Architecture & Town Planning

Sustainable Buildings Techniques

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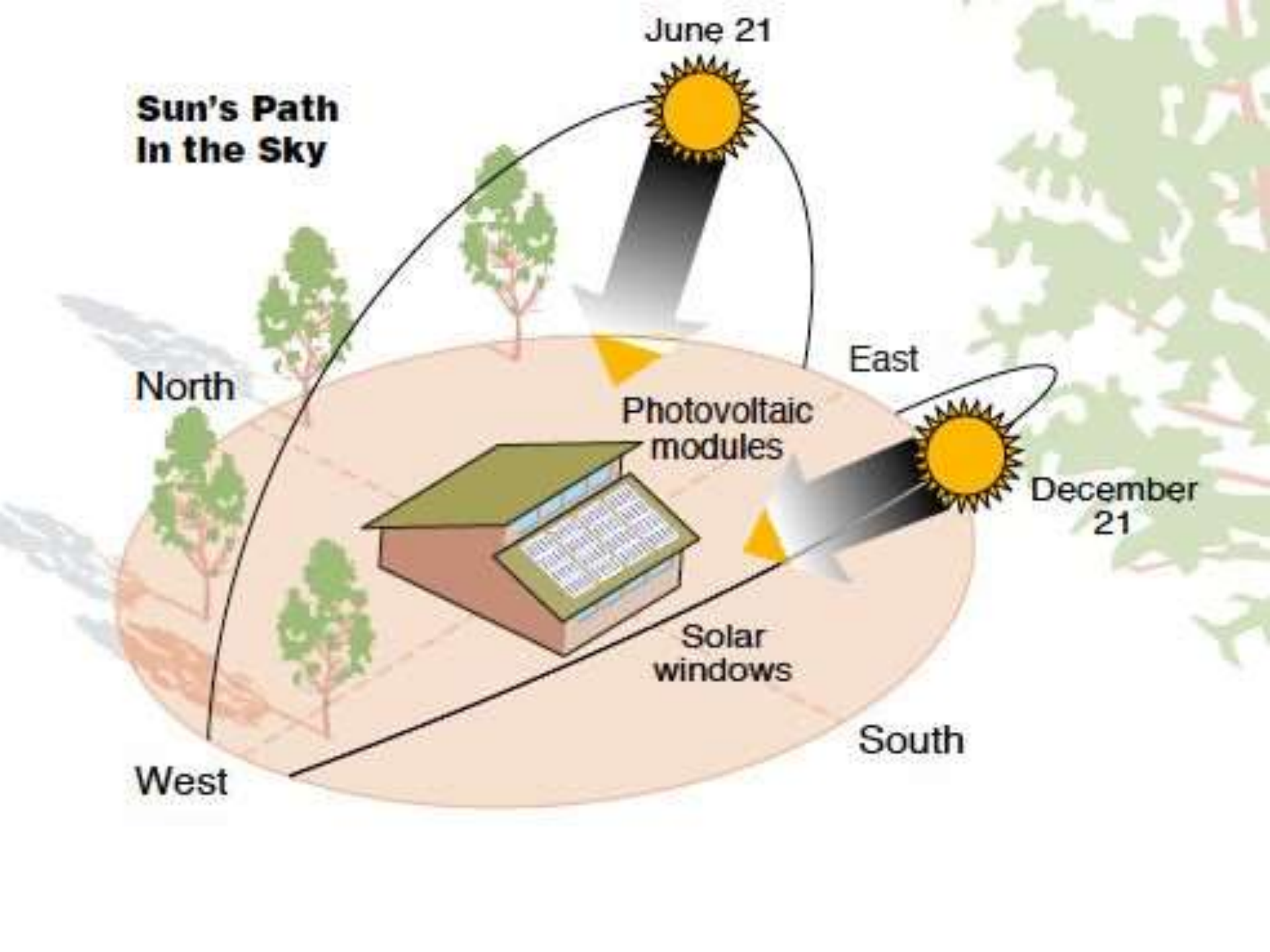
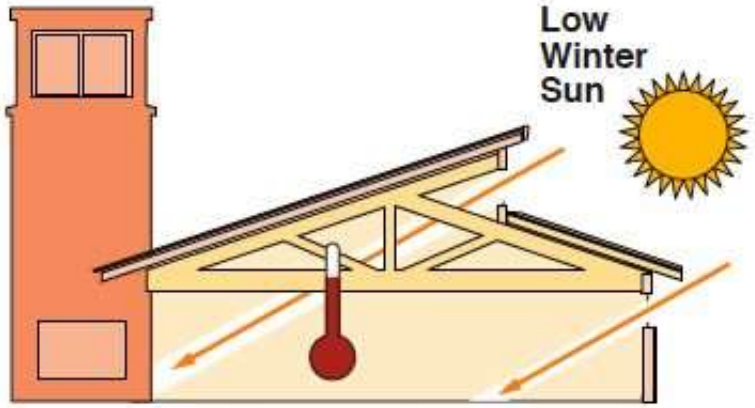
Orientation

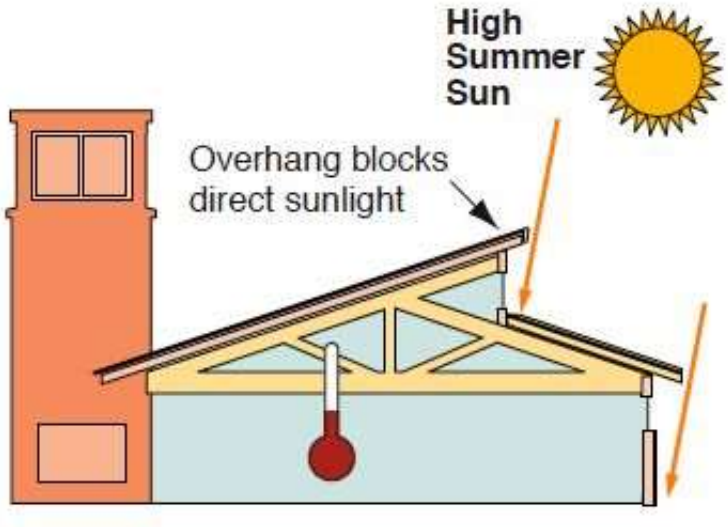

Sun's Path
In the Sky
June 21
East
North
Photovoltaic
modules
December
21
Solar
windows
South
West

Orientation for Passive Heating

- For best passive heating performance, daytime living areas should face south. Ideal orientation is true south but orientations of up to 20° west of south and 30° east of south still allow good passive sun control



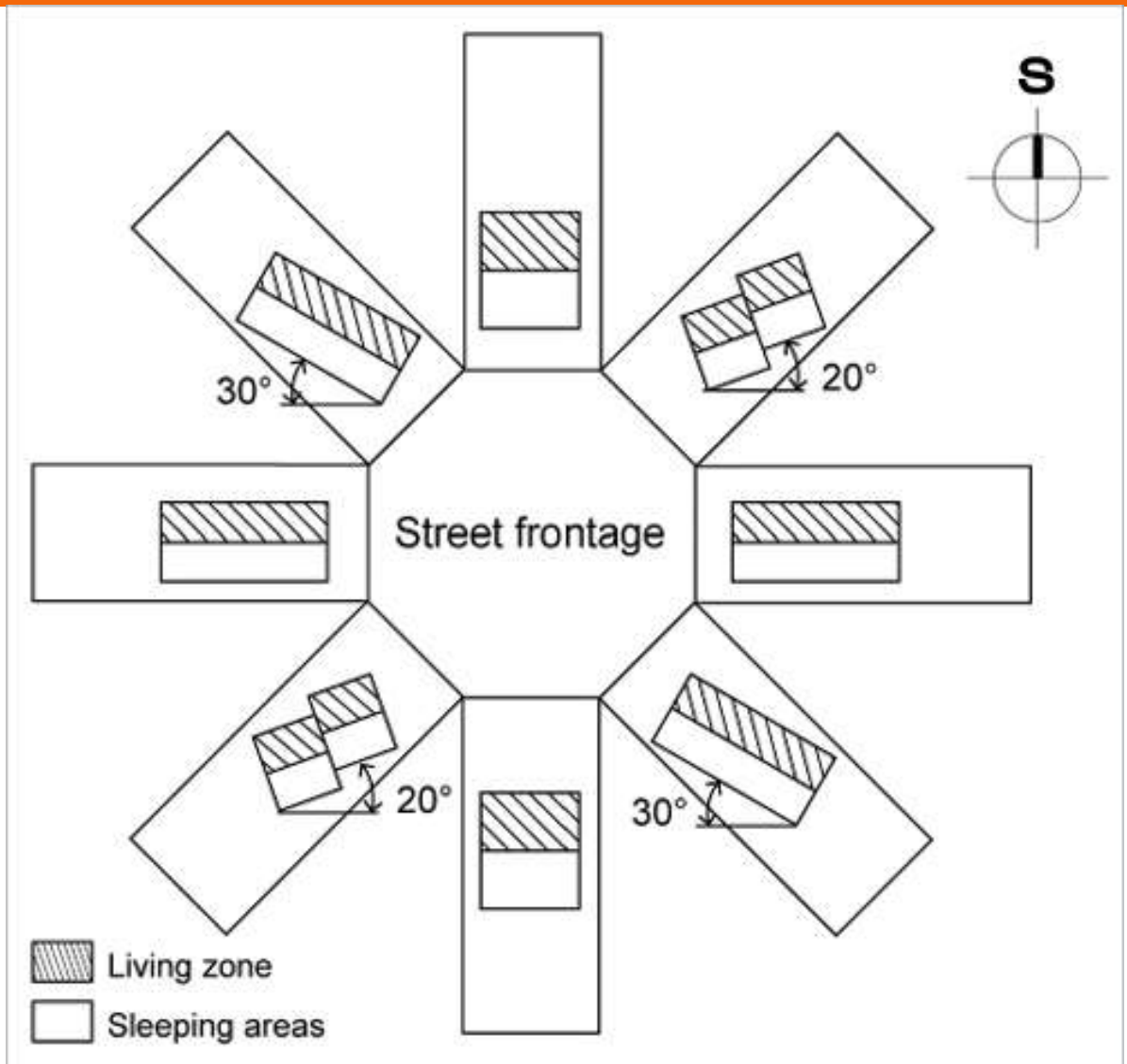
- Ideally, sunlight should not enter a home too much when the sun is at its highest but be allowed to enter when its at its lowest i.e. during the morning and in winter.



Orientation

- Orientation is the positioning of a building in relation to seasonal variations in the sun's path as well as prevailing wind patterns
- Living areas and rooms you spend lots of time in should be south-facing to catch sun and light for the longest part of the day
- Bedrooms should be positioned on the northern side so they are cooler and more pleasant to sleep in at night
- South-facing walls and windows receive more solar radiation in winter than in summer
- Prefer Longer south & North Facing walls & Windows

- Surfaces facing South-East or South-West receive 10% less solar energy during the year than surfaces facing South.
- Surfaces facing North are in the shade all year round. North-East and North-West receives very little sun except at the peak of summer.
- Provide insulation and minimize glazing on north side of a house.
- Avoid West facing glass. Shade the windows and walls particularly west facing
- 10 % of Floor Area should be Windows for natural Lighting.
- 5 – 10 % floor area should be fully operable windows for natural ventilation.


S
30°
20°
Street frontage
20°
30°
Living zone
Sleeping areas

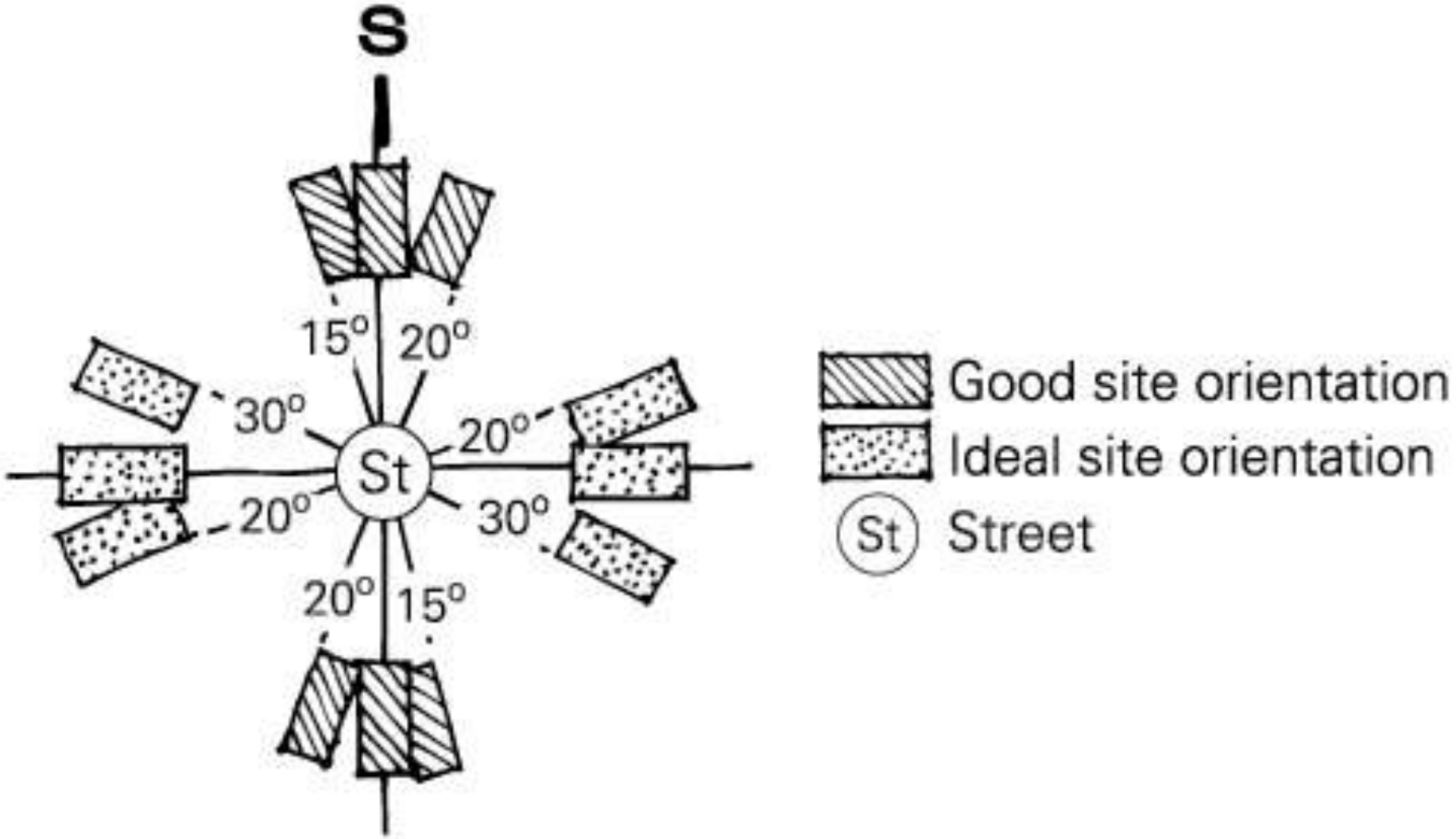
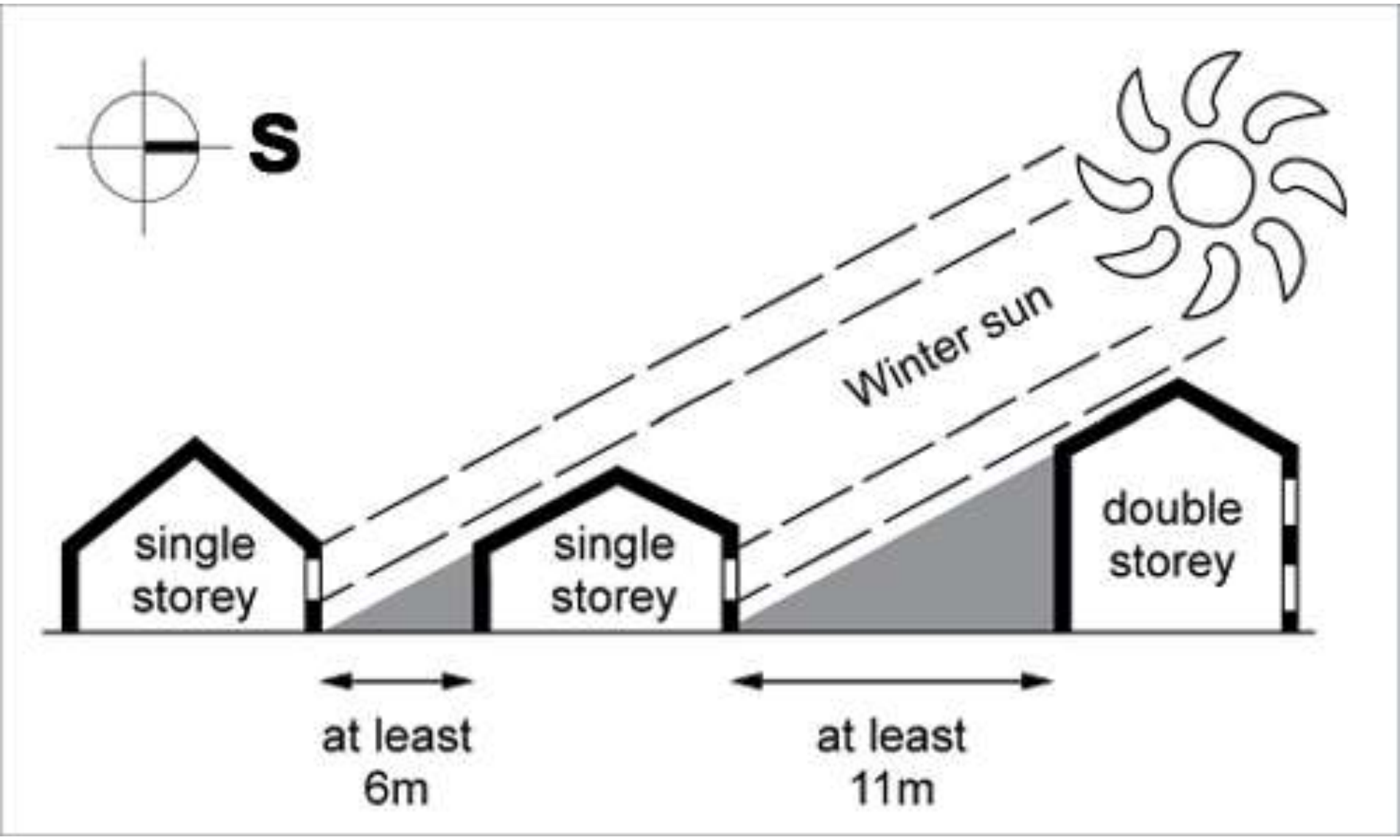

S
15°
20°
30°
20°
St
20°
30°
20°
15°
Good site orientation
Ideal site orientation
St
Street

TABLE 21a

Suggested room orientations

	N	NE	E	SE	S	SW	W	NW
Bedroom*	●	●	●	●	●			
Bath*	●	●	●	●	●	●	●	●
Kitchen			●	●	●			
Dining			●	●	●	●		
Living				●	●			
Family				●	●	●		
Utility / Laundry*	●	●						●
Workshop*	●	●						●
Storage*	●						●	●
Garage*	●					●	●	●
Sun porch				●	●	●		
Outdoor space*			●	●	●	●		

*The most suitable location of those indicated will depend on local climate — whether largely too hot or too cold, direction of winter winds and summer breezes, etc.


S
Winter sun
single storey
single storey
double storey
at least 6m
at least 11m

Zoning

Thermal Zoning

- We like different temperatures in different rooms- we like bathrooms to be very warm, living rooms to be a comfortable cozy temperature, and bedrooms to be cooler.

- An efficient eco-house creates different thermal zones for the different rooms.

Hot zone	20-23°	Bathrooms, airing cupboards, rooms for drying clothes, kitchen
Warm zone	18-21°	Living rooms, study, children's bedrooms
Cool zone	16-18°	Adult bedrooms
Cold zone	under 16°	Rooms that are not in use, storage rooms, garage, basement

- **Hot zone**

South facing window may be better for a bathroom where natural lighting and good ventilation is desirable.

- **Warm zone**

The main living rooms need constant warmth and light and are best placed on the South side of the house with large windows and good thermal capacity to hold any thermal gain through the evening.

- **Cool zone**

Adult bedrooms can be placed on the cooler side of the house. However, they need good light and an easterly window or skylight is preferred.

- **Cold zone**

Little used rooms are best located along the colder and darker North side of the house. Storage rooms need to be kept dry but heat, light, and thermal capacity are of little concern, though the preference is for constant cool temperatures.

Zoning

- Living areas and the kitchen are usually the most important locations for passive heating as they are used day and evening. Bedrooms generally require less heating.

- Bathrooms, laundries and garages are used for shorter periods, require smaller windows and generally require less heating.

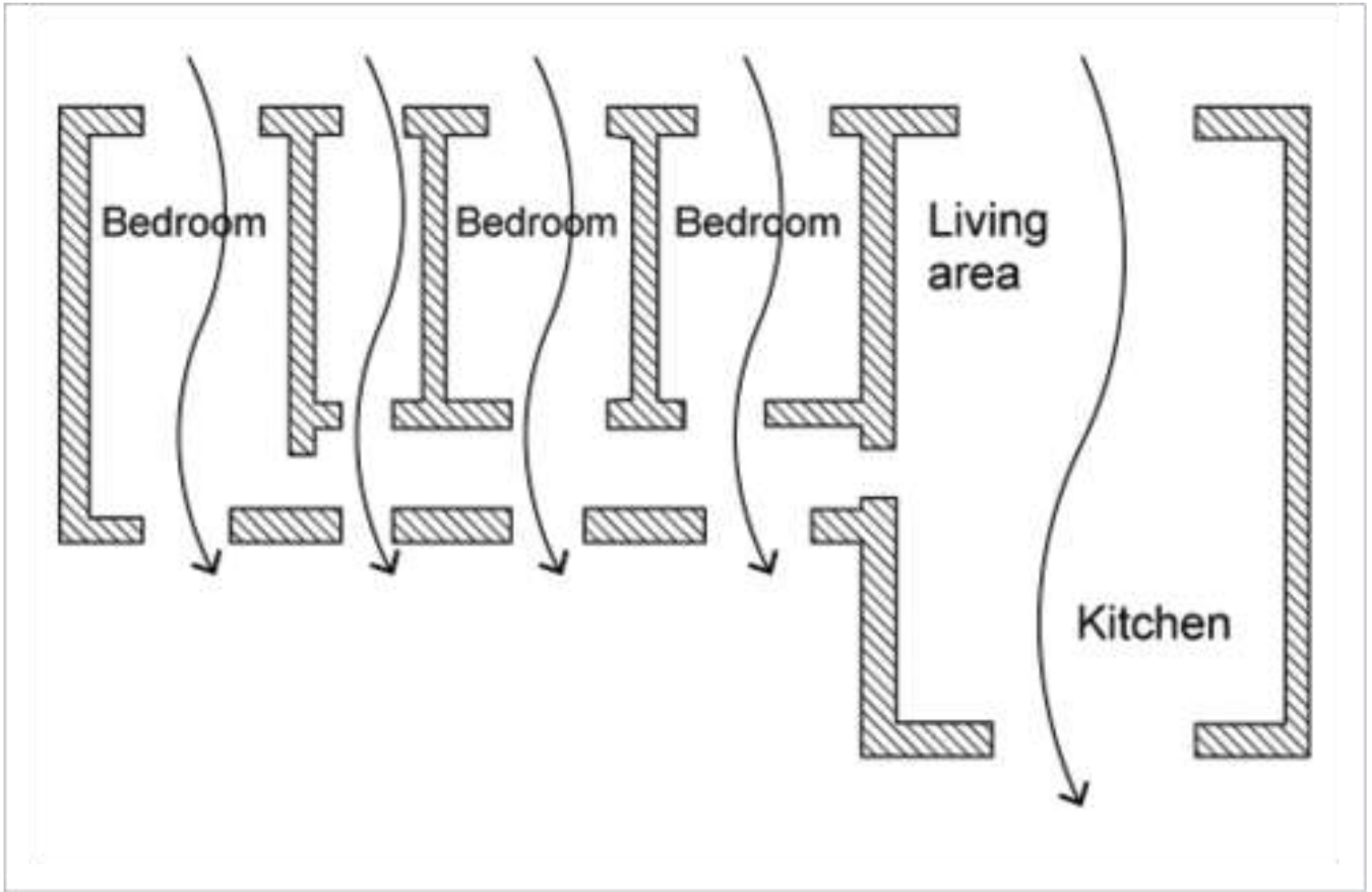
- Should be located to the west or south-west, to act as a buffer to hot afternoon sun and the cold westerly winds **OR** to the east and south-east, except where this is the direction of cooling breezes.

- Detached garages to the east and west provide shade from summer sun and direct cooling breezes into living spaces.

Ventilation

Narrow/ Open Planning

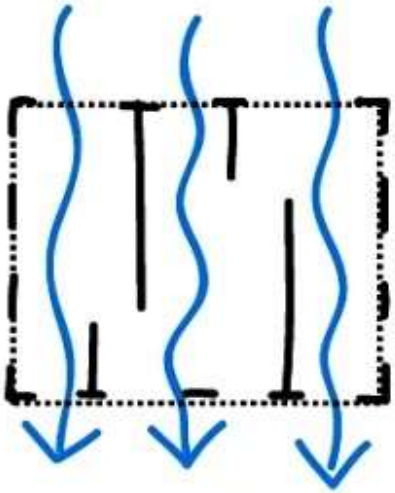
Cool breezes work best in narrow or open plan layouts

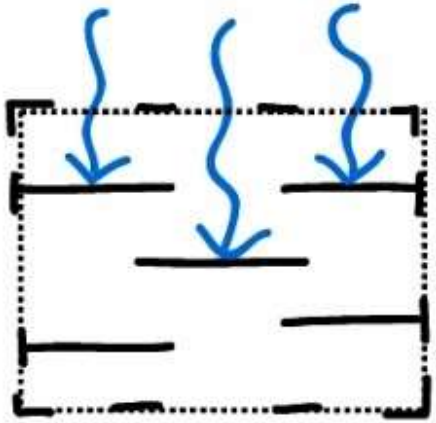


Cross Ventilation

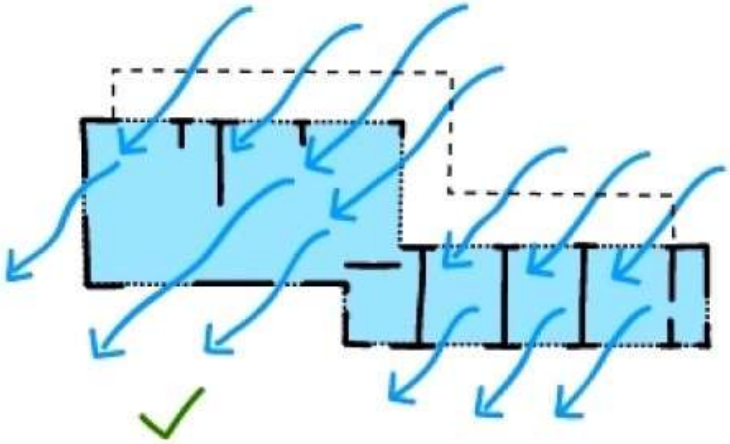
- Outdoor breezes create air movement through the house interior by the 'push-pull' effect of positive air pressure on the windward side and negative pressure (suction) on the leeward side.

- In order to have a good natural ventilation, openings must be placed at opposite pressure zones.

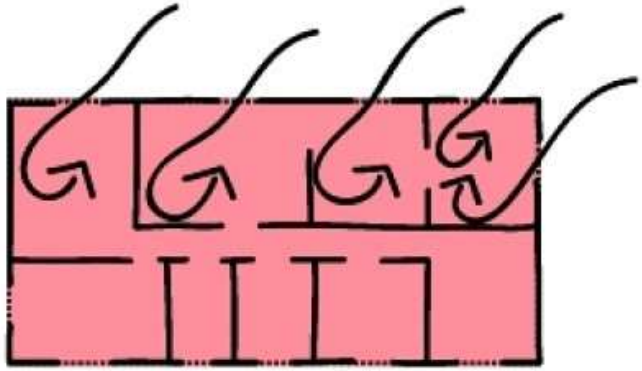




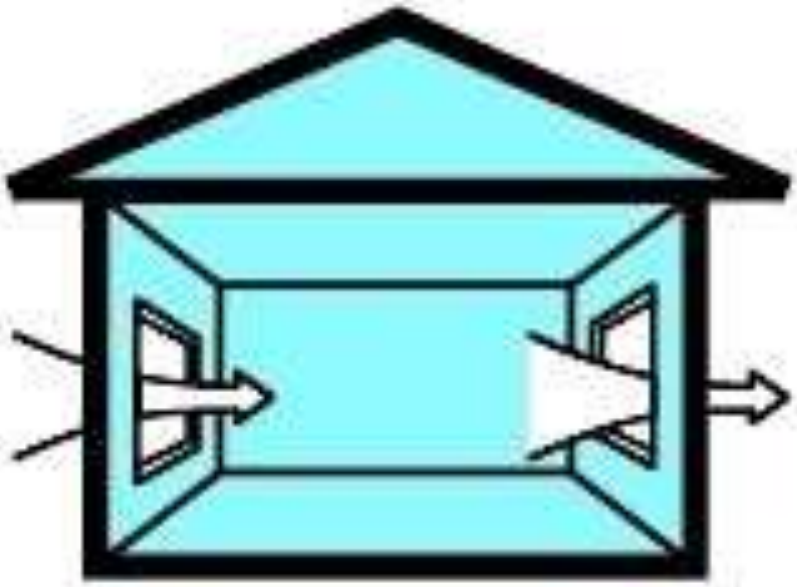
Walls running parallel to the breeze, aid in cross-ventilation.



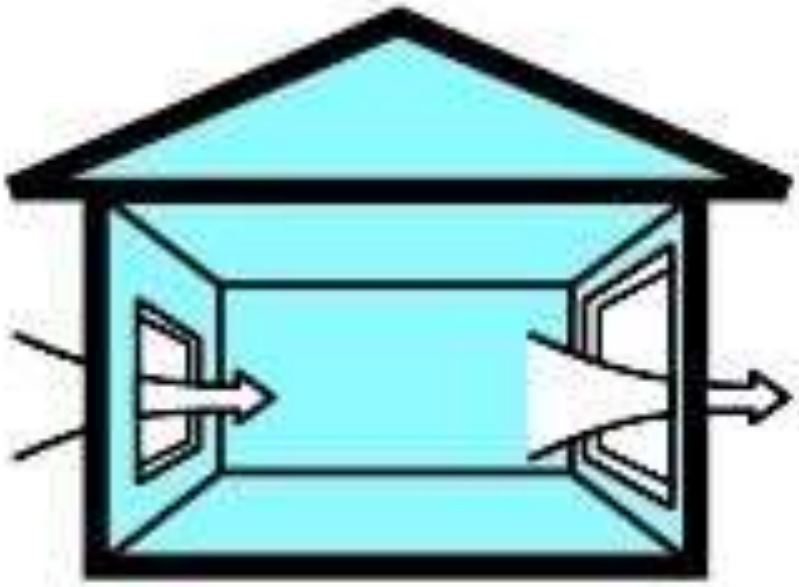
A well designed home with single room



A poorly designed home that will create hot stagnant areas.

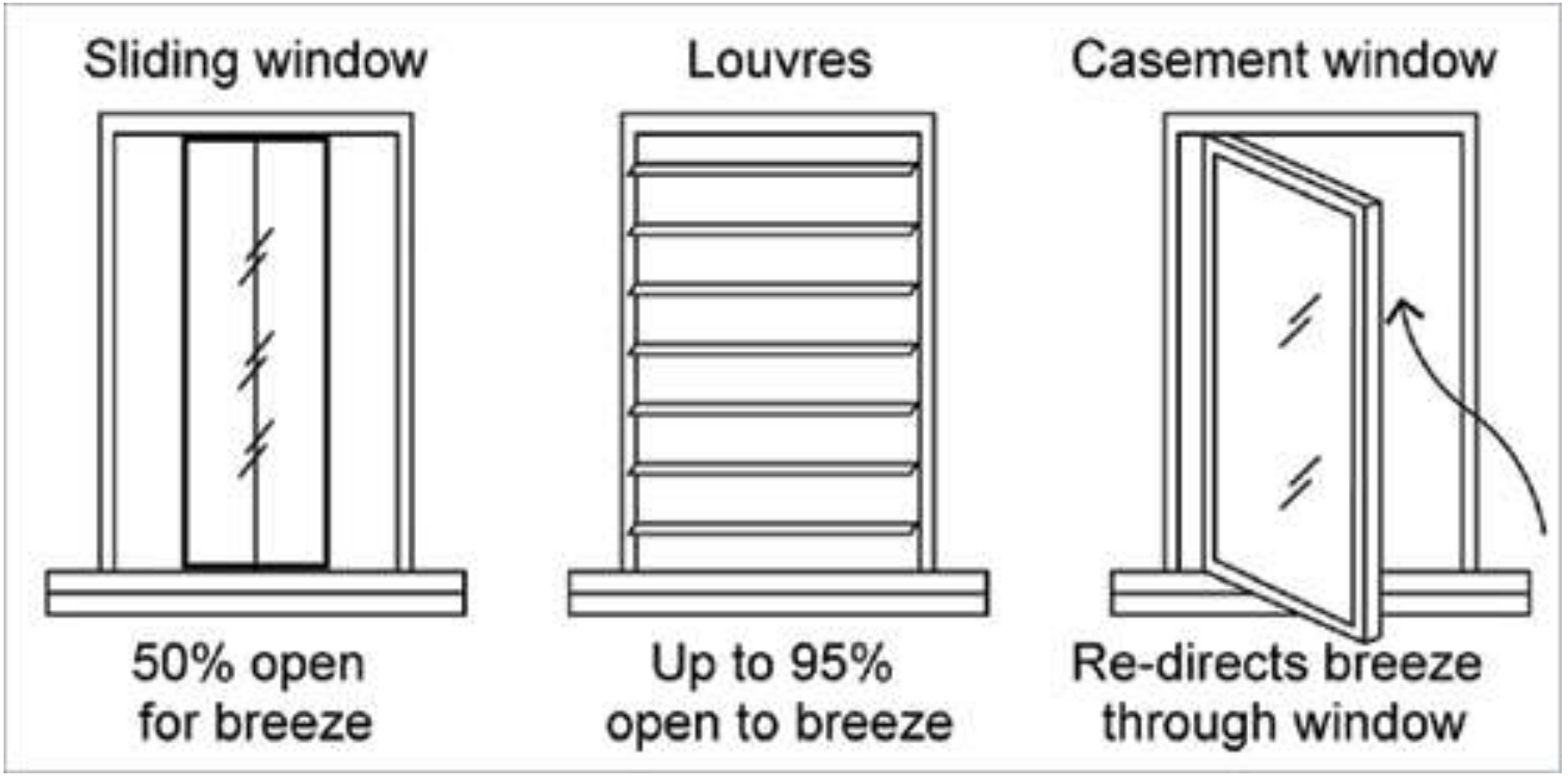


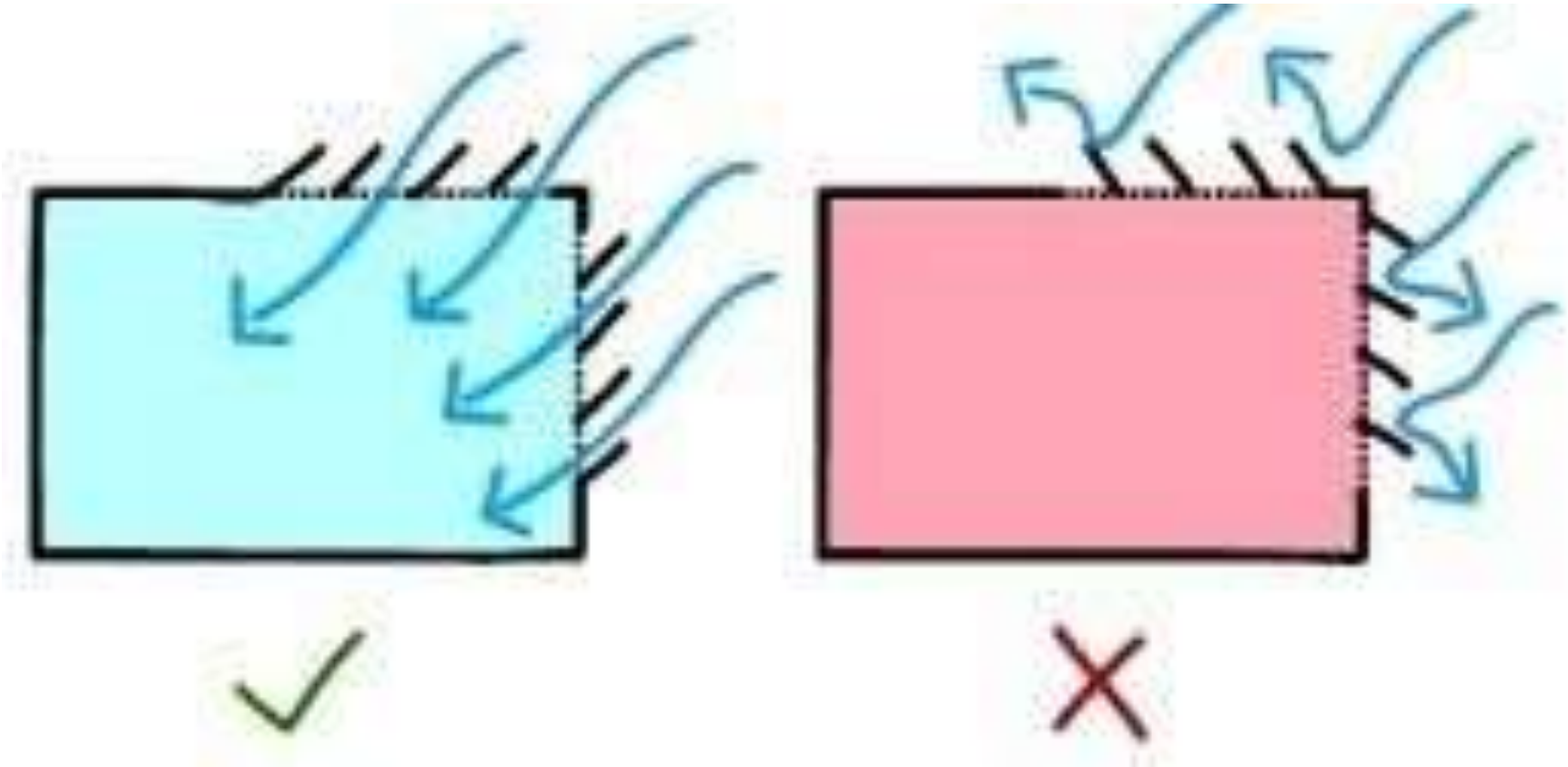
inside air
speed 35%
of outside



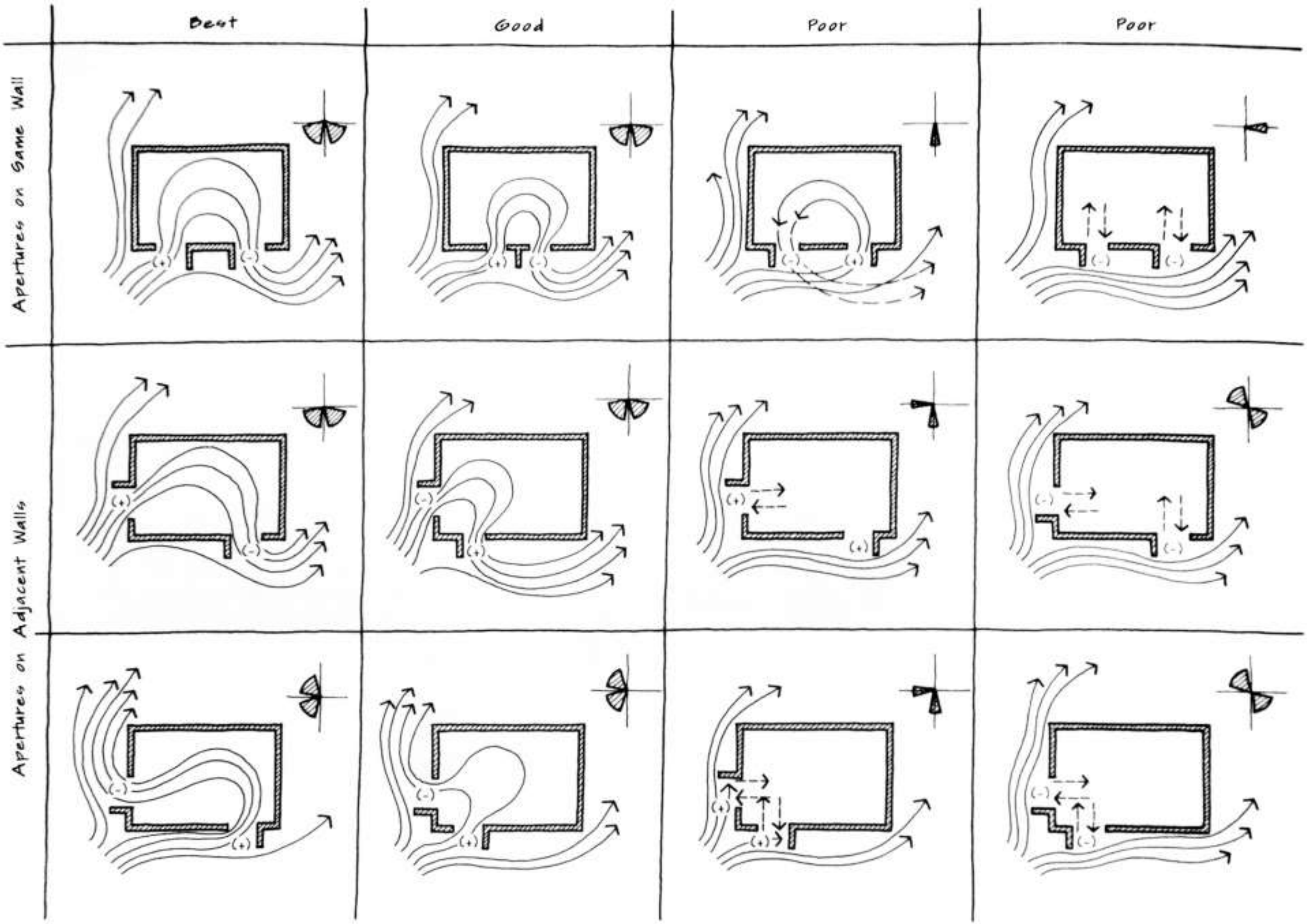
inside air
speed 44%
of outside

Relative window opening sizes


Sliding window
Louvres
Casement window
50% open
for breeze
Up to 95%
open to breeze
Re-directs breeze
through window

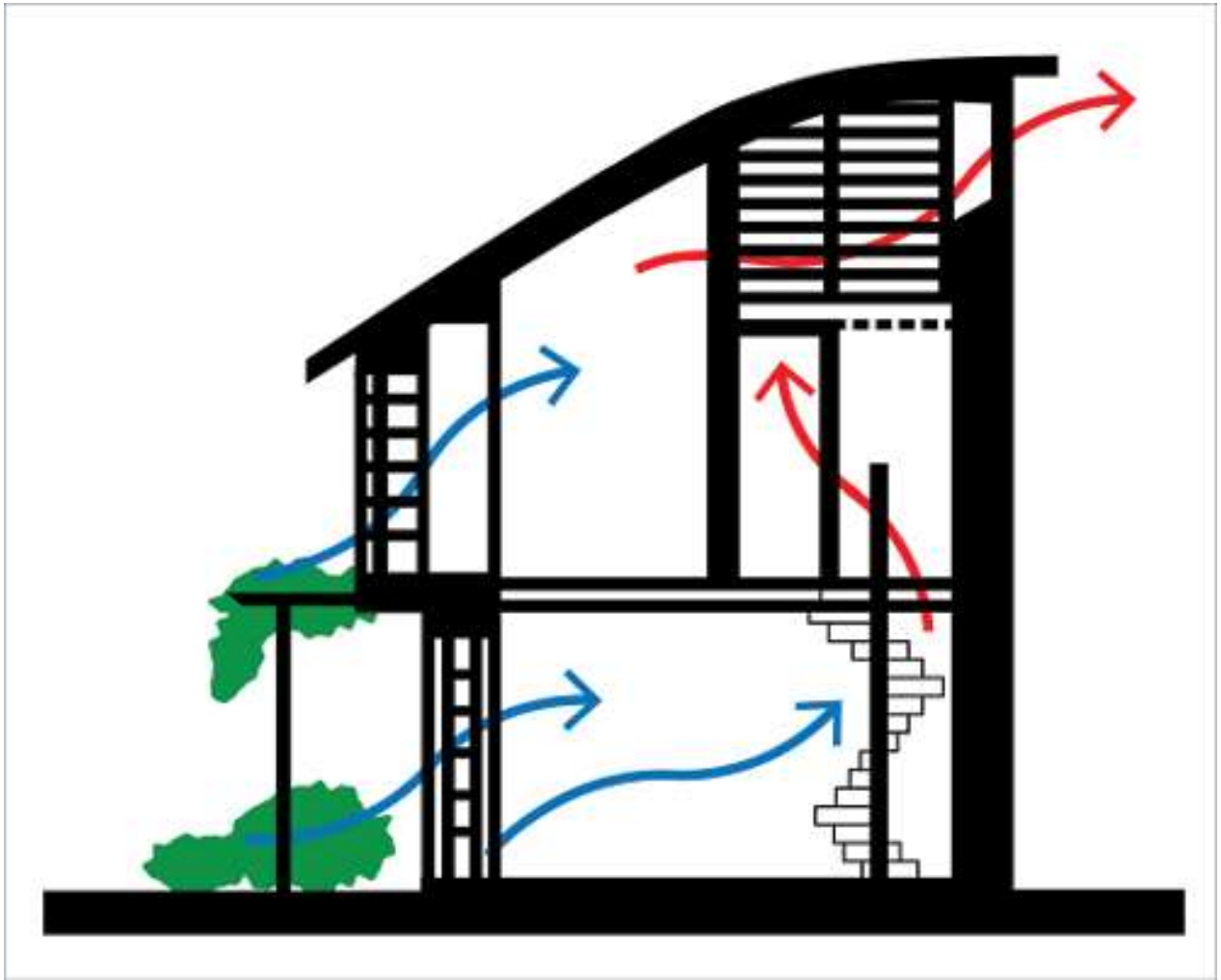


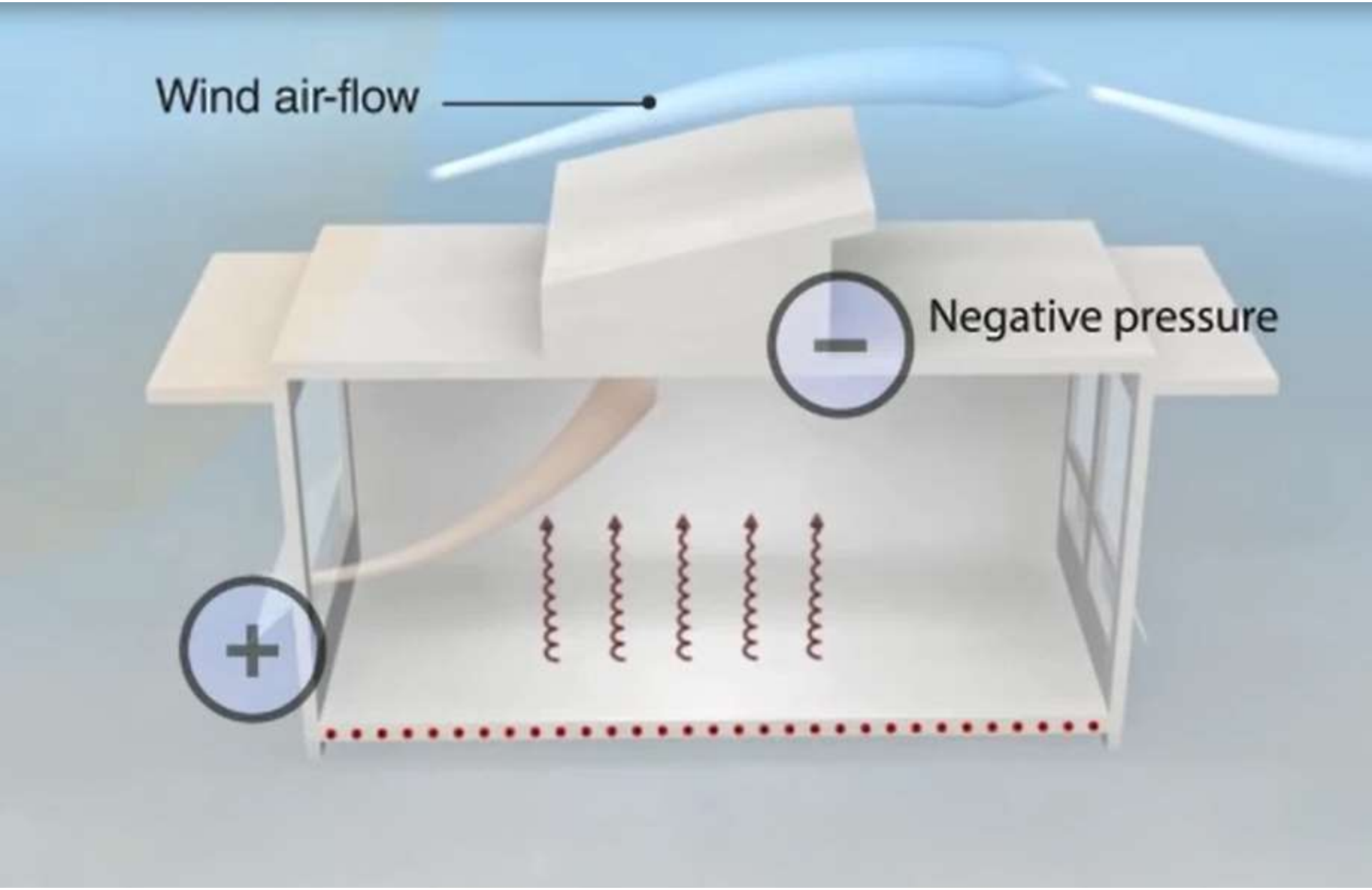
Casement windows should be hinged the right way to direct breezes into the home.


Best
Good
Poor
Poor
Apertures on Same Wall
Apertures on Adjacent Walls
(+)
(-)

Convective Air Movement

Convection causes warm air to rise, drawing in cool air




Wind air-flow
Negative pressure
−
+

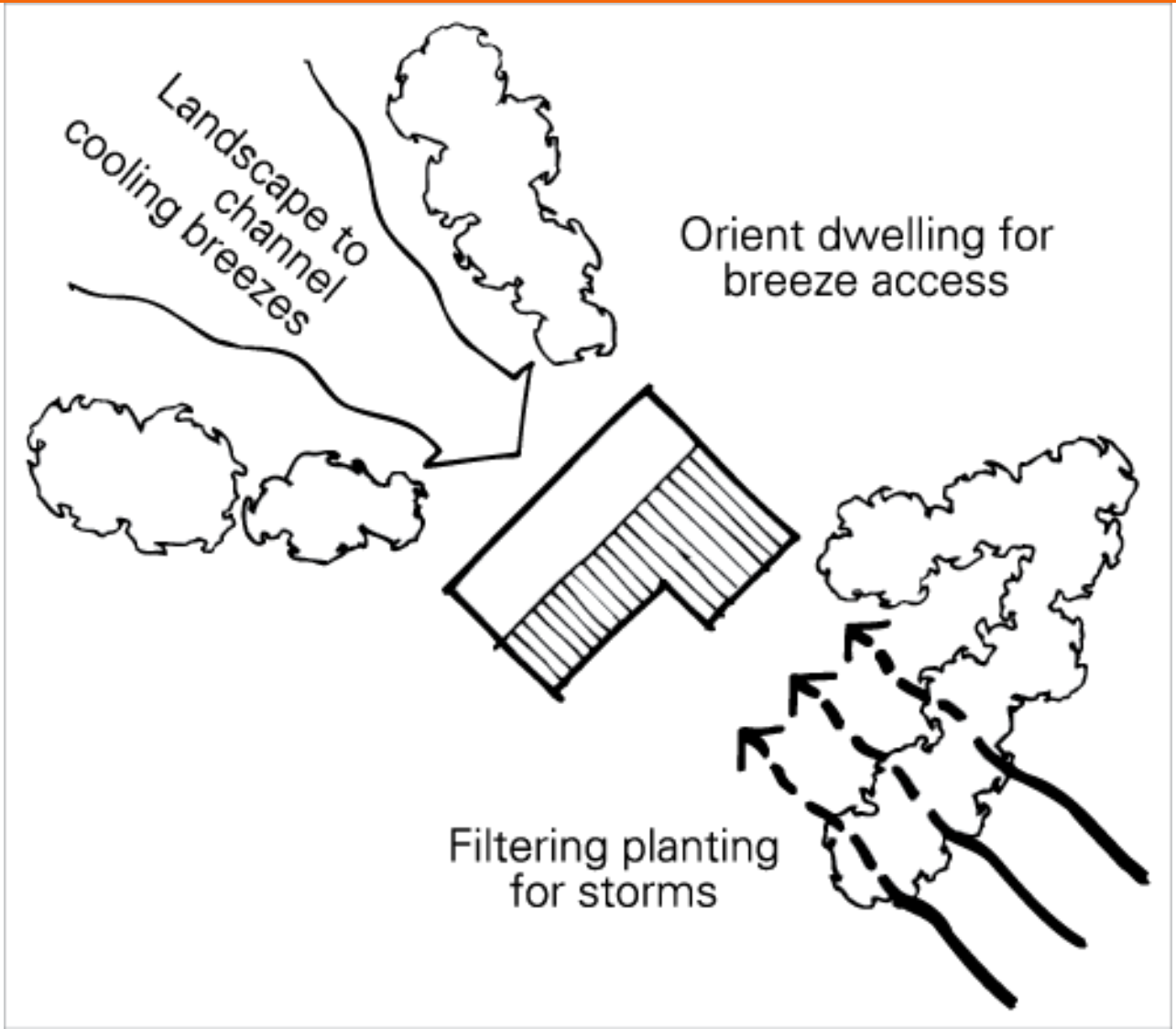
Convective air movement

Stake Effect

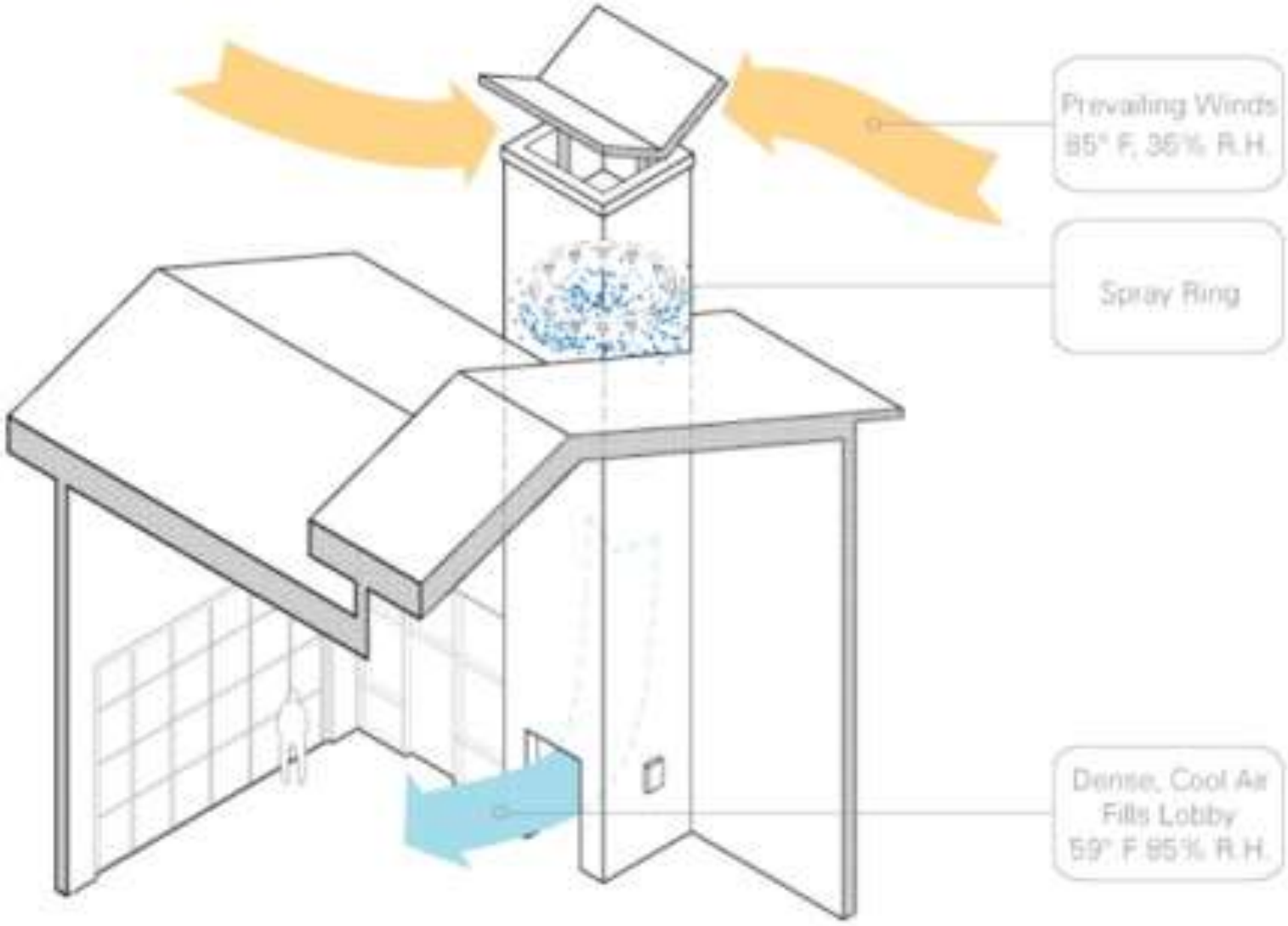
- Convection plays a leading role in natural ventilation. Hot air rises and escapes through small gaps in the building fabric at the top of the house. As it does so it draws in new cold air through similar gaps at the bottom of the house.

- It is the largest single cause of heat loss in a home. It requires particular attention when draught proofing a house

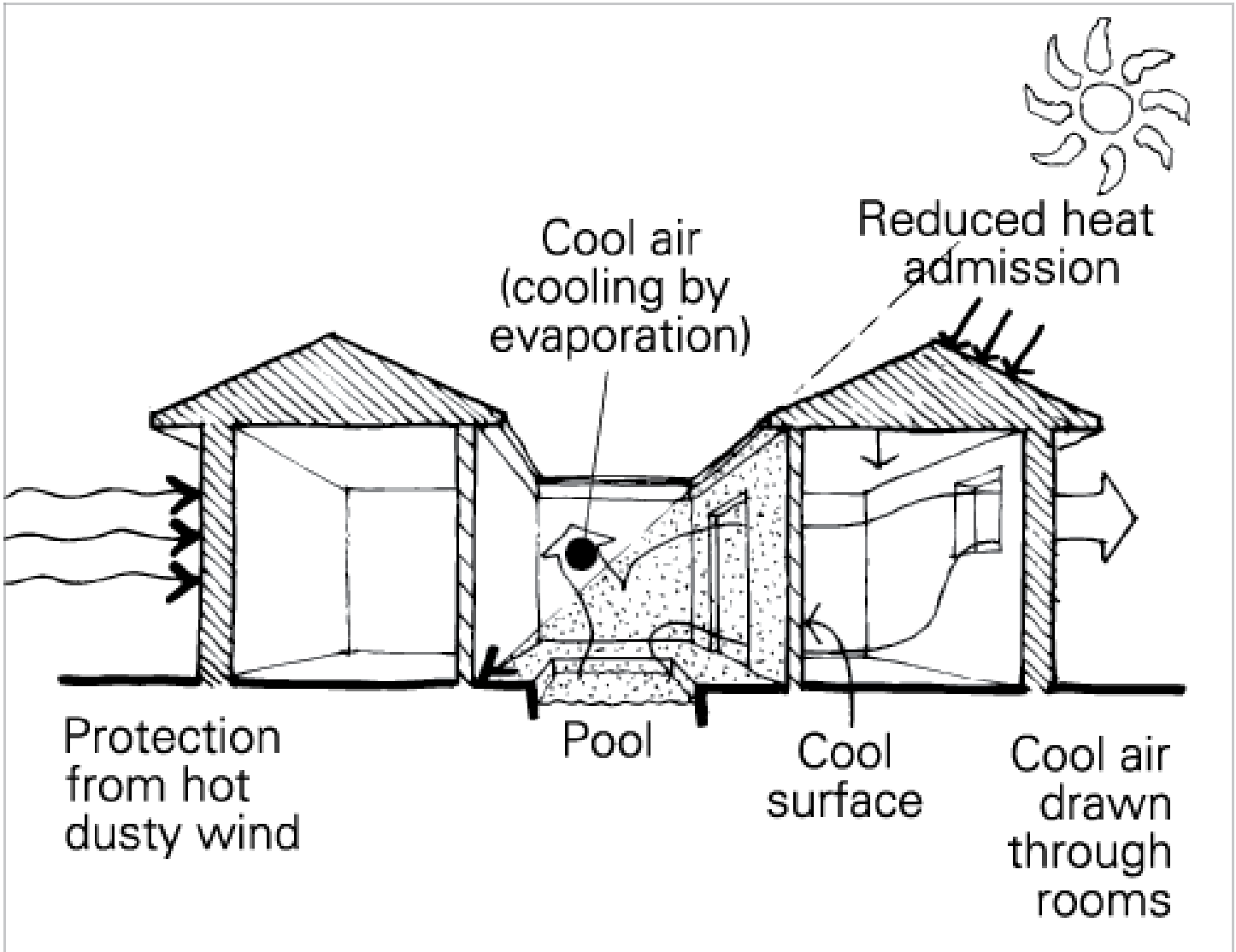
Plant, Trees & Shrubs to funnel breezes



Wind Tower

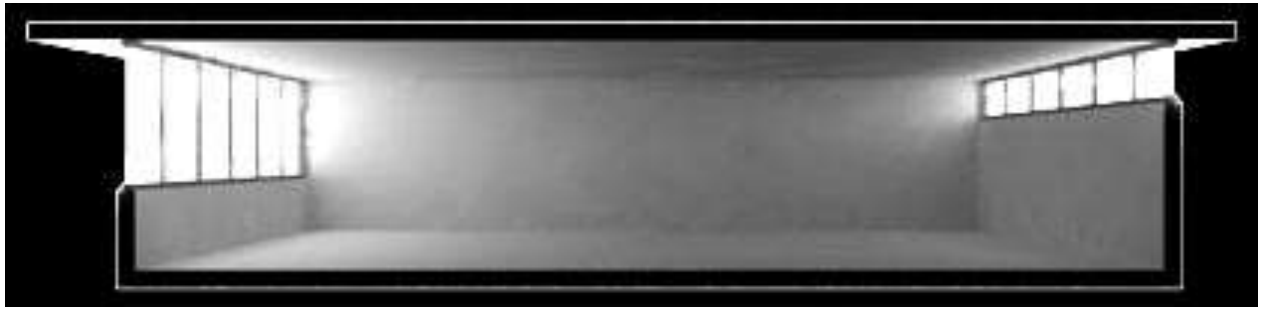

Prevailing Winds
85° F, 35% R.H.
Spray Ring
Dense, Cool Air
Fills Lobby
59° F 95% R.H.

Evaporative Cooling

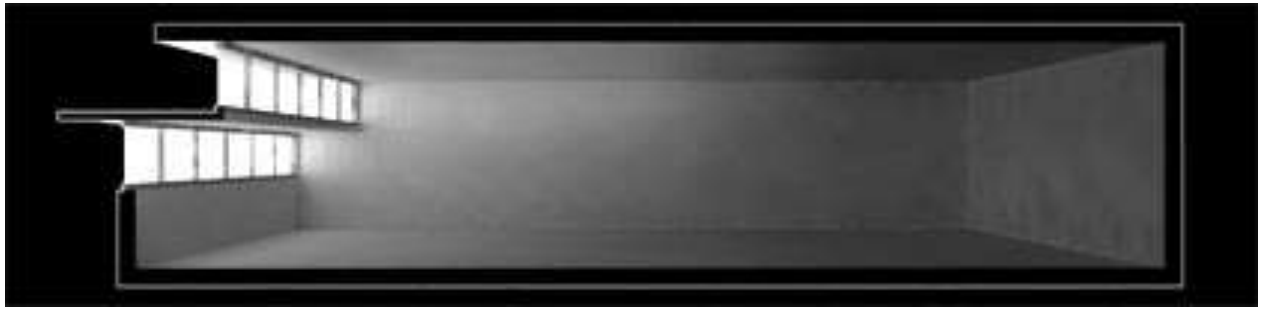


Natural Lighting

Window



Windows both sides



Light shelf

Skylight

Roof monitor

Sawtooth

Light well

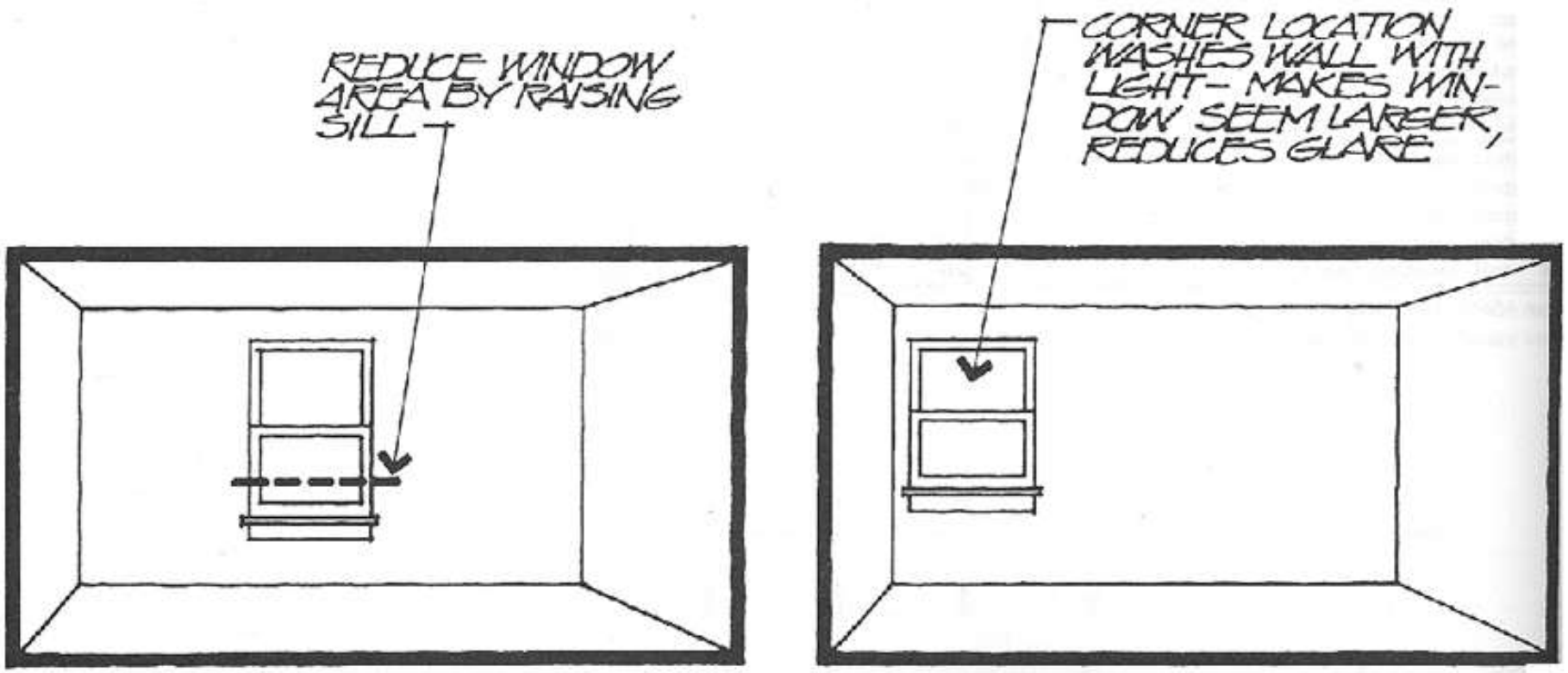
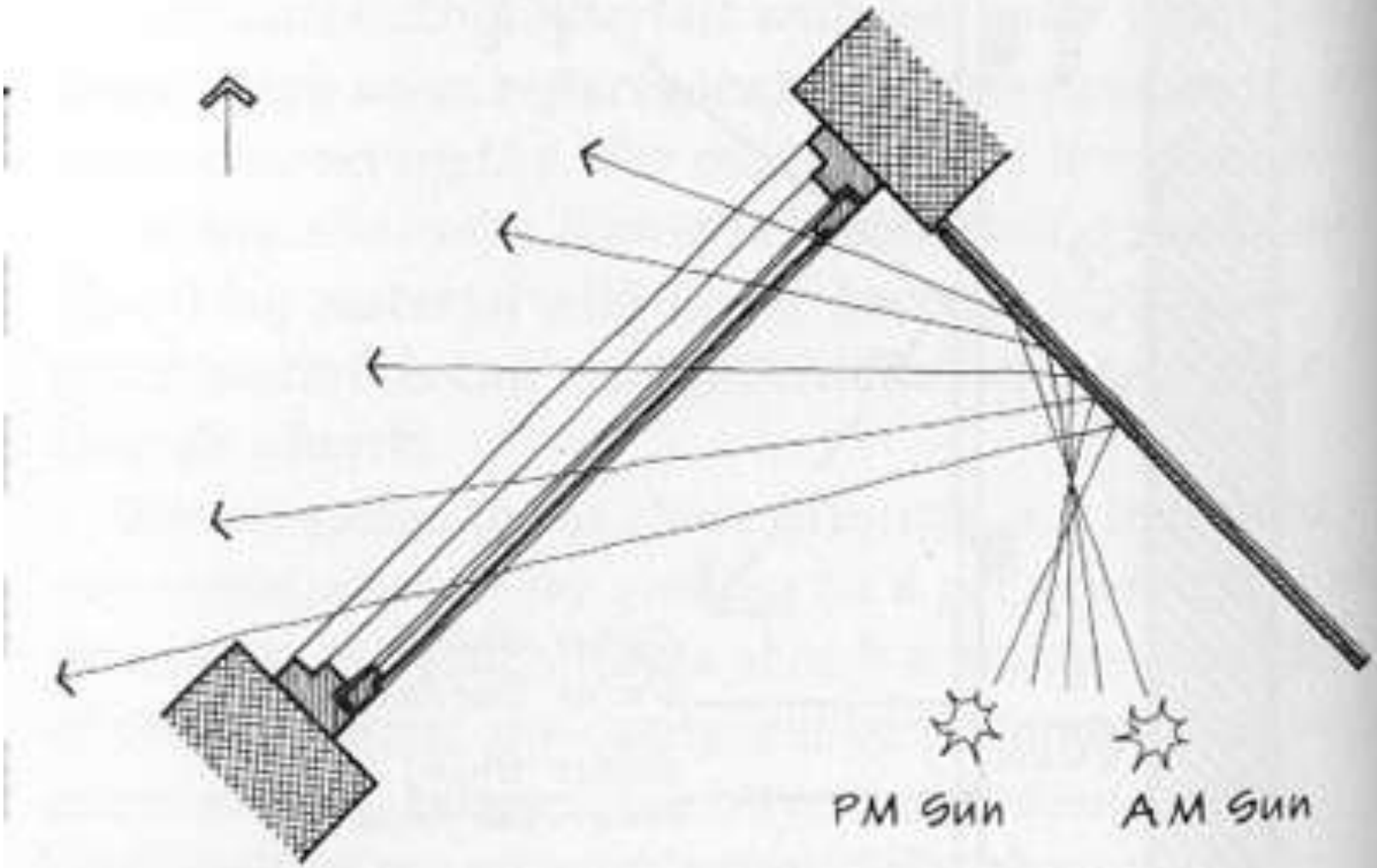


FIG. 40b. **When windows must be placed in north, west and east walls, keep the opening small, and use internal placement to best advantage.**



Plan View, Vertical Reflector for a Southeast-Facing Window
(northeast-facing in the Southern Hemisphere)

Heat Loss/ Gain

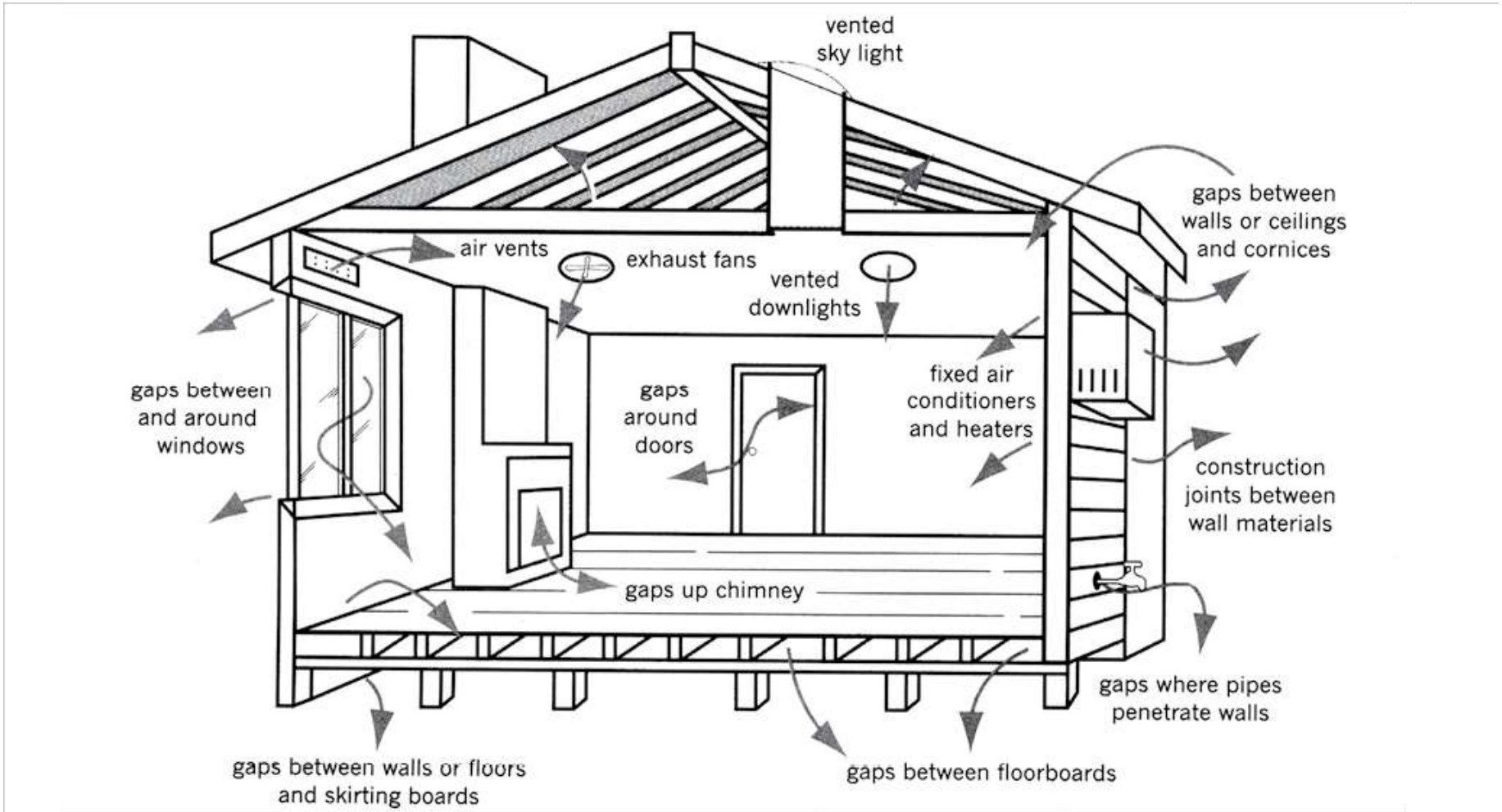
Preventing Heat Loss

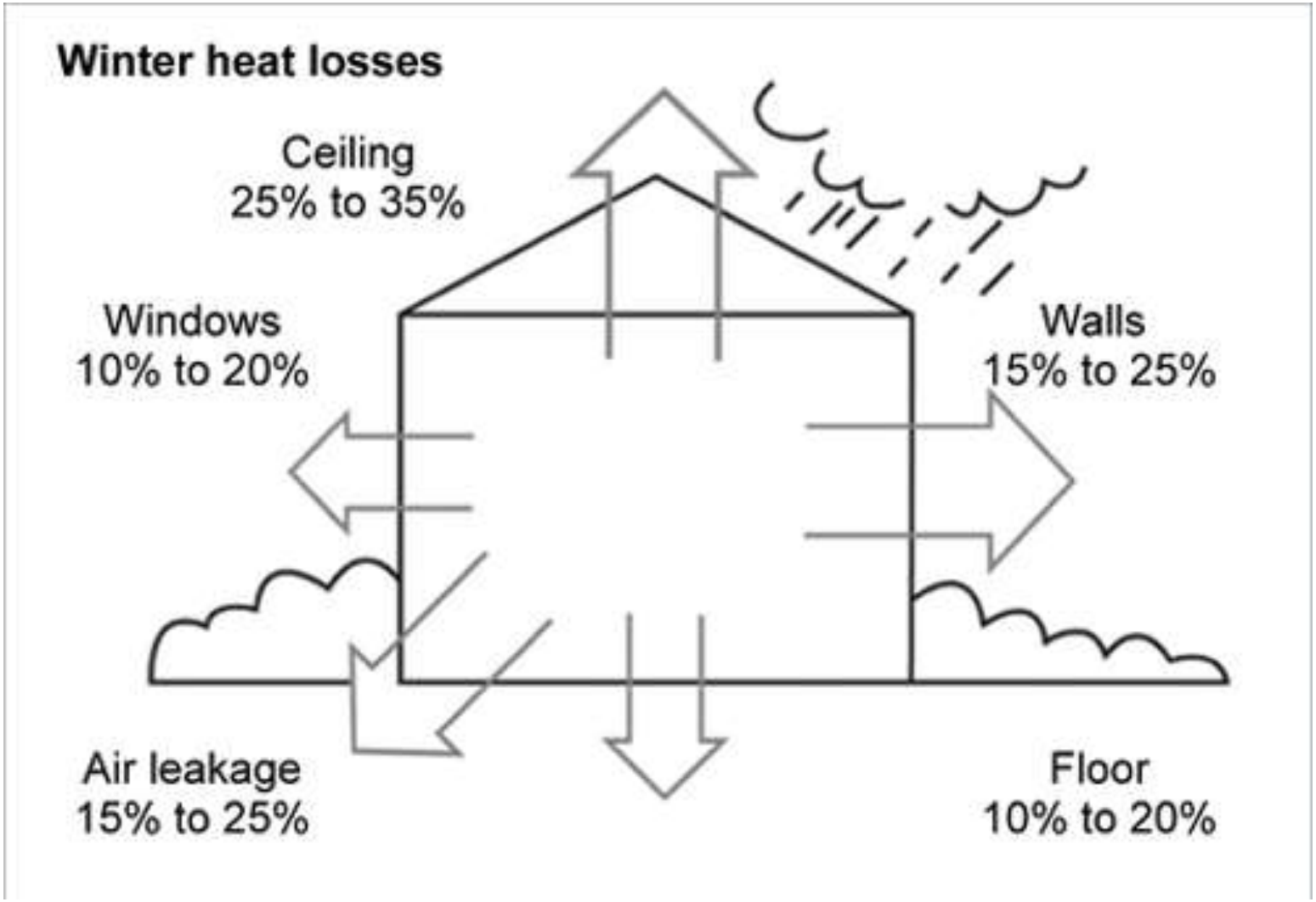
- The building fabric must retain energy collected during the day for up to 16 hours and considerably longer in cloudy weather.
- Ineffective if the heat is allowed to escape via the passage of air or heat moving from a warm surface to a cold one.
- Close up as many openings (Windows and Doors) as you can. Windows can be a significant source of heat loss in your home.
- Ceiling insulation prevent loss of heat.
- This maximizes winter heat gain, minimizes winter heat loss and concentrates heating where it is most needed.

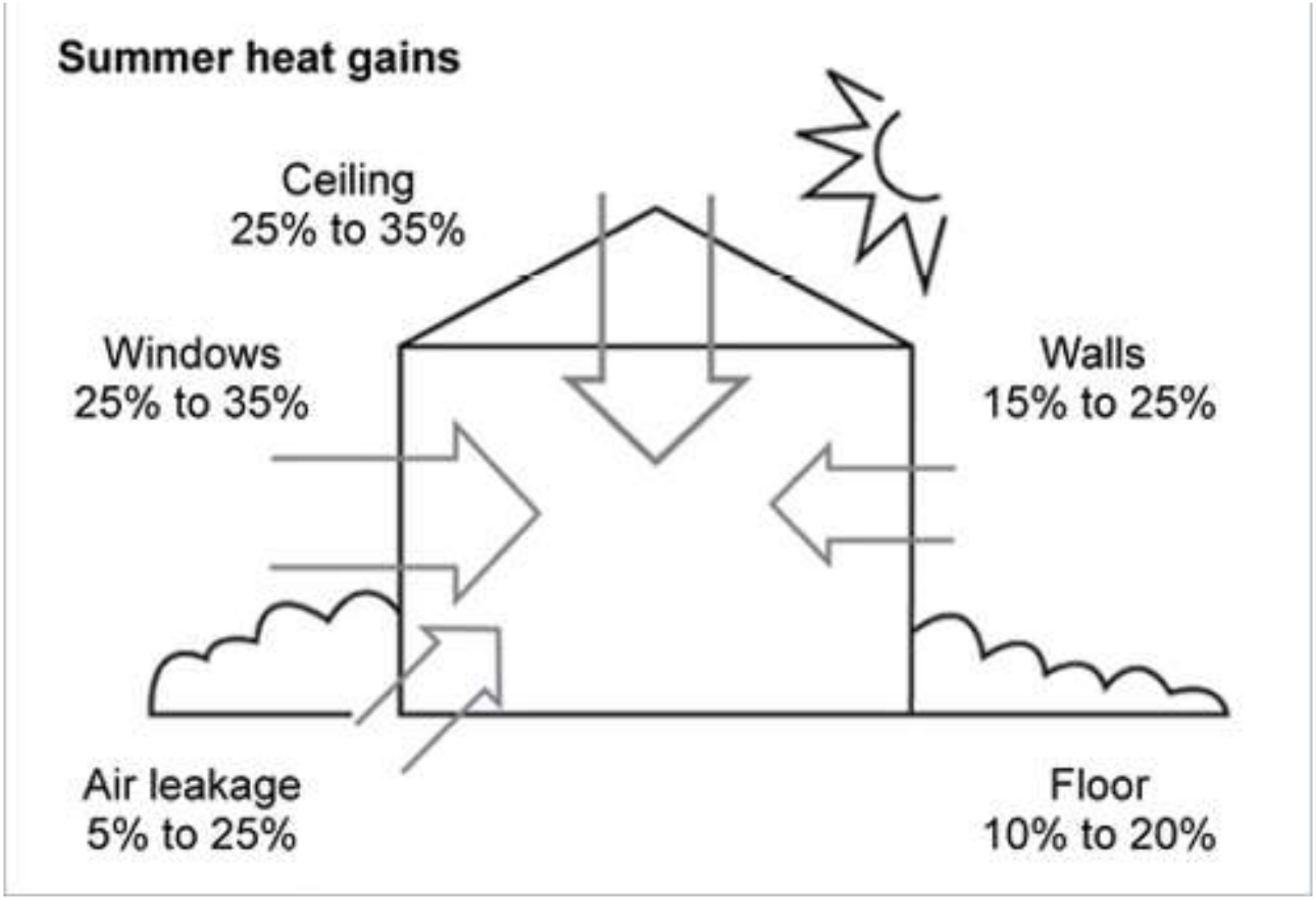
Draught Sealing

Sources of air leakage

Air leakage accounts for 15–25% of winter heat loss in buildings

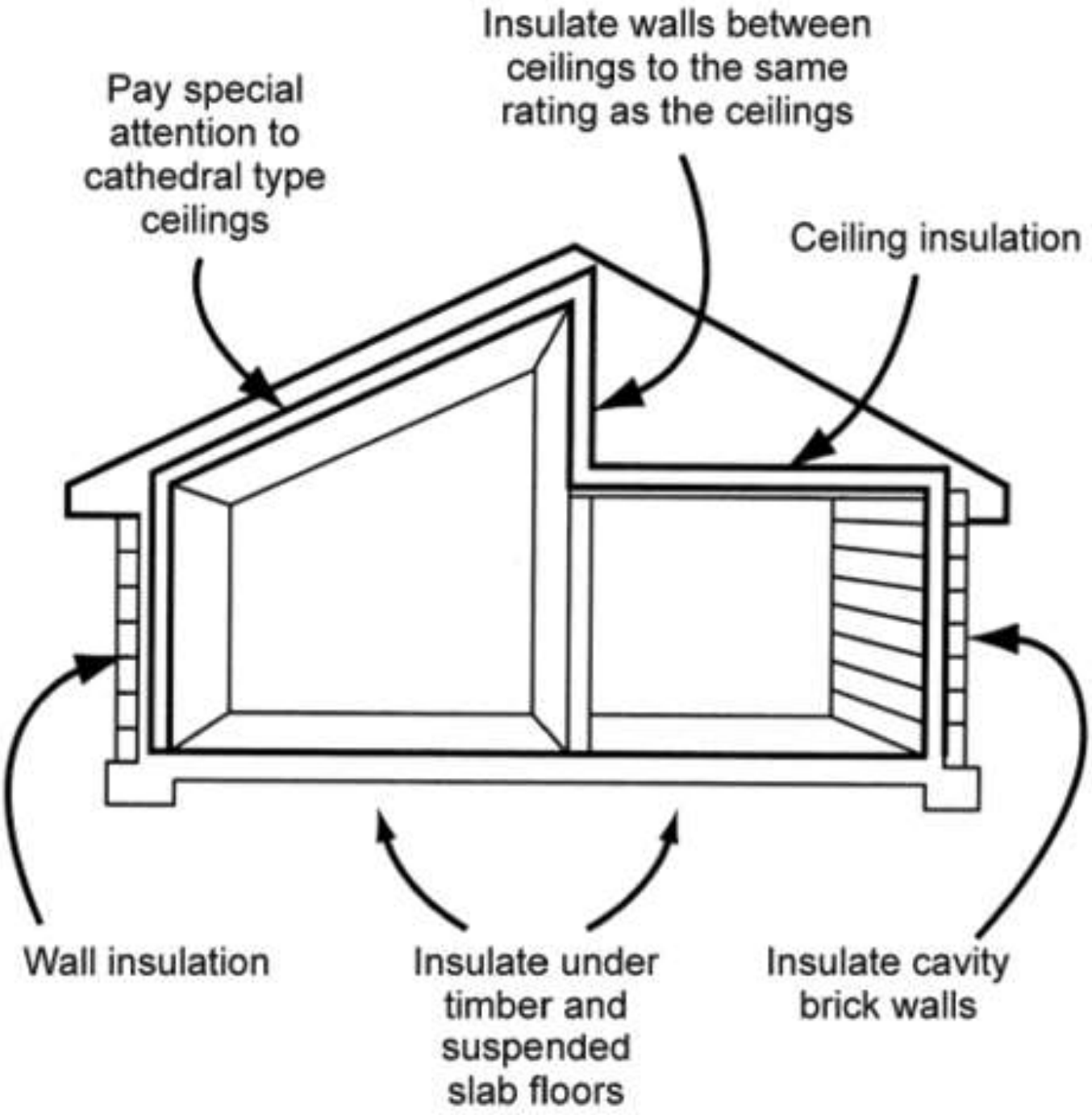



Winter heat losses
Ceiling
25% to 35%
Windows
10% to 20%
Walls
15% to 25%
Air leakage
15% to 25%
Floor
10% to 20%


Summer heat gains
Ceiling
25% to 35%
Windows
25% to 35%
Walls
15% to 25%
Air leakage
5% to 25%
Floor
10% to 20%

Insulation

- Insulation acts as a barrier to heat flow and is essential for keeping your home warm in winter and cool in summer.
- Insulation can help with weatherproofing and eliminate moisture problems such as condensation; some types of insulation also have soundproofing qualities.
- The most economical time to install insulation is during construction.
- Insulation can be added to cavity brick walls and other types of walls, roof and ceiling, floors
- Some insulation materials are as follows: rock woo, glass wool, Polyester etc.


Insulate walls between ceilings to the same rating as the ceilings
Pay special attention to cathedral type ceilings
Ceiling insulation
Wall insulation
Insulate under timber and suspended slab floors
Insulate cavity brick walls

Thermal mass

Thermal mass

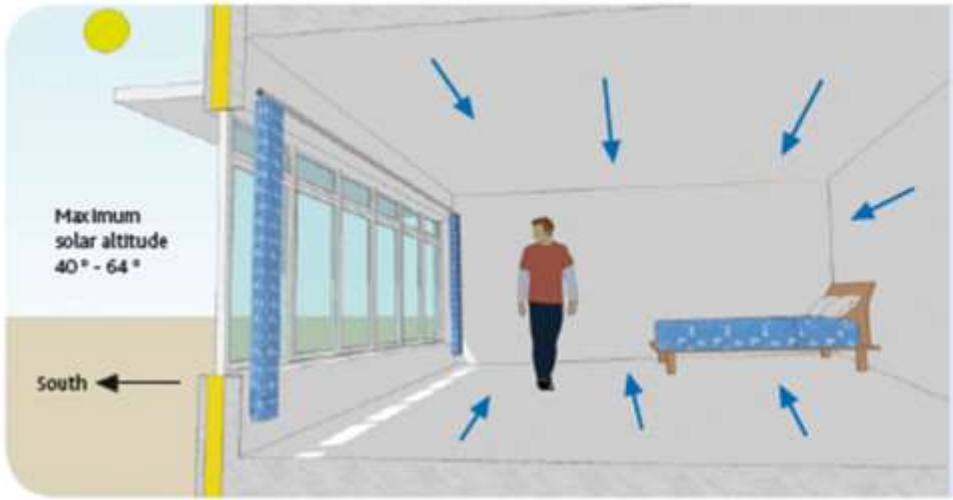
- A thermal mass is any material that is capable of **absorbing, storing and emitting solar heat.**

- The mass can **absorb heat from the sun during the day** and emit heat back into the room when the air temperature cools during the evening.

- A thermal mass is typically he**avy, dense and dark.**
- Examples: concrete, brick, sandstone.

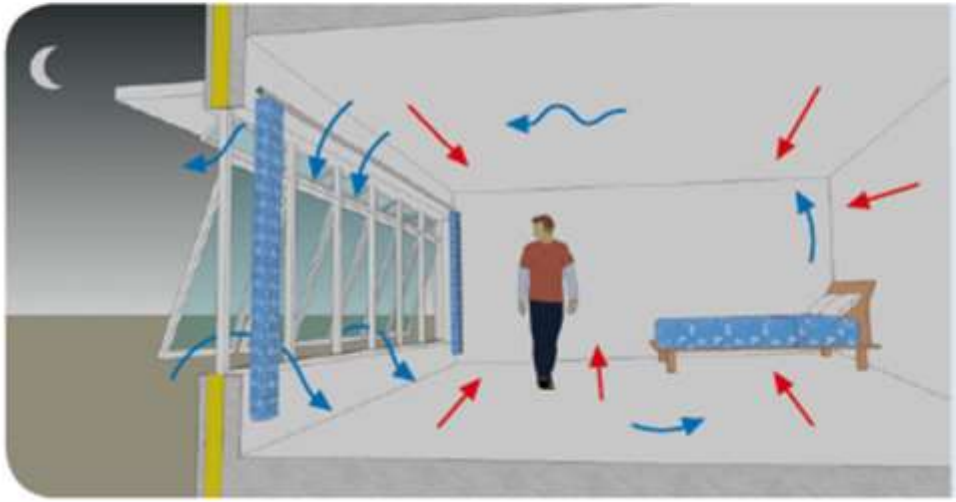
- Thermal mass must be **externally insulated** (so the stored heat is not lost) and **internally exposed** (so solar heat can flow easily into the material) to offset heat loss to colder night-time temperatures

Thermal Mass in Summer



Summer day

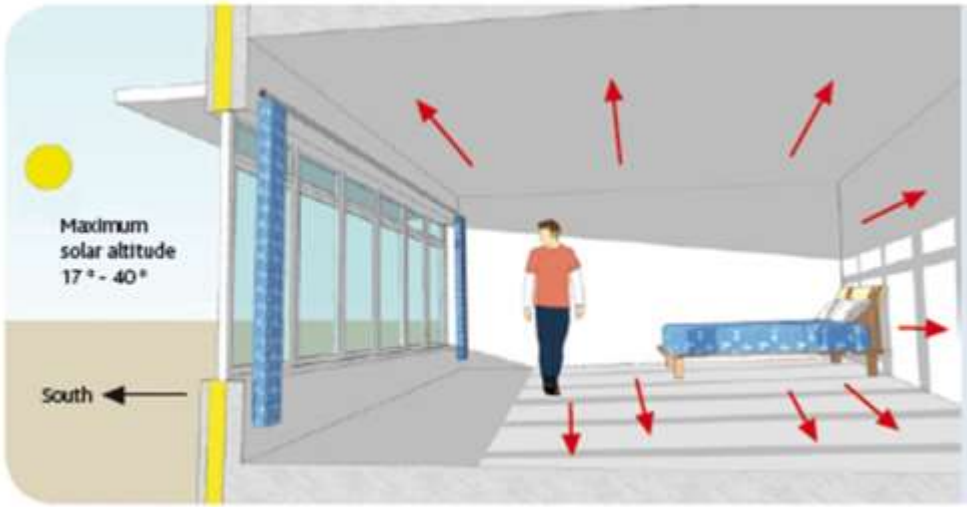
- During very hot weather, windows are kept shut to keep out the warm air.
- Overhangs on the south elevation can be used to keep out the high angle sun during the hottest part of the day.
- Cooling is provided by thermal mass in the floor and walls.



Summer night

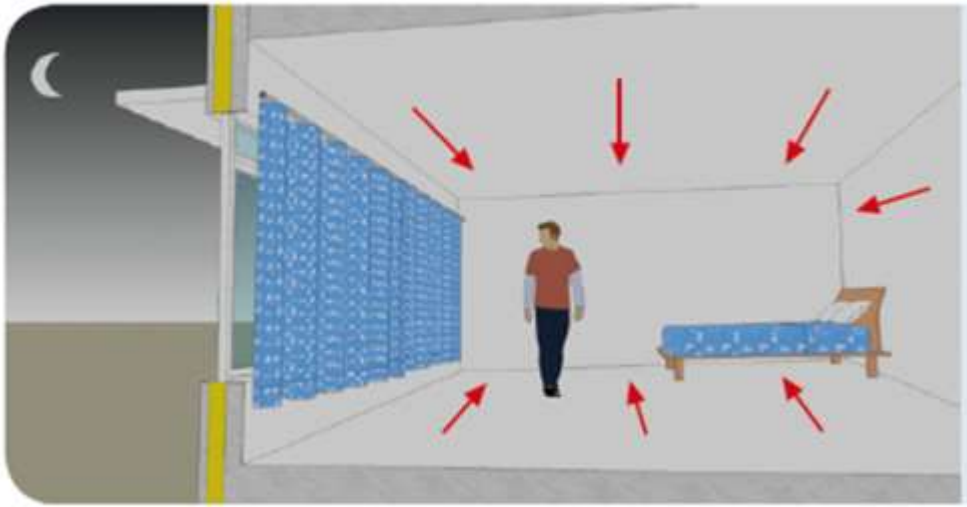
- The windows are opened at night to ventilate the building and cool the fabric.
- If another hot day is expected, the windows are closed again in the morning and the cycle is repeated.

Thermal Mass in Winter



Winter day

- During the heating season, the low angle sun can shine through south facing windows, and the heat is absorbed by thermal mass in the floor and walls.
- In the evening when the sun goes down and the temperature drops, the heat flow is reversed and passes back into the room.



Winter night

- At night, curtains are drawn and windows kept shut to minimise heat loss.
- Heat continues to be released by the thermal mass and supplementary heating is adjusted so only the minimal amount is used.
- By morning the thermal mass will have given up most of its heat and the occupants will typically have to rely on supplementary heating until later in the day.

Disadvantages of Thermal Mass

- **In summer**, thermal mass is only beneficial if night time ventilation can be used to cool it down. Local issues such as, pollution and security concerns can sometimes make this impracticable

- **In winter**, older buildings with low levels of insulation and poor airtightness often required a relatively long pre-heat period to warm up the fabric

Glass to Mass Ratio

- The area of South-facing glass with solar access:

15% in temperate climates and 25% in cold climates of the area of exposed thermal mass in a room.

- Double glazing is highly desirable in cool and cold climates.

- Double glazing glass prevent loss of heat.

Sun Shading

- Heavily insulated walls and roofs need less shading
- Reduce solar heat gain by recessing windows into the wall
- Use louvered shades to allow more daylight to enter, while shading windows from direct sunlight.