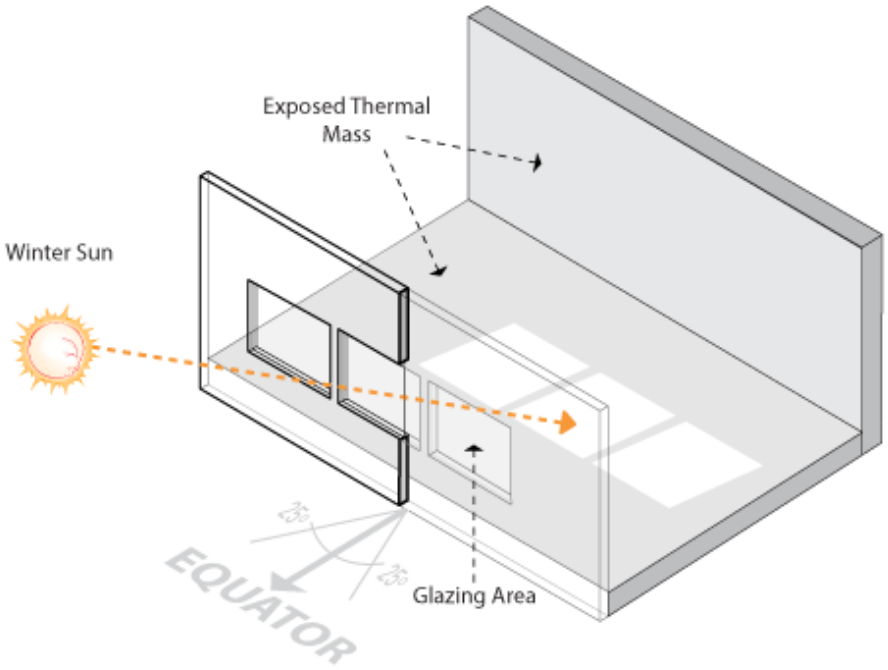
# Sizing Solar Glazing



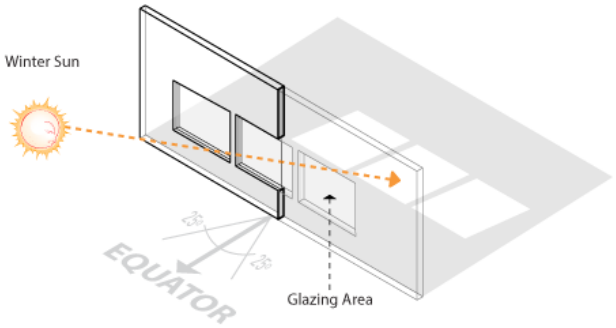

A Direct Gain passive heating system integrates the components of the system, solar glazing (solar collection) and thermal mass (heat storage medium), directly into a building. The most important factor in collecting the sun's energy is the placement and size of glazed openings.

Direct Gain systems are characterized by solar glazing areas oriented towards the equator – south in the Northern Hemisphere and north in the Southern Hemisphere. Solar glazing functions as the solar collector for the passive heating system, admitting sunlight and heat directly into a space during the cold months.

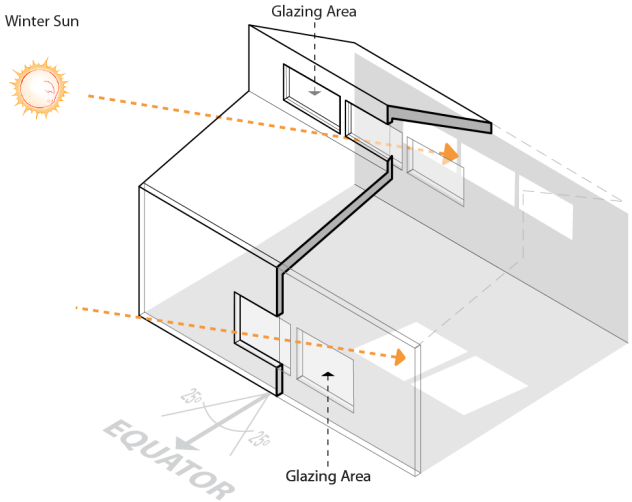
Direct Gain systems also provide daylight to a space, however care should be taken to avoid glare conditions. They are also well-suited for any climate where heating is needed, and are normally designed for skin-load dominated buildings (most residential and low rise commercial buildings). When designed correctly, Direct Gain systems are highly efficient, transferring about 60-75% of the sunlight incident on the solar glazing into the space for space heating. Sunlight entering a space is unlikely to be reflected back out through the glazing, regardless of the color or shape of the space.

## Location

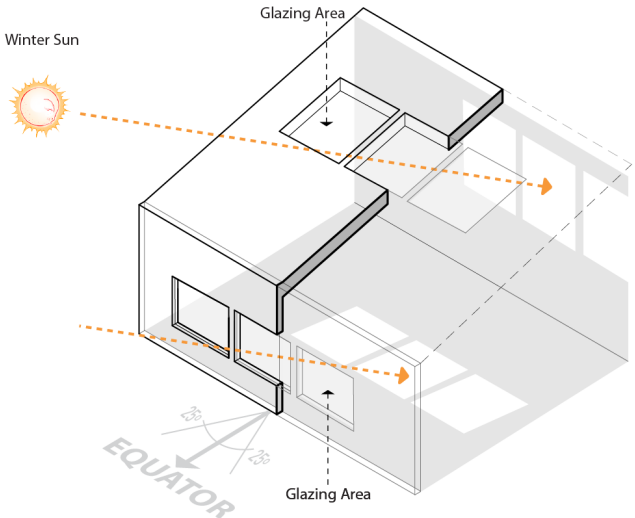
Glazing can be integrated into the vertical skin of the solar façade – fixed or operable windows, glazed doors, and curtain walls – or into a clerestory or solar-facing sloped skylight to admit sunlight through the roof of a space. Solar skylight and clerestory glazing allows for additional freedom when locating spaces with exposure to the roof plane, and can reduce interior glare, provide privacy, and is less likely to be shaded by off-site obstructions. Solar glazing can be oriented within a range of 25° east or west of facing the Equator with little decrease in system performance. See the Swatch Clerestories and Skylights for additional design information.




1. Direct Gain glazing can be integrated into the vertical skin of the solar façade – fixed or operable windows, glazed doors, and curtain walls.




2. Direct Gain glazing can be integrated into a clerestory located on the solar façade (i.e. facing the equator). Clerestory glazing allows for additional freedom when locating spaces with exposure to the roof plane, and can reduce interior glare, provide privacy, and is less likely to be shaded by off-site obstructions.




3. Direct Gain glazing can be integrated into a solar facing sloped skylight to admit sunlight through the roof of a space. As with clerestories, using skylights to provide top heating allows for additional freedom when locating spaces with exposure to the roof plane, and can reduce interior glare, provide privacy, and is less likely to be shaded by off-site obstructions.

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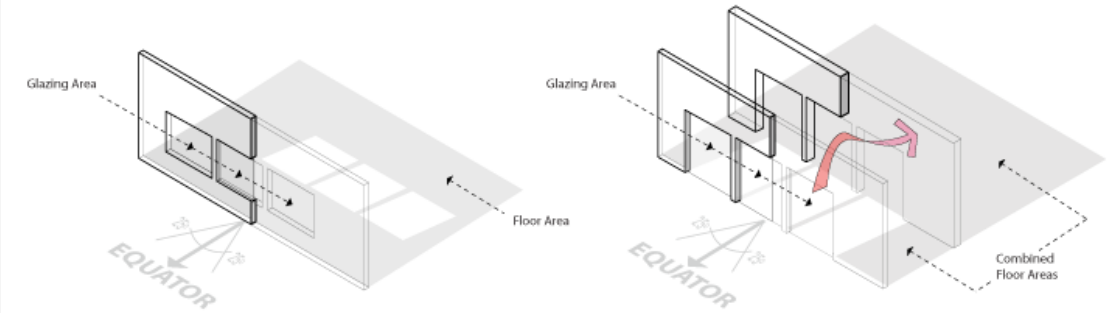
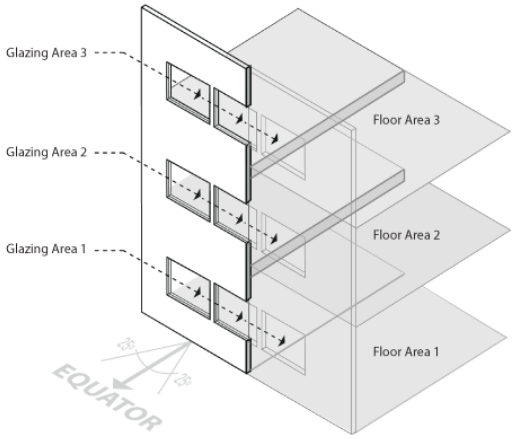



Size solar glazing for each space as a percentage of the floor area to be heated. For heating adjacent spaces, size solar glazing as a percentage of the total combined floor area.

When heating unconnected spaces, each space requires its own glazing.

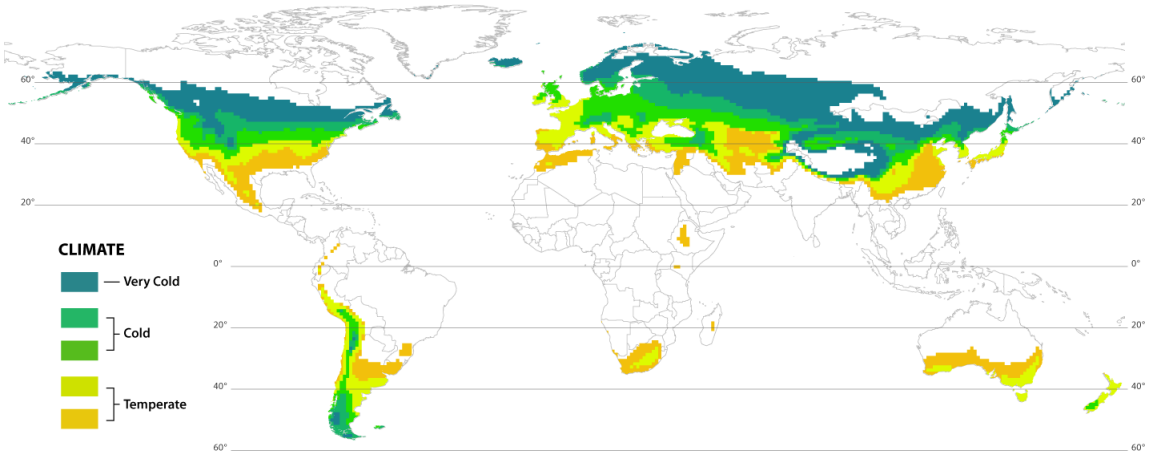
The amount of solar glazing determines the average temperature in a space over a sunny day. During a typical sunny winter day, if a space becomes uncomfortably hot from too much sunlight, the solar glazing is either oversized or there is not enough exposed thermal mass distributed within the space to absorb heat from incoming sunlight. As a space becomes too warm, heated air is vented from the space by opening windows or activating an exhaust fan to maintain comfort, reducing the efficiency of the system. For this reason, our criterion for a well-designed space is that it gains enough solar energy, on an average sunny day in winter, to maintain comfortable indoor space temperatures for that 24-hour period.




Size the total area of solar glazing as a percentage of the total floor area to be heated.

Heat is distributed within a space by radiation and convection, and can be distributed to adjacent spaces by convection through large wall openings. For heating adjacent spaces with an adequate thermal connection – large, unobstructed openings for air movement between Direct Gain and adjacent spaces – size the solar glazing area as a percentage of the total combined floor area.

Use the following table to determine the approximate percentage of solar glazing to floor area for a given climate and latitude:



| Climate | | Average Daily Winter Temperature °C | °F | Percentage of Glazing Area to Heated Floor Area (North or South Latitude) 28°-36° | 40° | 44° | 48° | 52° | 56° |
|---|---|---|---|---|---|---|---|---|---|
| **Very Cold** | | -12 | 10 | 22%[1] | 22%[1] | 24%[1] | 26%[1] | 26% to 30% [1,2] | 26% to 30% [1,2] |
| **Cold** | | -7 | 20 | 18%[1] | 18%[1] | 20%[1] | 22%[1] | 25%[1] | 26% to 30% [1,2] |
| | | -4 | 25 | 16% | 16% | 17% | 19% | 22%[1] | 26% to 28% [1,2] |
| **Temperate** | | 2 | 35 | 12% | 13% | 13% | 15% | 17% | 21% |
| | | 7 | 45 | 8% | 9% | 9% | 10% | 12% | 14% |

NOTE: Temperatures listed are for a clear day in winter, usually the coldest month.
1. In cold and very cold climates, incorporate night insulation over solar glazing during the cold evening hours (e.g., exterior or interior insulating shutters, blinds, or curtains).
2. Adjust the solar glazing area according to the surface area of exposed thermal mass in the space. Use the lower values for high thermal mass spaces (e.g., exposed masonry walls, and floors) and the higher values for very high thermal mass structures (e.g., exposed masonry walls, floors, and ceilings). SeeDirect Gain: Heat Storage for additional information.Remember to size the glazing area as a percentage of the total floor area to be heated. For heating well connected adjacent spaces use large, unobstructed openings to encourage air movement between Direct Gain and adjacent spaces, and size solar glazing as a percentage of the total combined floor area.
Table Credit: Adapted from The Passive Solar Energy Book: A Complete Guide to Passive Solar Home, Greenhouse, and Building Design. Edward Mazria.

The above percentages in the table apply to a well-insulated space (or thermally connected spaces) with a total space heat loss coefficient of 5.6 Btu/day-sq ft-°F (0.018kwh/day-m2-°C). If a space's heat loss coefficient is lower – 4.6 Btu/day-sq ft-°F (0.015kwh/day-m2-°C) – reduce the percentage of glazing area by approximately 5%. If a space's heat loss coefficient is higher – 6.6 Btu/day-sq ft-°F (0.021kwh/day-m2-°C) – increase the percentage of glazing area by approximately 2%. You can also adjust the percentages based on internal heat loads; decrease the percentages for spaces that have high incremental heat gains from people, appliances, or systems within the space.

## Other Considerations

When selecting appropriate solar glazing, consider the properties of the glazing as well as its size, location, and orientation. To maximize the performance of the glazing, use glazing assemblies that:

- are well-insulated (low U-values < 0.35) and have low air leakage rates to minimize the heat that can escape through the glazing and frame back to the exterior environment, and
- admit large amounts of direct sunlight into the space (high Solar Heat Gain Coefficients (SHGC) > 0.6).

To ensure that a Direct Gain system works effectively, incorporate thermal mass – typically exposed masonry floors, walls, and/or ceilings – to absorb and store a portion of the heat gained during the daytime and release it back into the space at night. Shading and natural ventilation can be used to control sunlight and prevent daytime overheating during warmer weather (see Solar Shading). Choose interior fabrics and materials that will not easily fade and discolor over time, and provide a small back-up heating system for situations when the heating by a Direct Gain system is insufficient, such as extremely cold or cloudy days.