is to conserve as much as possible. Passive solar building design can aid energy conservation efforts because building design is directly related to energy use. Buildings with passive solar building designs naturally use the sun for free heating, cooling and lighting. This reduces the need to consume energy from other sources and provides a comfortable environment inside. The principles of passive solar design are compatible with diverse architectural styles and building techniques. This approach can also complement active solar energy systems such as photovoltaic arrays and solar hot water systems.

Quality construction techniques to minimize unintended building openings are also important compliments to passive heating and cooling. Local building codes require seals around doors, plugs and windows and a minimum amount of insulation. Consider exceeding local building code requirements for insulation and other items as part of your passive solar design project.

In addition to the principles and techniques in these guidelines, see the City's Solar Energy references and resources handout at www.SantaBarbaraCA.gov/Resident/Home/Forms/planning.htm for more information about how to incorporate passive solar building design into projects. Also, after the building is occupied, be sure to take steps to conserve energy by using energy-efficient appliances and equipment and by avoiding unnecessary energy usage.

The following nine techniques are generally from the Santa Barbara County Green Building Guidelines. Each technique is an item on the checklist for the City of Santa Barbara's Solar Design Recognition Program. Projects that meet at least seven of the principles on the checklist can qualify for recognition in the "Passive Solar Building Design" category.

Passive Solar Heating

1 Building Orientation
2 Window Selection and placement
3 Using Thermal Mass to Moderate Temperature
4 Meet remaining heating load with an efficient back-up system

Passive Cooling

5 Minimize direct sun exposure and heat absorption
6 Allow for cool air to enter the building
7 Give hot air a way out of the building

Natural Lighting

8 Maximize natural light
9 Special glazing and automated controls

Follow the ☑ check mark symbols throughout the document to design an effective passive solar building eligible for the City's Solar Recognition Program. Awards are presented publicly each summer at a City Council hearing.

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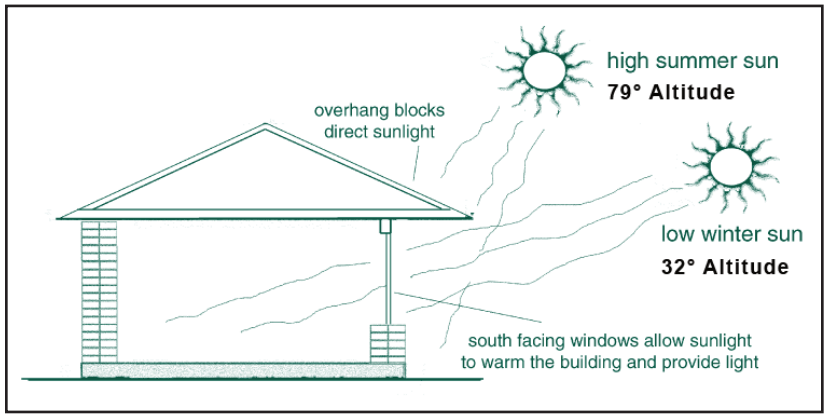
Passive Solar Heating Techniques

1. Orient buildings or additions to maximize winter sun exposure.

- Place buildings or additions on the site where they receive the most winter sun and are blocked from cold winter winds.
- Elongate the building or addition on its east-west axis for increased winter sun exposure.
- Minimize north-side building or addition exposure.
- Place habitable rooms on the south side and rooms with minimal heating and lighting requirements (closets, corridors, laundry, garage, utility rooms, etc.) along the north side.

☑ **Have you oriented buildings or additions to maximize winter sun exposure?**

2. Choose top-quality windows and place them strategically.



This drawing shows a home that uses passive solar heating principles. In the summer, the overhang blocks the warm sun. In the winter, south-facing windows allow sunlight for warmth. Source: "Santa Barbara County Green Building Guidelines," by the Sustainability Project. Also see the last page of these guidelines for information about how the sun's daily path varies in summer and winter

- Locate major window openings on the southeast, south, and southwest. Keep windows small on the north and west.
- Select top-quality windows. Optimize building glazing by evaluating R-value, visible light transmittance and solar heat gain coefficient of the glass.

2 continued:

- In the Santa Barbara region, provide 0.11-0.25 square feet of south-facing glass for each square foot of habitable floor area to allow for direct heat gain. Do not over-glaze; too many windows will cause the building to overheat.

☑ **Have you chosen top-quality windows and placed them strategically?**

3. Use thermal mass to moderate temperature swings indoors.

Incorporate thermal mass in floors and walls where possible to serve as a heat sink for direct or indirect passive solar heating strategies and to minimize indoor temperature fluctuations. Thermal mass saves energy in regions like ours where the outdoor air temperature fluctuates daily above and below the comfort range. The thermal mass absorbs energy during the day, and then transfers it to the indoor environment at night, serving as an effective (and free) heat source.

☑ **Have you used thermal mass to moderate temperature swings indoors where possible?**

4. Meet remaining heating load with an efficient back-up system.

- Consider using radiant floor heating produced by a solar hot water system.
- Consider an efficient wood or pellet stove with a catalytic converter to minimize particulate emissions as a back-up heat source. When buying a wood stove, make sure that it meets all applicable air quality regulations and is correctly sized for the space it will heat.

☑ **Have you considered meeting the remaining heating load with an efficient back-up system?**

Passive Cooling Techniques

5. Minimize direct sun exposure and heat absorption.

- Give priority to exterior sun controls, such as trees, awnings or trellises – as opposed to interior controls, such as drapes and shutters – in order to block light and heat before they penetrate the building skin.

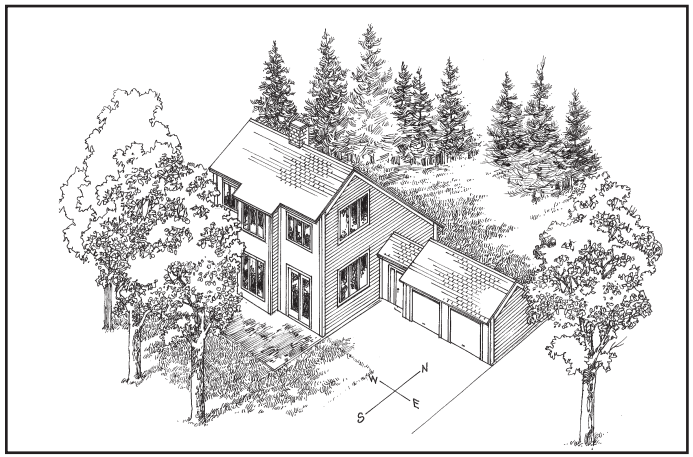
5 continued:

- Shade south windows with overhangs sized to keep the sun out in the summer and early fall. Shading devices can take on many attractive forms, such as trellises and awnings.
- Try to minimize west-facing glazing. Shade west glazing by strategically locating shade trees, trellises, awnings, exterior blinds or shutters. In hillside areas, east-facing glazing may require shading as well. Vertical shading devices work best on east-west orientations because of the low sun angle.
- Minimize the size of skylights and use them mostly for natural lighting. Skylids can be used for direct heat gain, or skylights can be indirect (solar tube) to eliminate overheating and glare.
- Make the roof a light color if appropriate. Always take into account the context of the project; for example, earth tones are preferred in hillside areas to minimize visual impact.
- Use light-colored, non-reflective finishes balanced with glare control for outdoor sidewalks, driveways, patios, and parking areas and shade them whenever possible.
- Use high-performance glazing selected for your climate and purpose to optimize heat transfer between the interior and exterior.

☑ **Have you minimized direct sun exposure and heat absorption?**

6. Allow a way for cool air to enter the building.

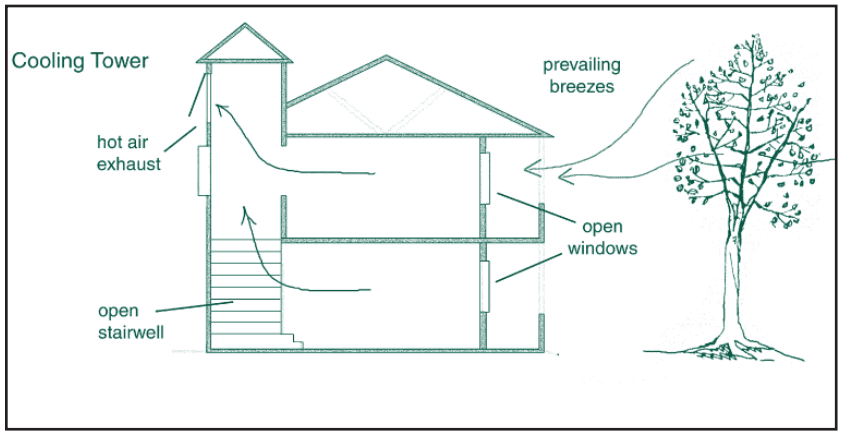
- Arrange openings to catch cooling summertime breezes (which come mostly from the southwest in Santa Barbara). Size and locate outlet openings to accelerate the flow of breezes through habitable rooms. Avoid heat sinks (thermal mass) outside inlet openings. For example, do not place an asphalt driveway in front of the inlet openings catching the cooling breezes.
- Pre-cool entering breezes by passing air through vegetation or by passing it over water ponds or fountains. Avoid dark-colored paving.



Passive solar homes take advantage of natural climate conditions for heating and cooling. In the winter, when the trees' leaves have fallen, the home's long south-facing frontage and large windows let in sunlight for warmth. In the summer, the roof overhang and the leafy trees block the hot sun. Source: The Passive Solar House, by James Kachadorian

6 CONTINUED:

- Consider using a "Solar Slab" to create a functional thermal mass flooring with concrete materials.



Design buildings to let in cool air and release hot air. Source: "Santa Barbara County Green Building Guidelines," by the Sustainability Project

- Use attic fans, whole house fans, and ceiling paddle fans (preferably solar-powered) to assist in cooling airflows and exhausting hot air.
- Consider incorporating cooling towers or thermal chimneys.

☑ **HAVE YOU ALLOWED A WAY FOR COOL AIR TO ENTER THE BUILDING?**

7. GIVE HOT AIR A WAY OUT OF THE BUILDING.

- Employ strategies that utilize nighttime and early morning cooling. These can help reduce the need for mechanical air conditioning.
- Consider cupolas, belvederes, operable skylights and clerestory windows, and thermal chimneys at roof peaks to pull out hot air.
- Incorporate reflective foil and an airspace underneath the roof sheeting to reduce heat penetration.

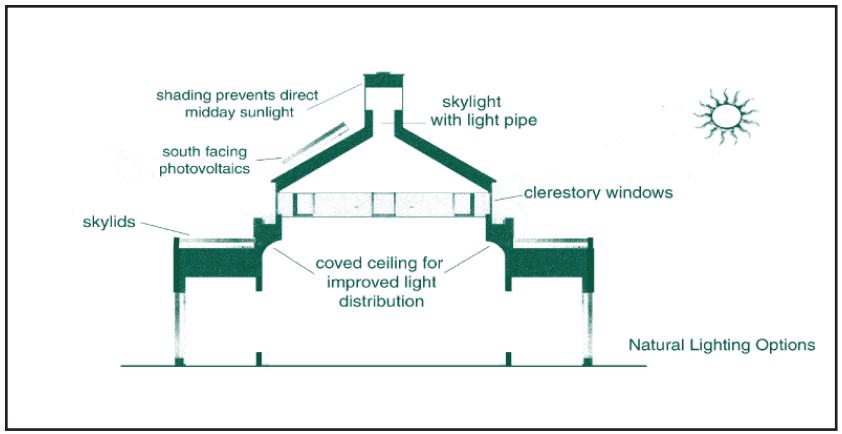
☑ **HAVE YOU GIVEN HOT AIR A WAY OUT OF THE BUILDING?**

Natural Lighting Techniques

8. CONSIDER THE FOLLOWING STRATEGIES TO MAXIMIZE NATURAL LIGHT AND COMFORT.

- Consider using computer modeling tools along with technical advances in glazings to optimize natural lighting. See the resources section for software tools.
- Try to arrange natural lighting from at least two planes of every room, (i.e., two walls or a wall and ceiling).

8 CONTINUED:



Properly designed buildings will let in plenty of natural natural light but not too much heat. Source: "Santa Barbara County Green Building Guidelines," by the Sustainability Project

- Consider using clerestory windows, roof monitors, or skylights for overhead natural lighting. Integral tracking reflectors can increase skylight performance early and late in the day. Carefully design skylight areas to avoid overlighting and overheating. Indirect natural lighting systems will prevent overheating and glare.
- For improved distribution of natural light and reduced glare, use light shelves on south-facing windows at about head height, highly reflective ceilings, and light-colored interior surfaces. Surprisingly, it is more important to reduce "veiling glare"—stray light that washes out contrast—than it is to add more natural lighting.
- Consider integrating photovoltaics into large south glazing areas to reduce glare and cost.
- To avoid overheating, minimize direct-beam sunlight penetration into workspaces with the use of shading devices.
- Use task lighting to supplement ambient natural lighting in work areas.

☑ **HAVE YOU CONSIDERED THE STRATEGIES ABOVE TO MAXIMIZE NATURAL LIGHTING AND COMFORT?**

9. CONSIDER SPECIAL GLAZING AND AUTOMATED CONTROLS.

- Maximize visible light transmittance of glazing while minimizing heat loss and, on east and west exposures, solar heat gain through the use of spectrally selective glazings. Attractive options are:

  - spectrally selective tinted glass;
  - low emissivity coatings (low-E and low E2);
  - "heat mirror" (incorporates a thin plastic film within the air space to effectively create two air spaces);
  - electrochromic glazing (uses electric current to control the amount of heat and light that enters); and
  - "super windows" (incorporate multiple thin plastic films within an enlarged air space)
  - low energy (low E) transmitting glazing and double or triple glazed windows

9 CONTINUED:

- Consider using light pipes or fiber-optic systems for natural lighting spaces far from light openings and reducing glare and overheating. Fiber-optic systems are expensive and may be feasible only in commercial installations).
- Zone lights so that those near windows can be off at times when lighting further from windows is necessary. Continuous dimming electronic ballasts can further reduce energy consumption by up to three times over fixed-output models.
- As part of natural lighting strategies, arrange lights and controls for maximum flexibility and adjustability, including the use of automated natural light-actuated controls.

☑ **HAVE YOU CONSIDERED SPECIAL GLAZING AND AUTOMATED CONTROLS?**

SOLAR DESIGN RECOGNITION PROGRAM CHECKLIST: PASSIVE SOLAR BUILDING DESIGN

Use this checklist to determine whether a project is eligible for a City Passive Solar Recognition Award. If answers to questions below is "yes," the project may be eligible.

Passive Solar Heating

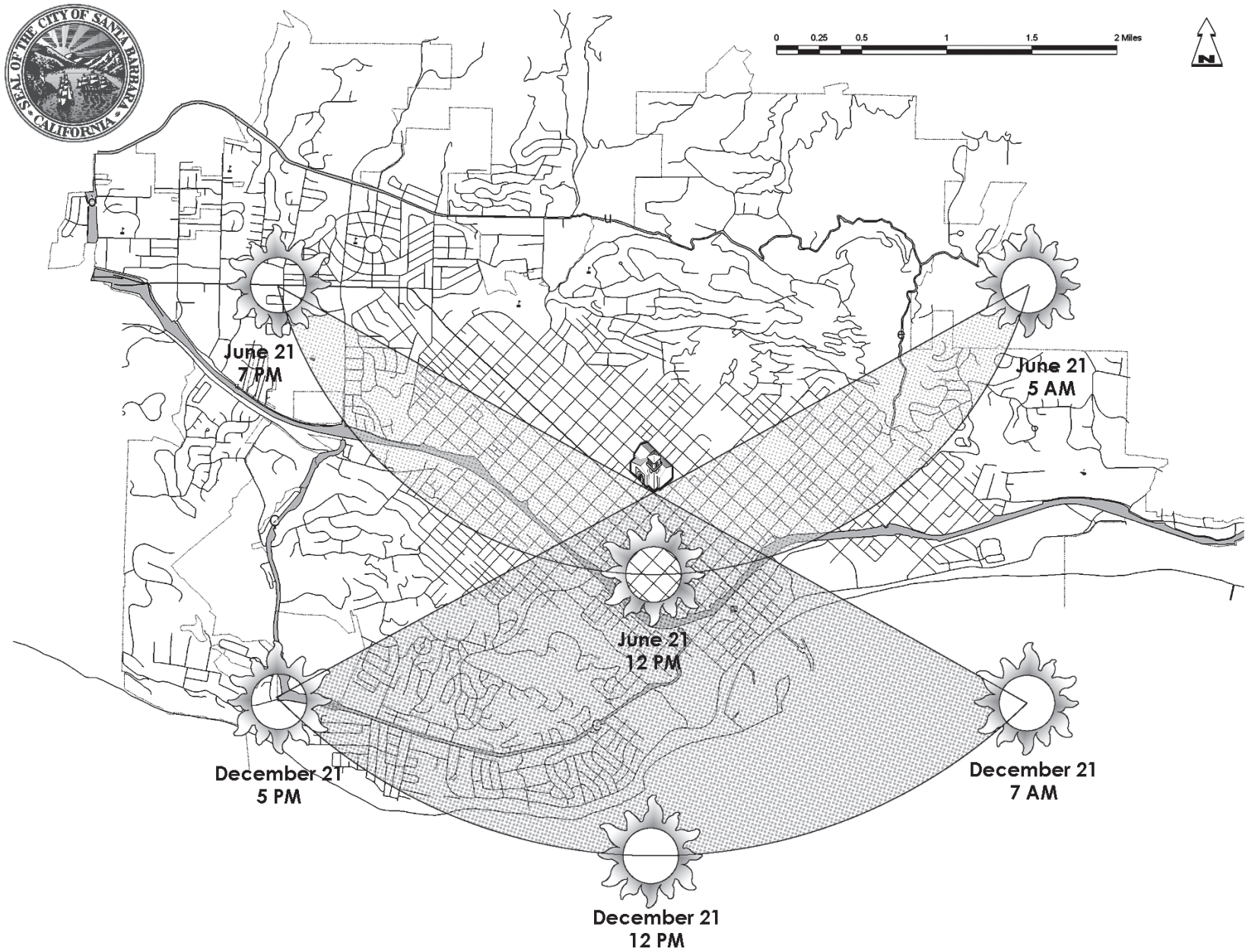
1: ❑ Have you oriented buildings to maximize winter sun exposure?
2: ❑ Have you chosen top-quality windows and placed them strategically?
3: ❑ Have you used thermal mass to moderate temperature swings indoors where possible?
4: ❑ Have you met remaining non-passive heating load with an efficient back-up system?

Passive Cooling

5: ❑ Have you minimized direct sun exposure and heat absorption?
6: ❑ Have you allowed a way for cool air to enter the building?
7: ❑ Have you given hot air a way out of the building?

Natural Lighting

8: ❑ Have you maximized natural lighting and comfort?
9: ❑ Have you used special glazing and automated controls?



This diagram shows the sun's path from sunrise to sunset at summer and winter solstice from the perspective of the Santa Barbara County Courthouse.