

# DESIGNING SOLAR HOMES

## Summer Institute 2017

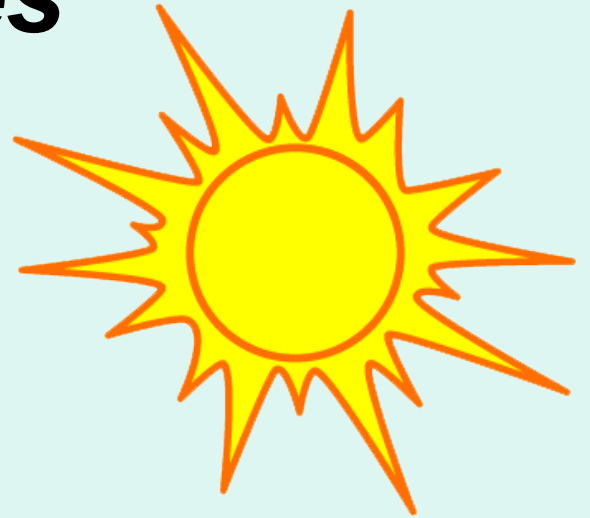




# ***Solar Design Principles***



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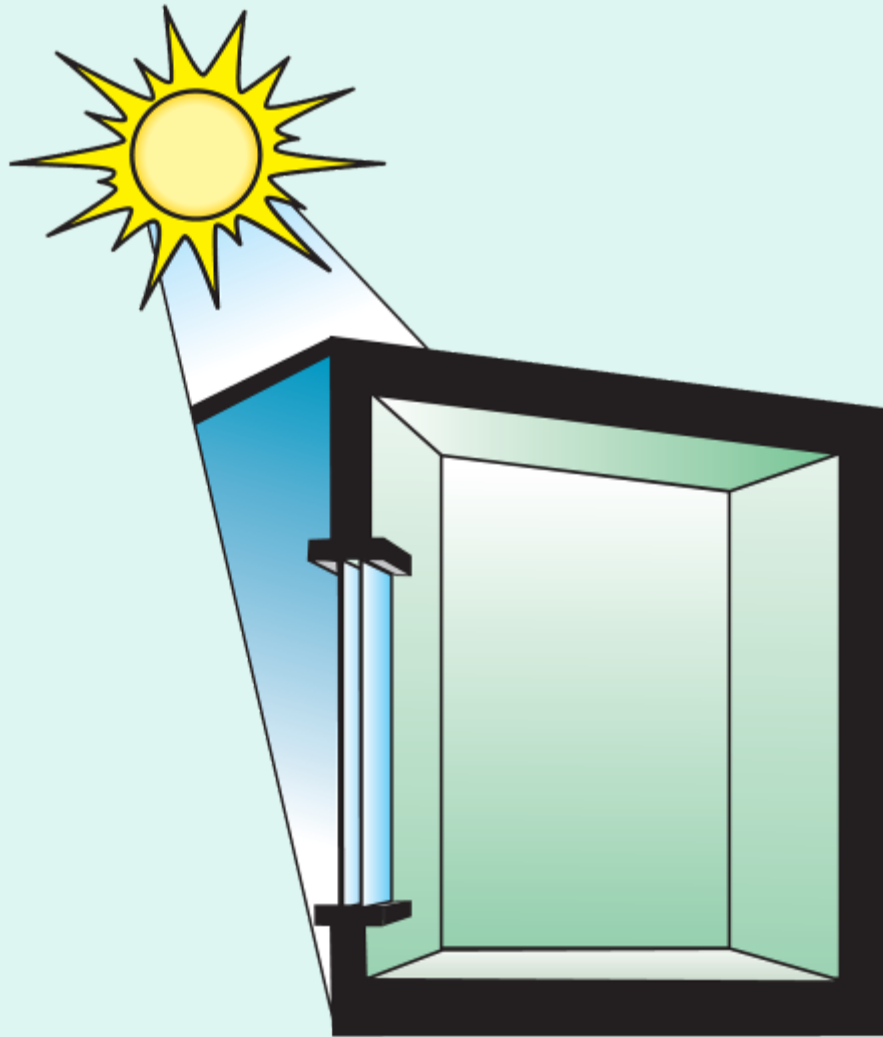


**# 1.**

**Use sunlight for warmth.**

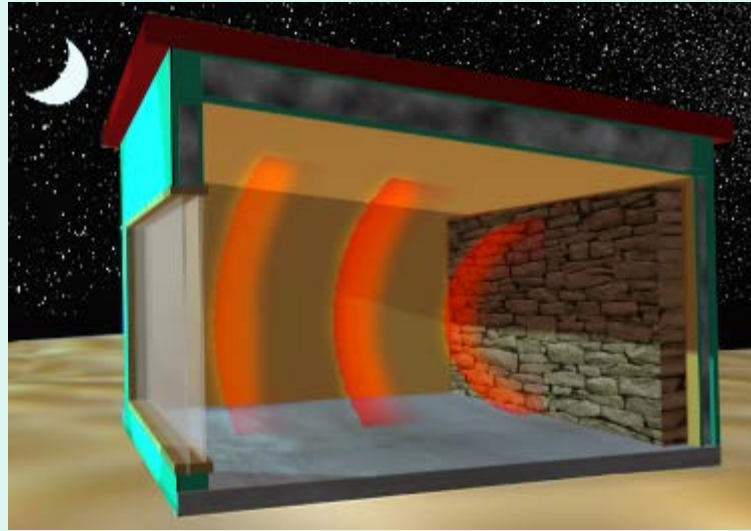


# ***Solar Design Principles***



**# 2.**  
**Use shade**  
**to stay cool.**

# *Solar Design Principles*



**# 3.**

**Use thermal mass to store warmth & “coolth.”**

# ***Solar Design Principles***

## **# 4.**

**Use insulation  
to keep heat  
in or out.**





# ***Solar Design Principles***

## **# 5.**

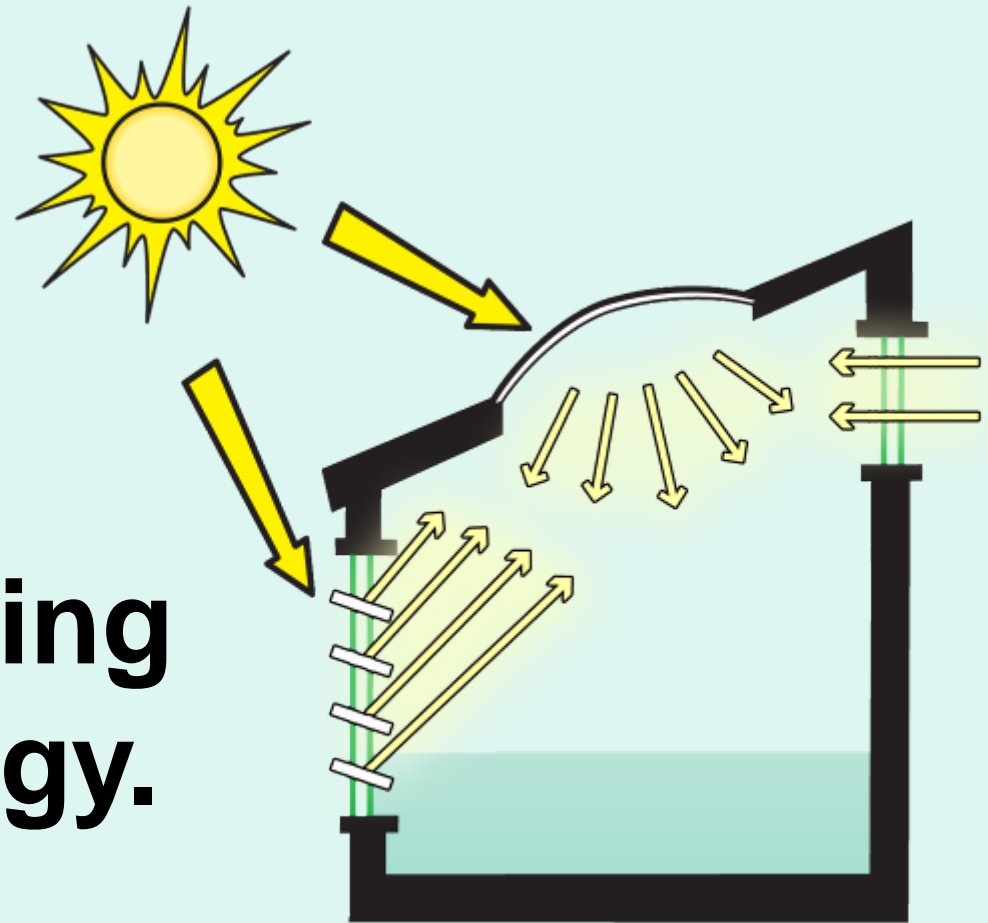
**Use air to move  
heat &  
coolness.**



# Solar Design Principles

**# 6.**

**Use daylighting  
to save energy.**





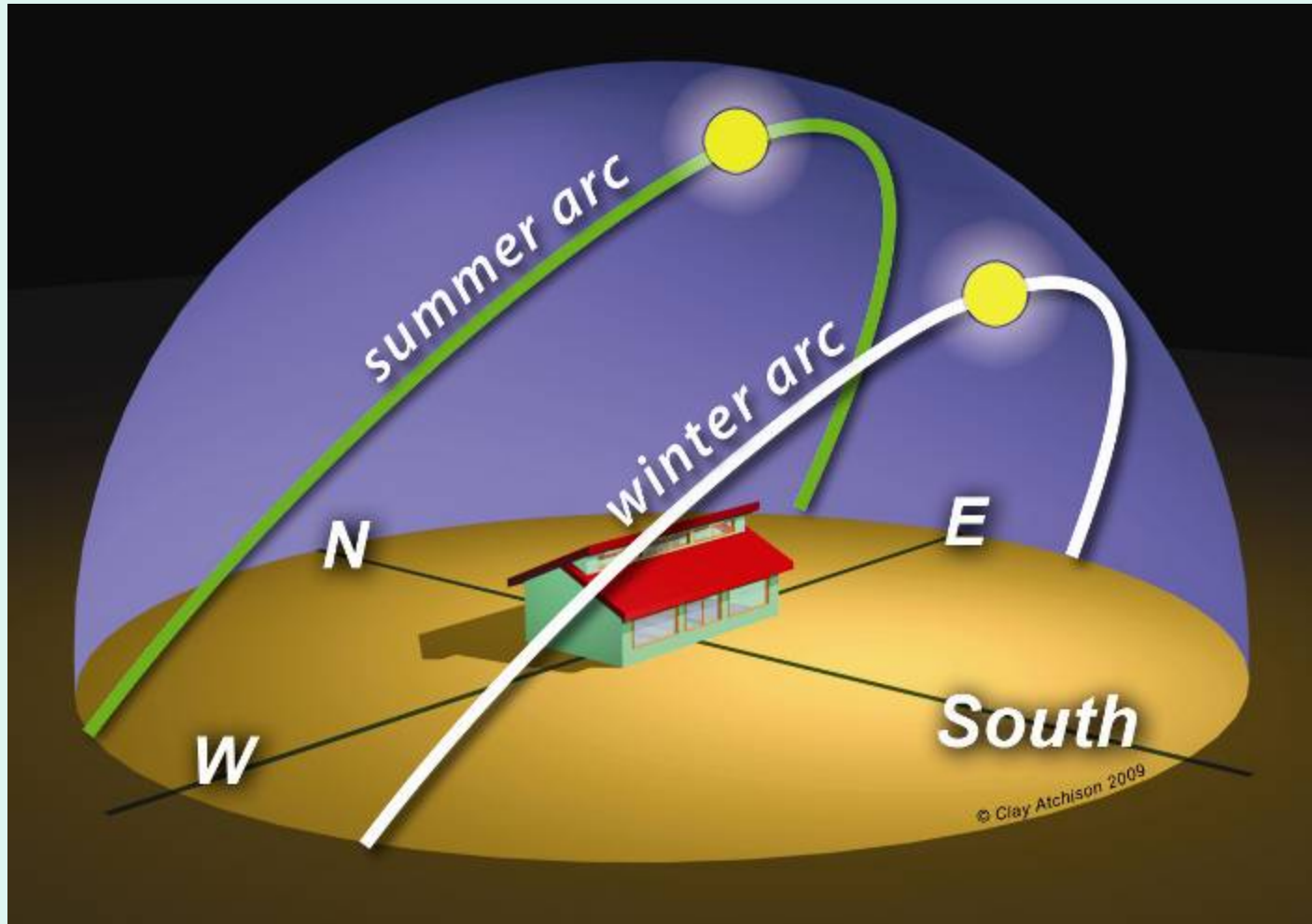


# ***Solar Design Principles***



- 1. Use sunlight for warmth.**
- 1. Use shade to stay cool.**
- 2. Use thermal mass to store warmth & “coolth.”**
- 3. Use insulation to keep heat in or out.**
- 4. Use air to move heat & coolness.**
- 5. Use daylighting to save energy**

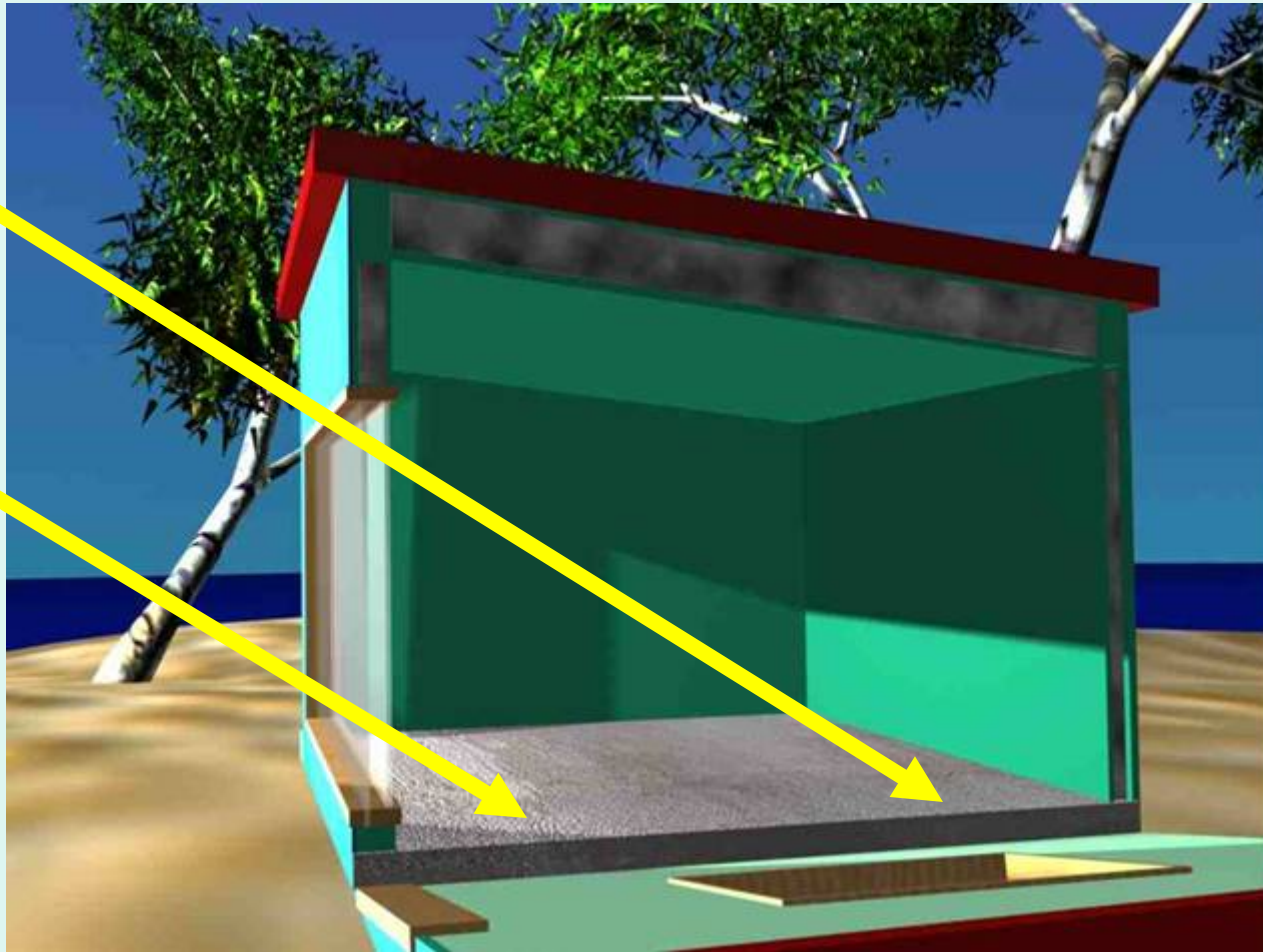
# #1: Use Sunlight: Orientation





# Direct Gain:

***Glass: the magic solar heating technology***



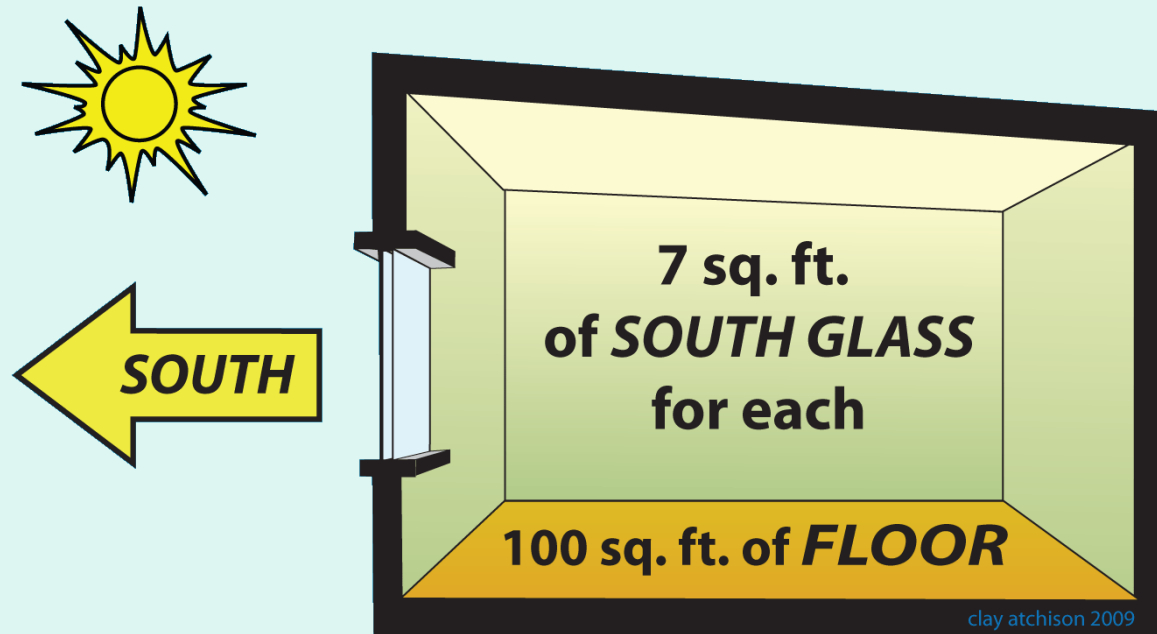


# Window to Floor Ratios

(Suggested for SF Bay Area)



**7:100** (without Thermal Mass)



**12:100** With Thermal Mass

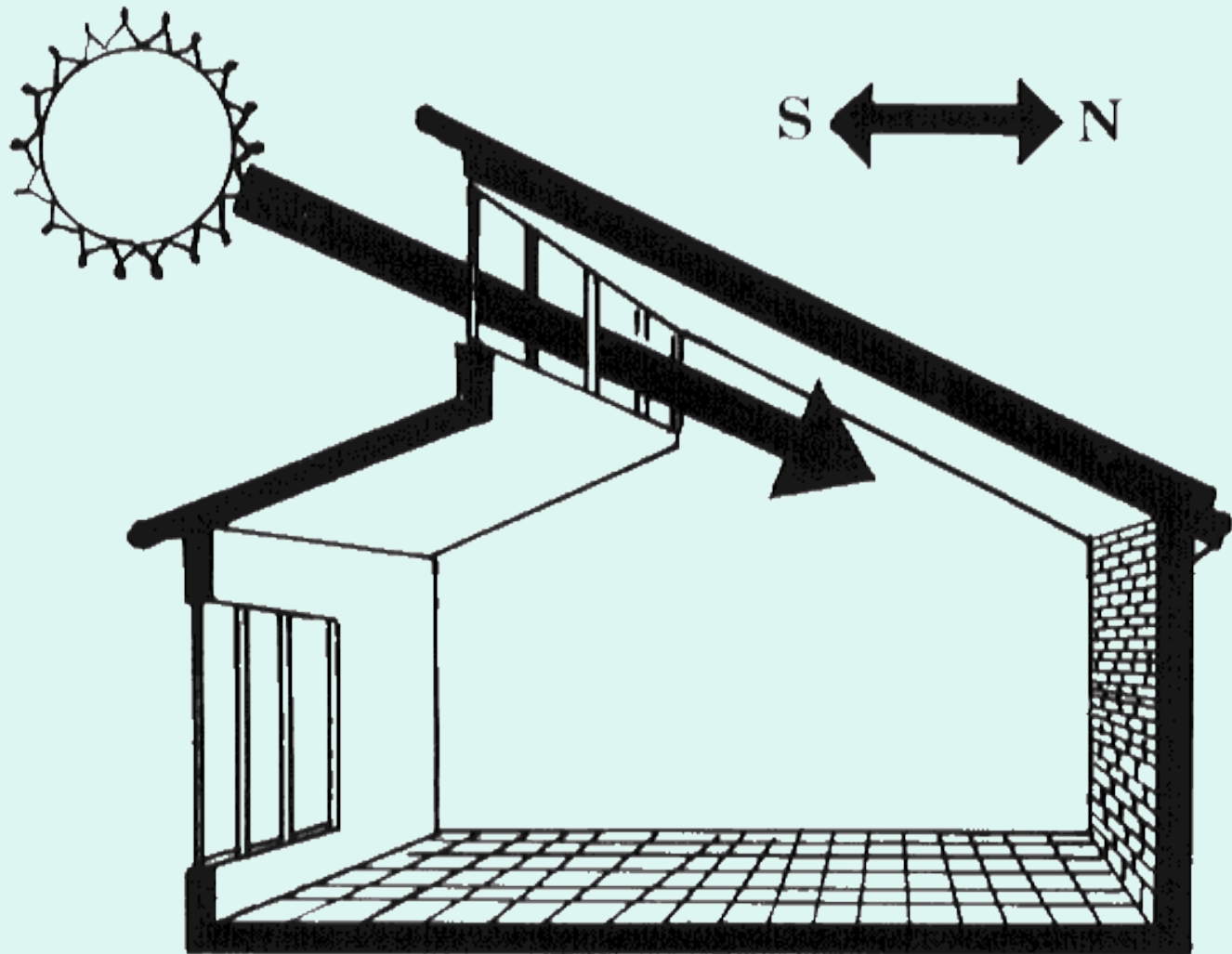


# South Facing Windows

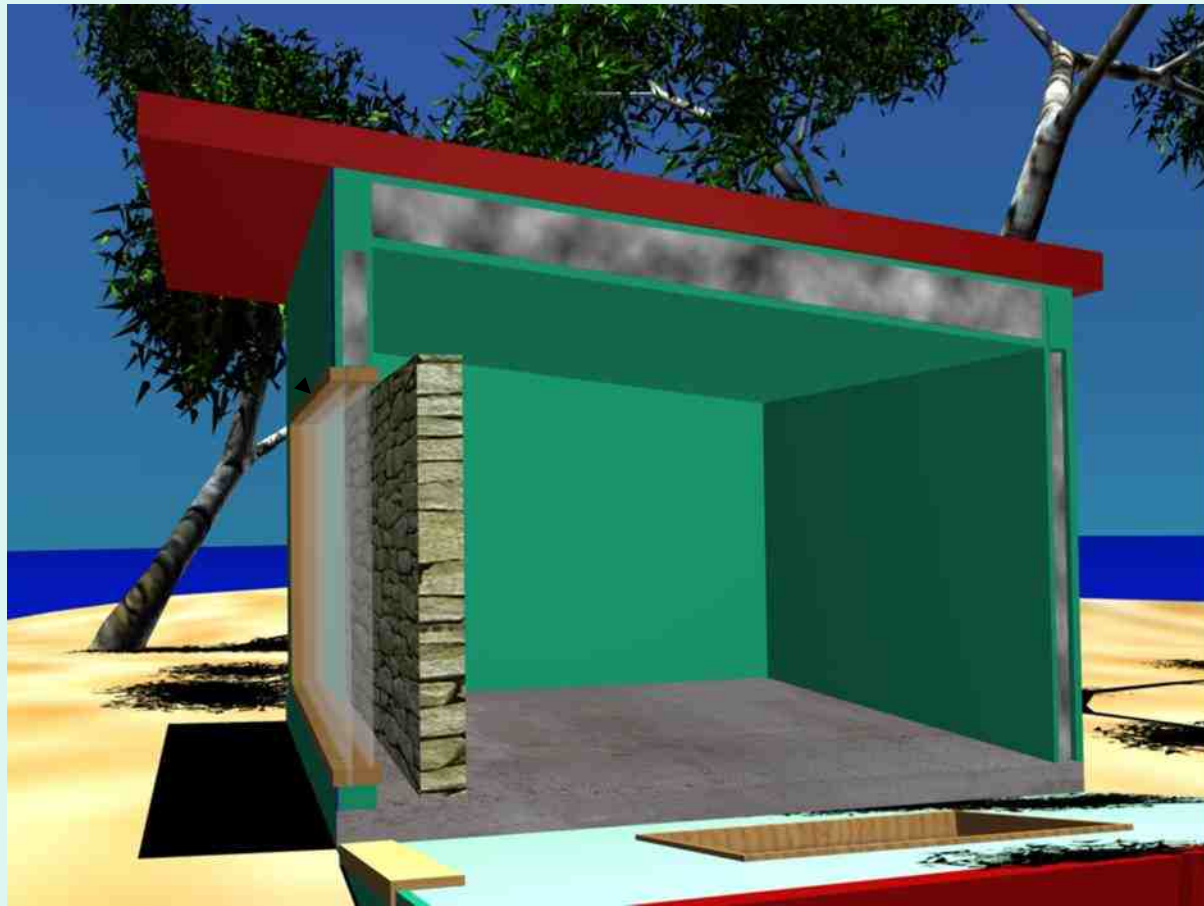




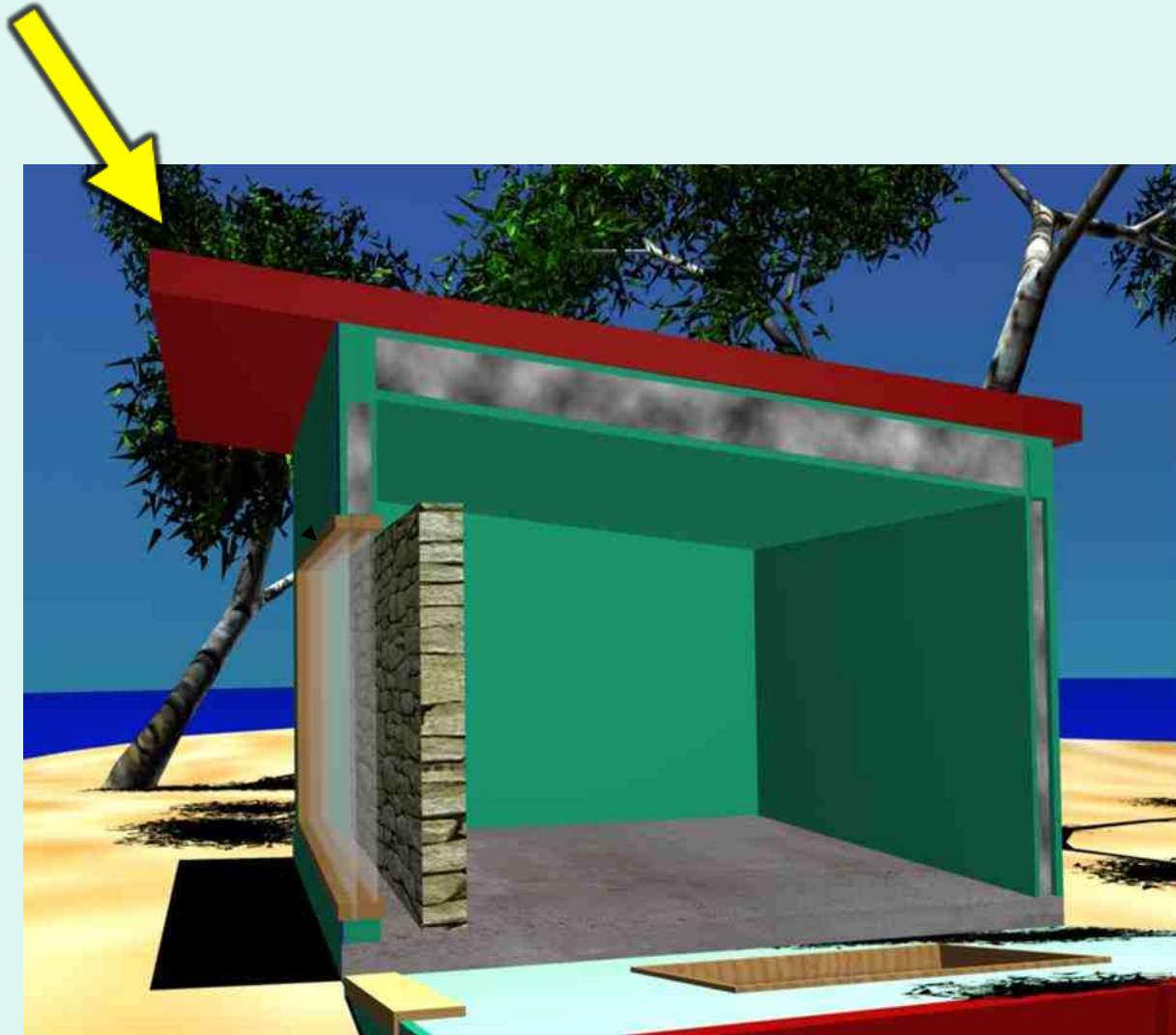
# Clerestory Windows



## #2. Use shade to stay cool

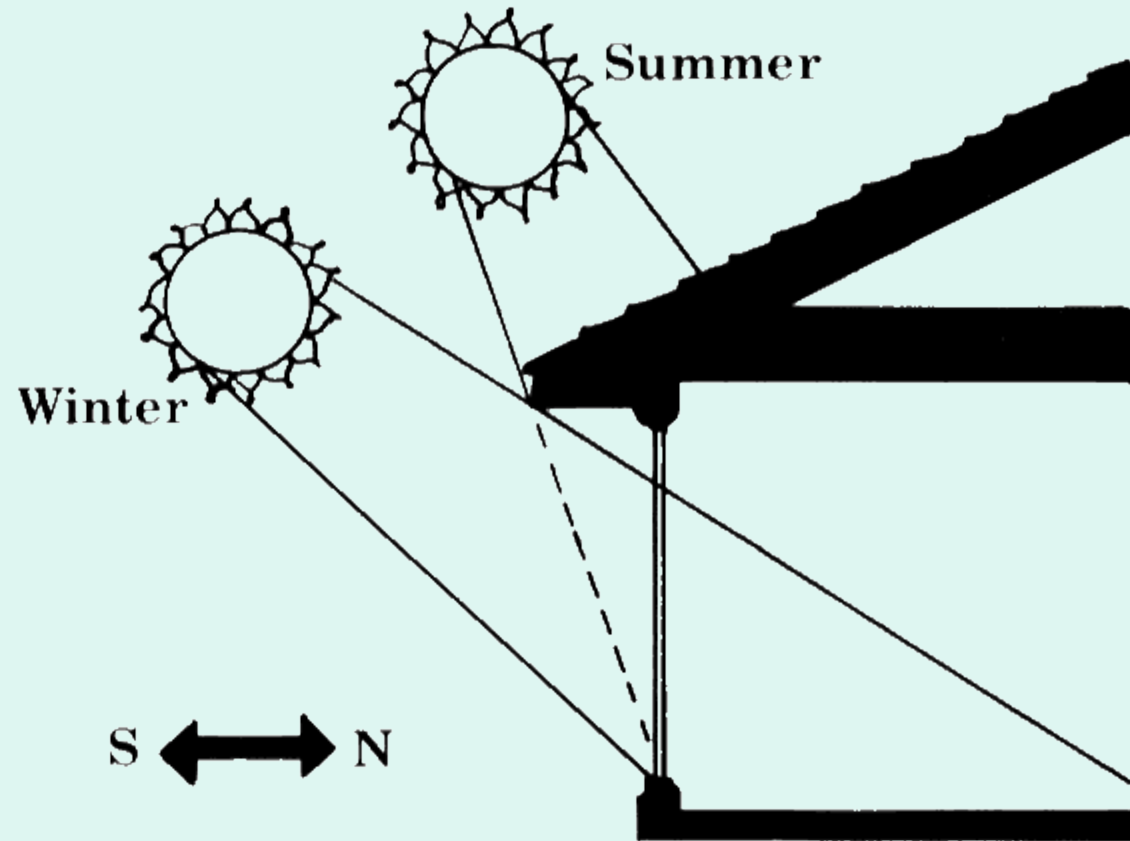


# Overhang shades windows

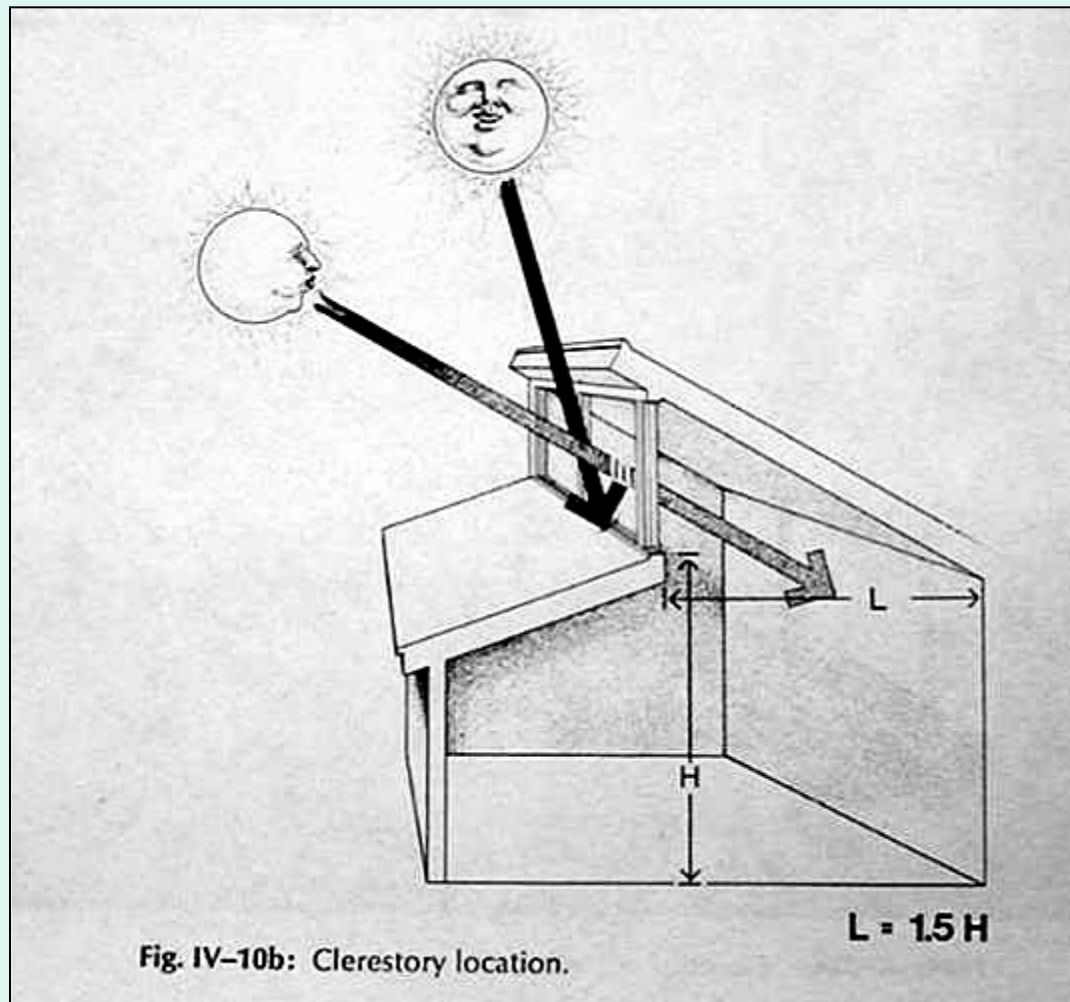




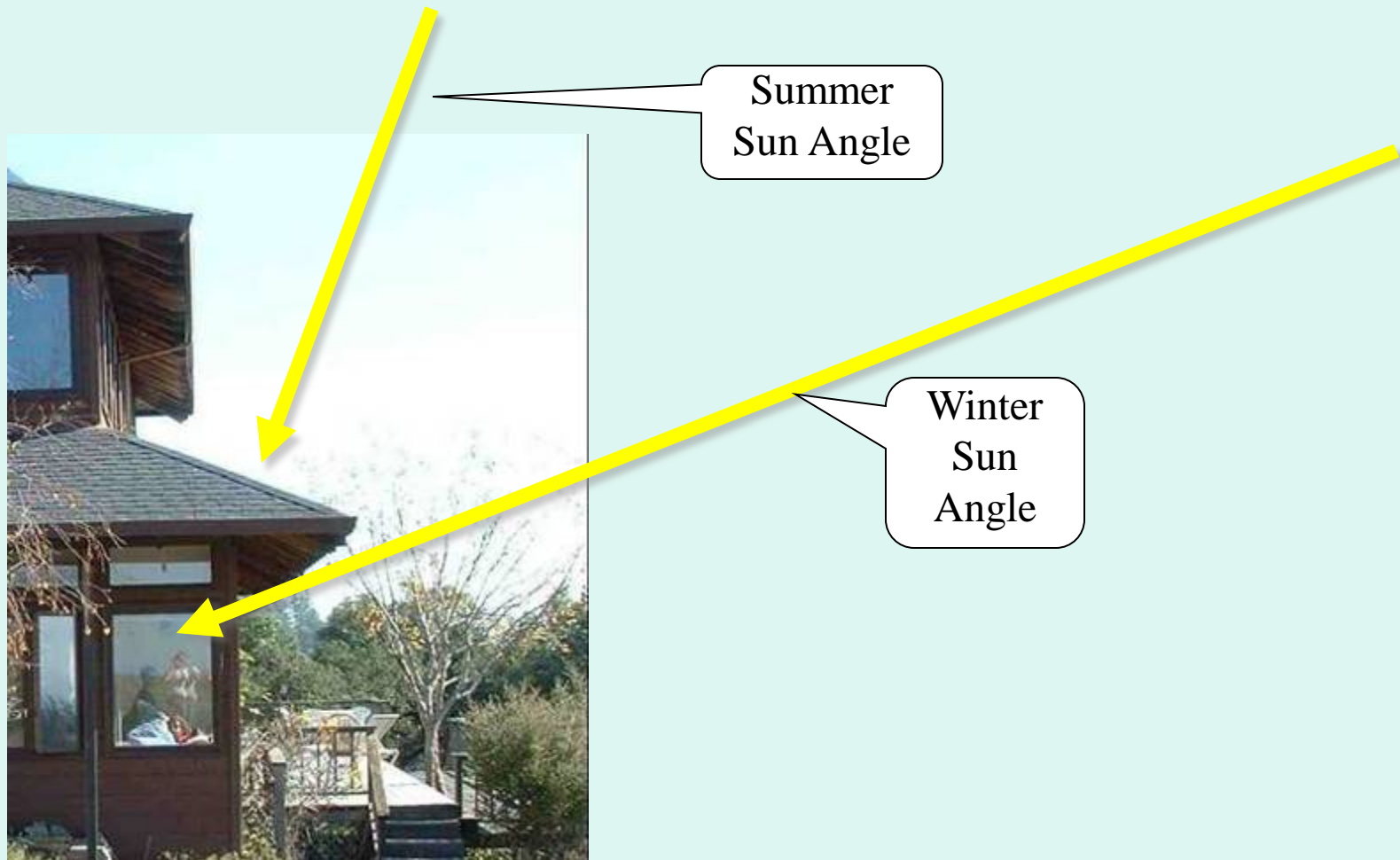
Block summer sun  
Let winter sun in



# Sun Angle Key: Vertical Glass



# Eaves Keep Summer Sun Out Let Winter Sun In





# Porches, shade zones, strategically planted trees







## Angled Slats in Shade Structure

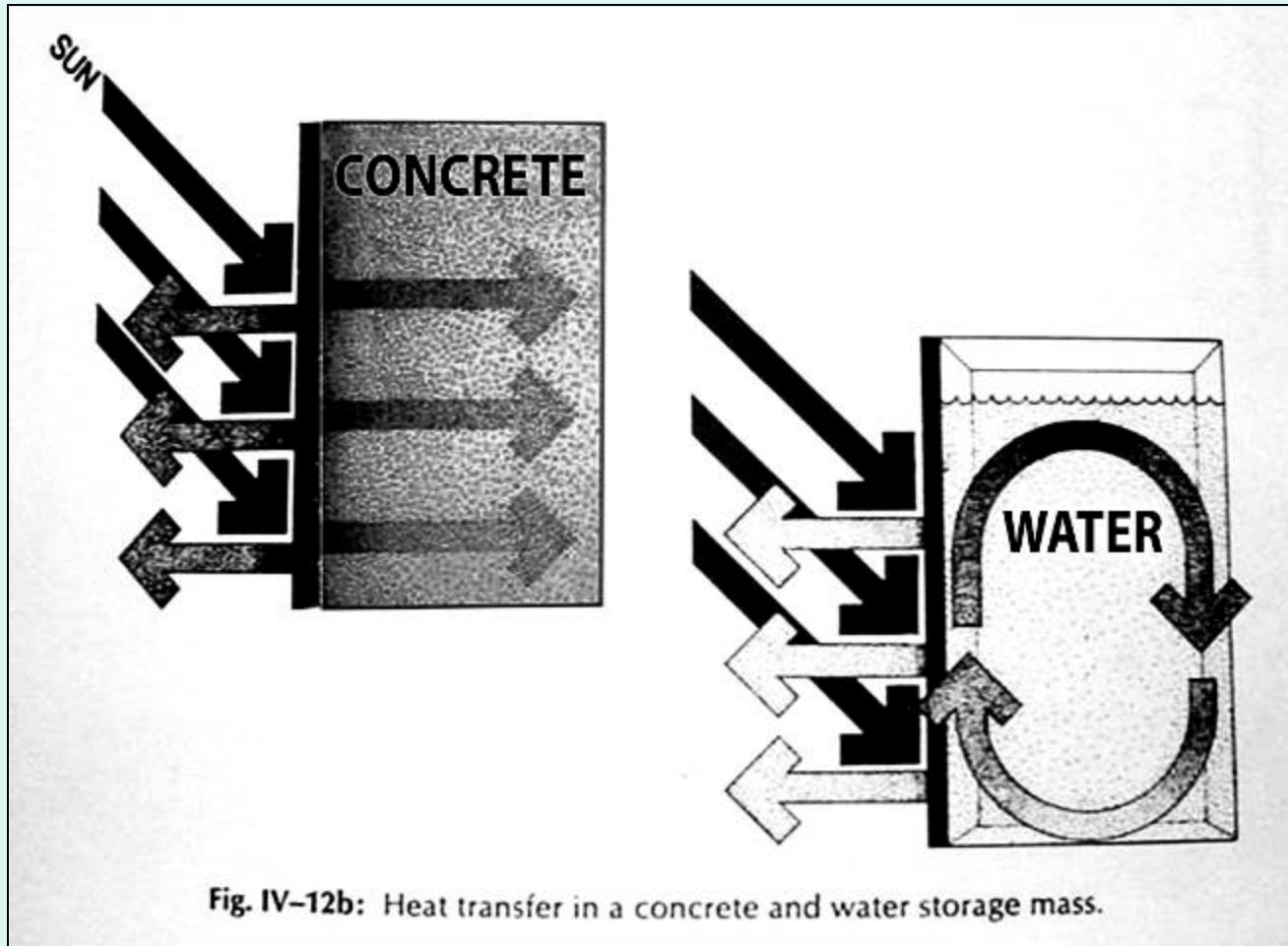
# #3 - Thermal Mass:



ability to store heat

### #3: Use Thermal Mass

to store warmth & coolth







# *Direct Gain with Thermal Mass*

## *12:100 South Glass to Floor Area (Berkeley)*



***Thermal  
Mass***

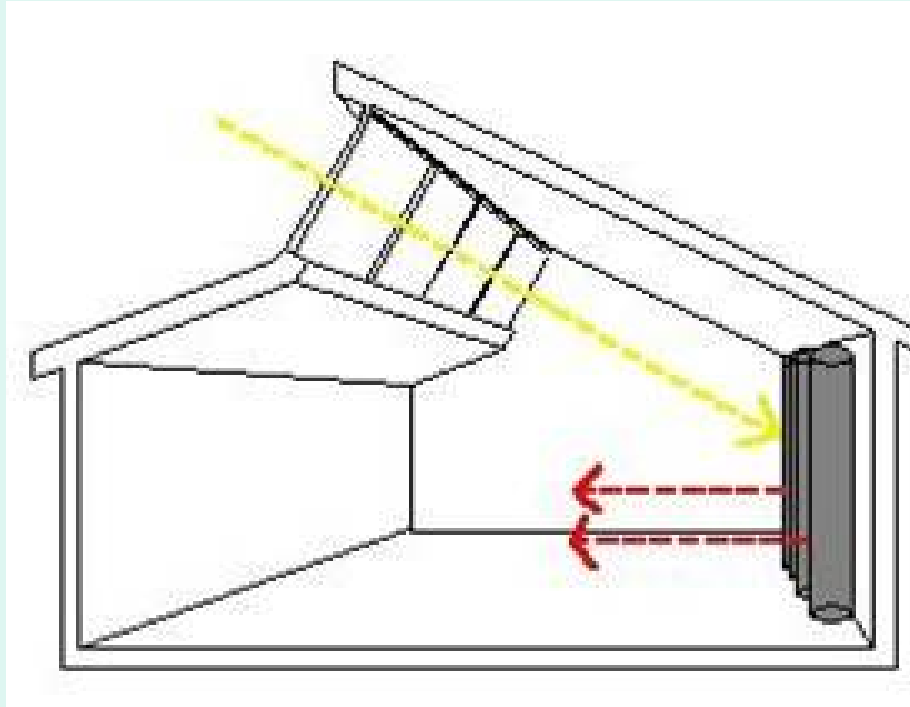


# *Thick Plaster Wall*

- Thermal mass not in direct sunlight: 70% as efficient.
- Notice another Solar Home Feature?



# *Thermal Mass: Water Tubes*





# Trombe Wall:

Block Glare, Thermal Storage, Heat Control





# *Trombe Wall*

## Added to building in Wales





# *Trombe Wall with Windows*





# Windows let direct gain & daylight in



## Wall absorbs & releases heat in a controlled way

## *#4: Use insulation to keep heat in or out*





# Neat Installation is more effective





# *Straw Bale*: waste material: R35 (needs less energy for heating and cooling)



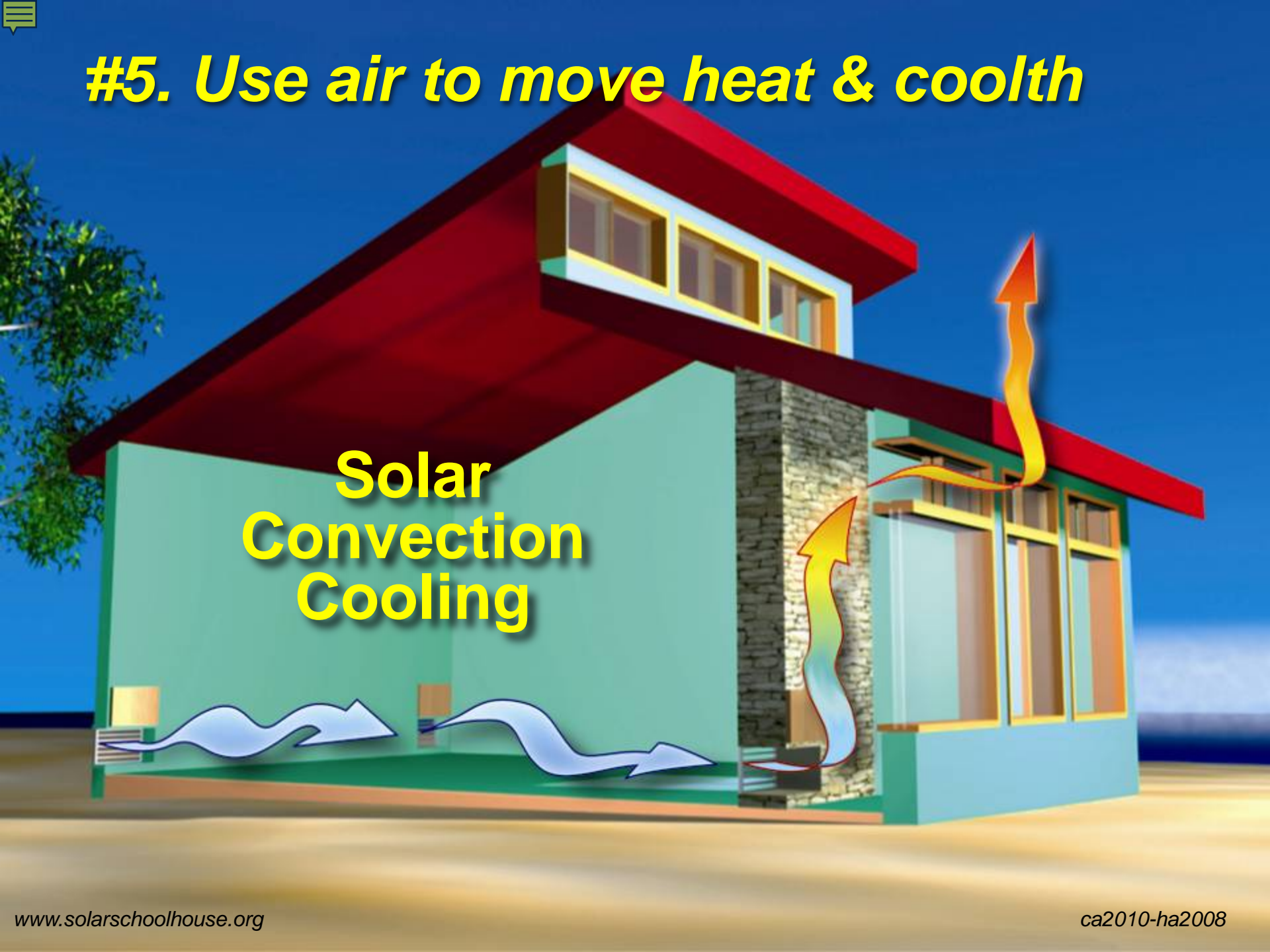


***Straw Bale:*** 2 feet thick:  
Keeps heat in during winter & out in summer



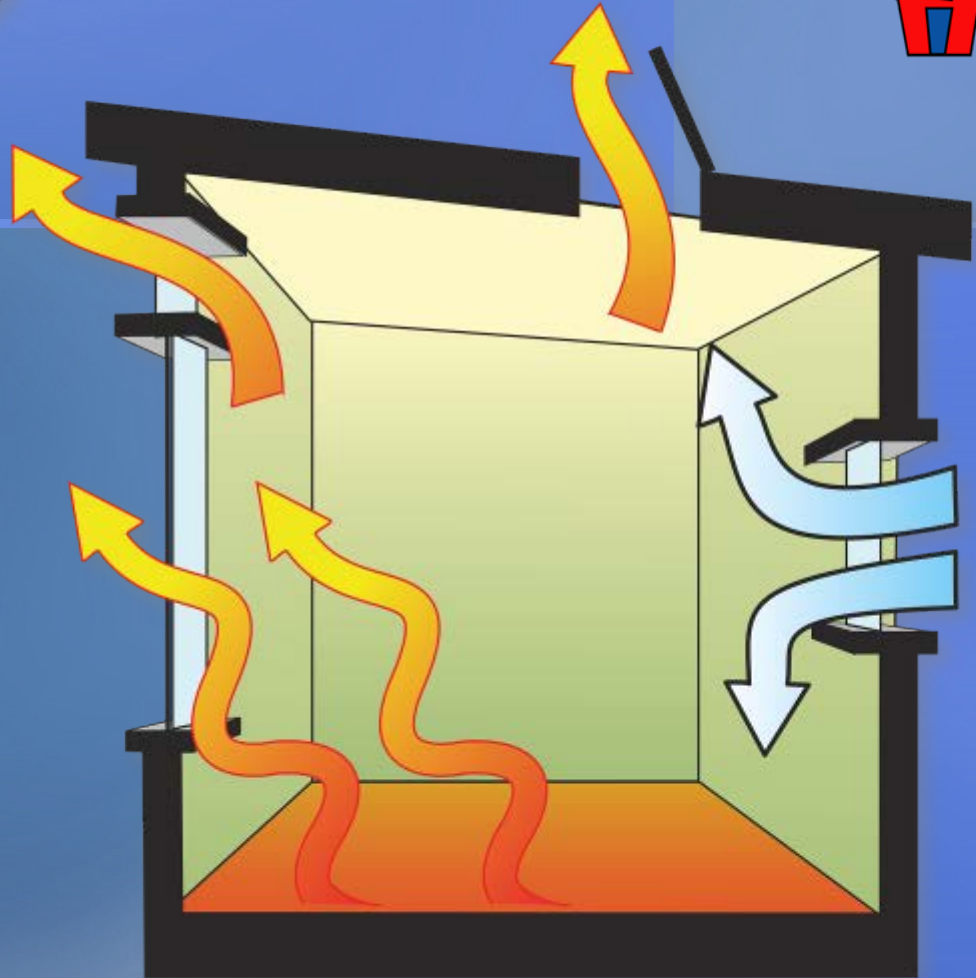
## #5. Use air to move heat & coolth

**Solar  
Convection  
Cooling**



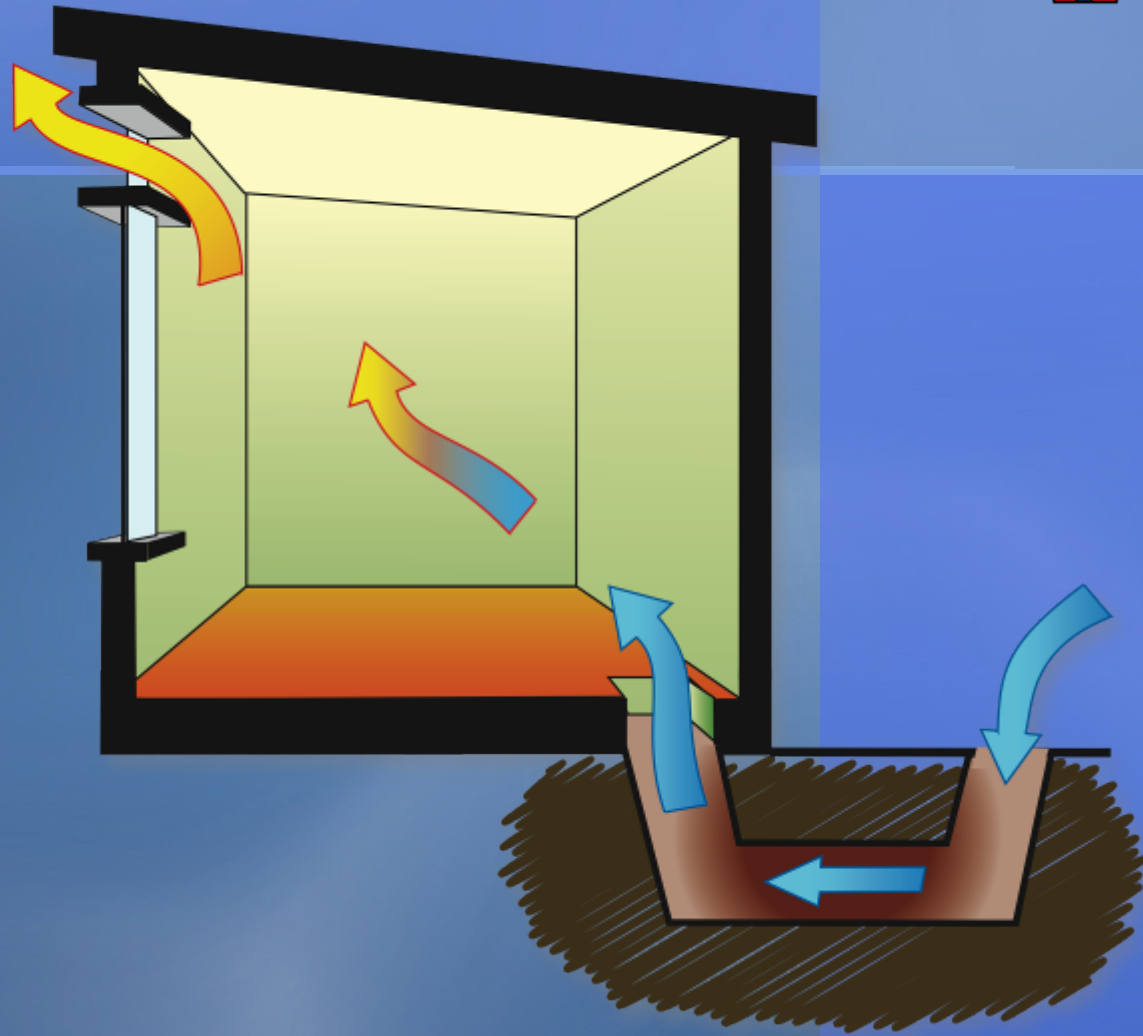


# Night Convection Cooling





# Earth Cooling





# **# 6.**

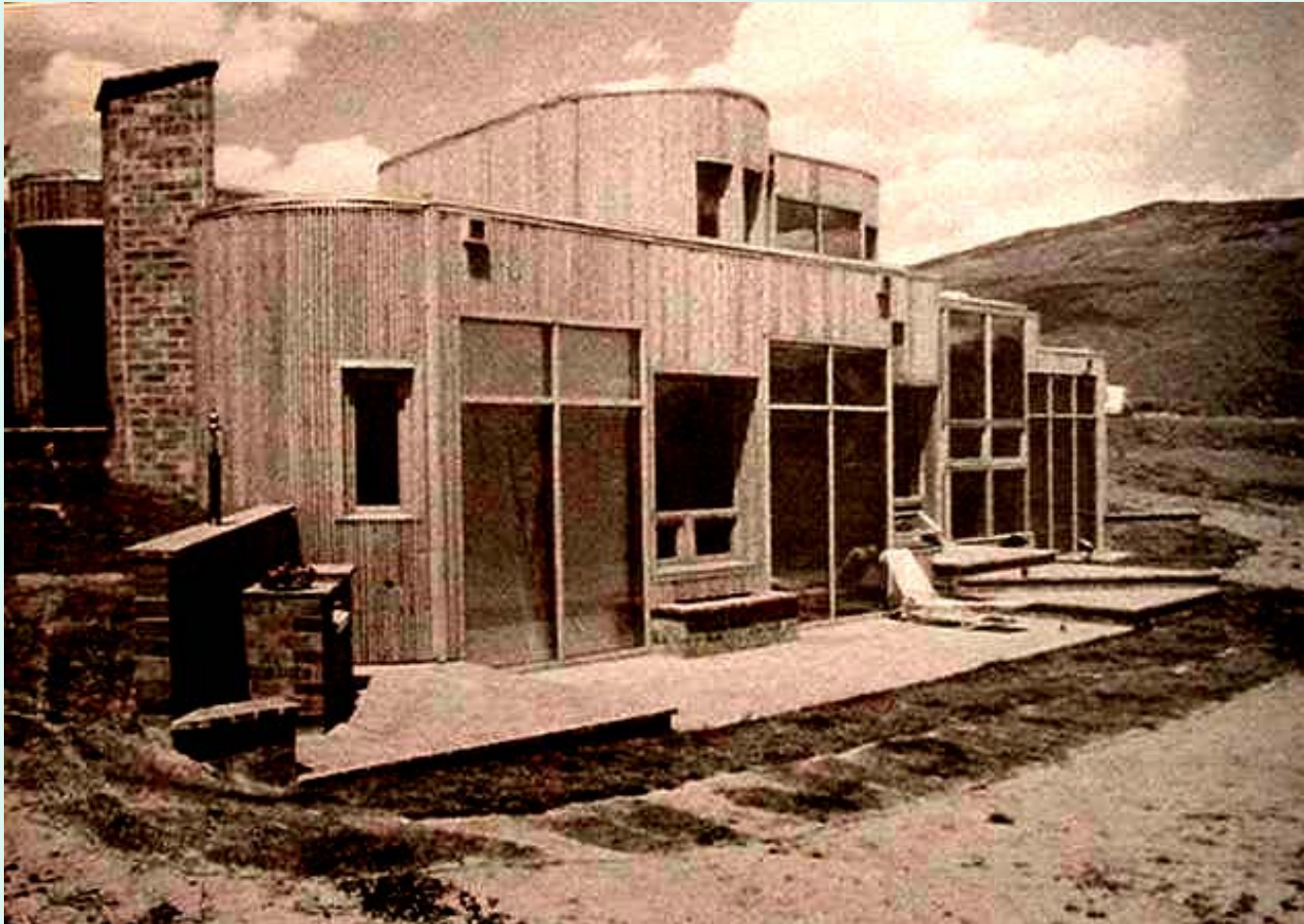
## **Use daylighting to save energy.**





# *Solar Design Features?*

## *Anything missing?*



# *Solar Design Features?*





# Earthships





# Earthships





# *Earthships*



# *Inside an Earthship*







# *Solar Design Features?*



# *Solar Decathlon*





# *Solar Design Features?*

## Anything missing?



# *Solar Design Features?*



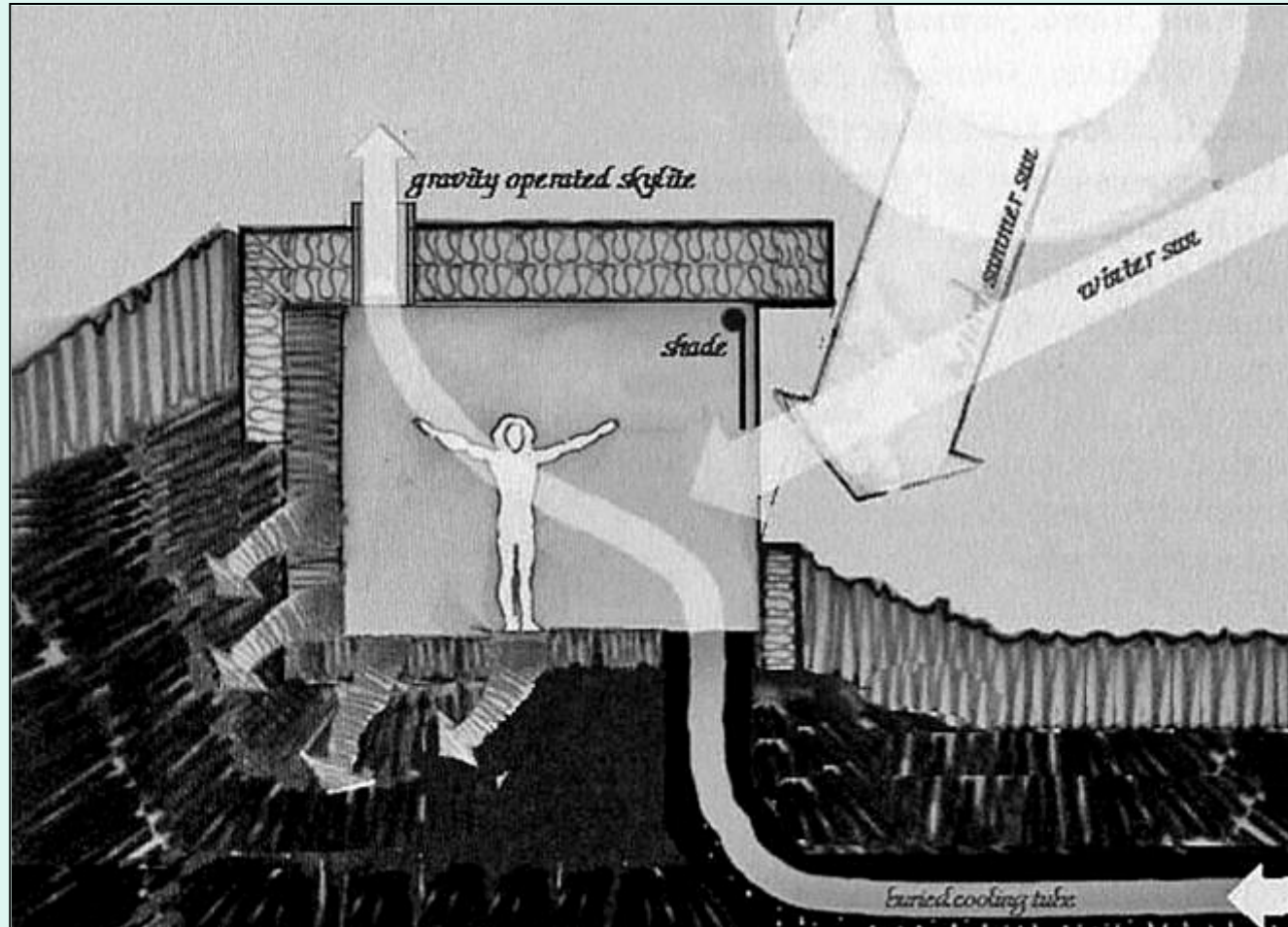
Architect: Craig Henritzy





# Contemporary Design:

Taking advantage of 58 degree earth temperature



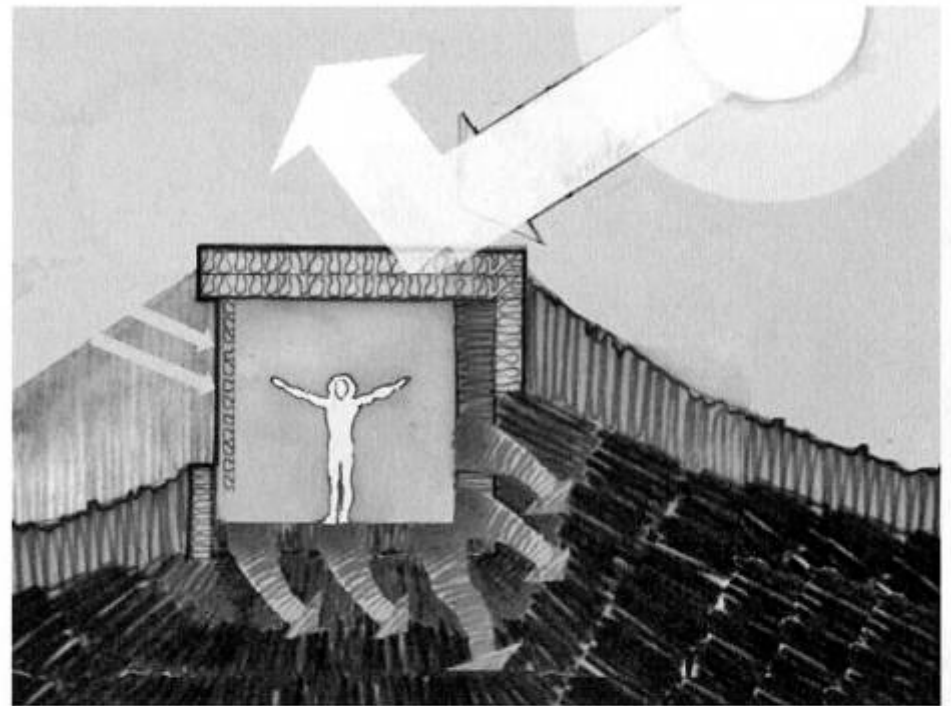
*From: Comfort in Any Climate, by Michael Reynolds,*

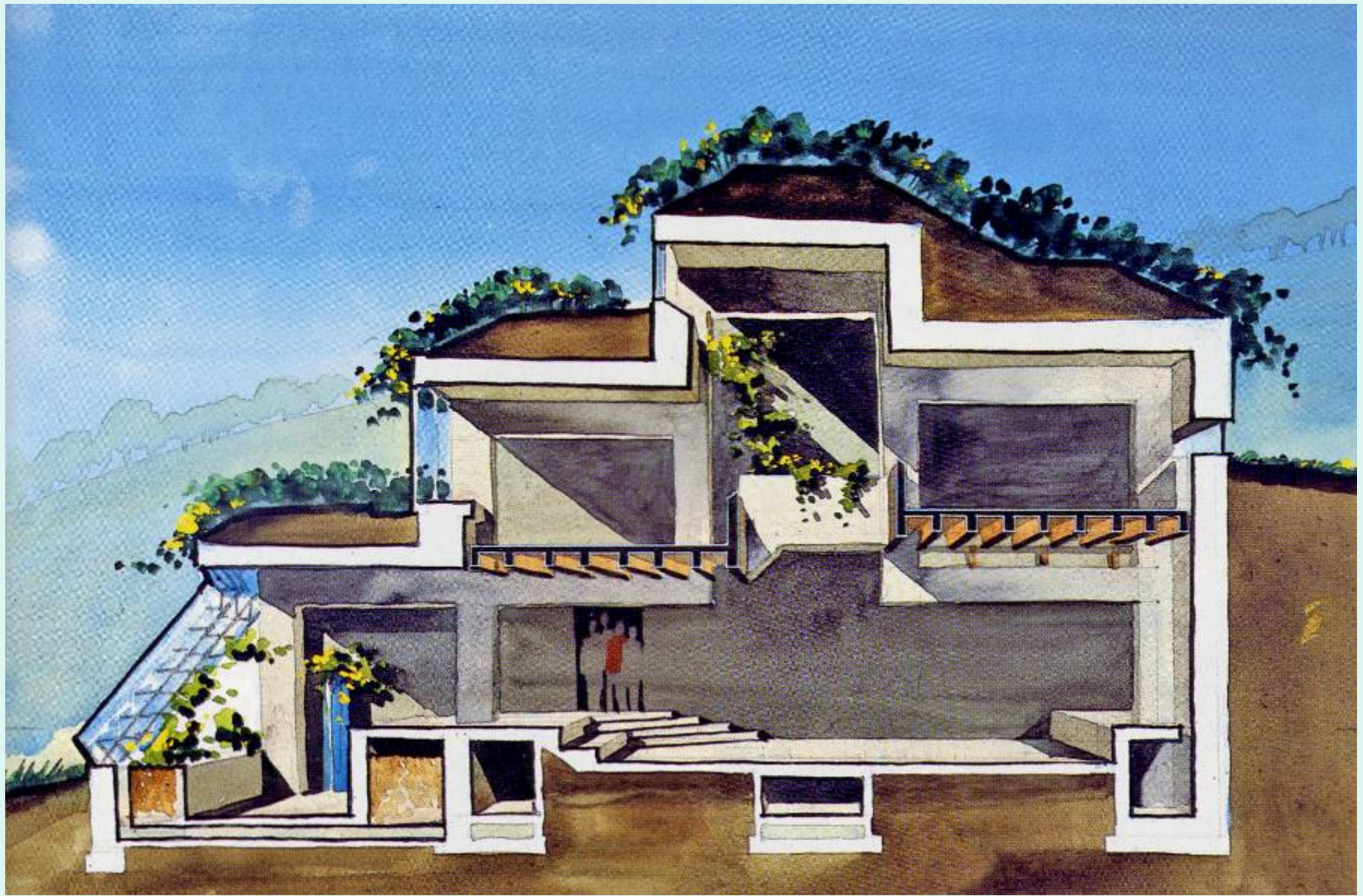


# Extremely Hot Climate

1. Build into the earth
2. Reflective Roof
3. Use ***NORTH*** facing windows

*From:*  
*Comfort in Any Climate,*  
*by Michael Reynolds*





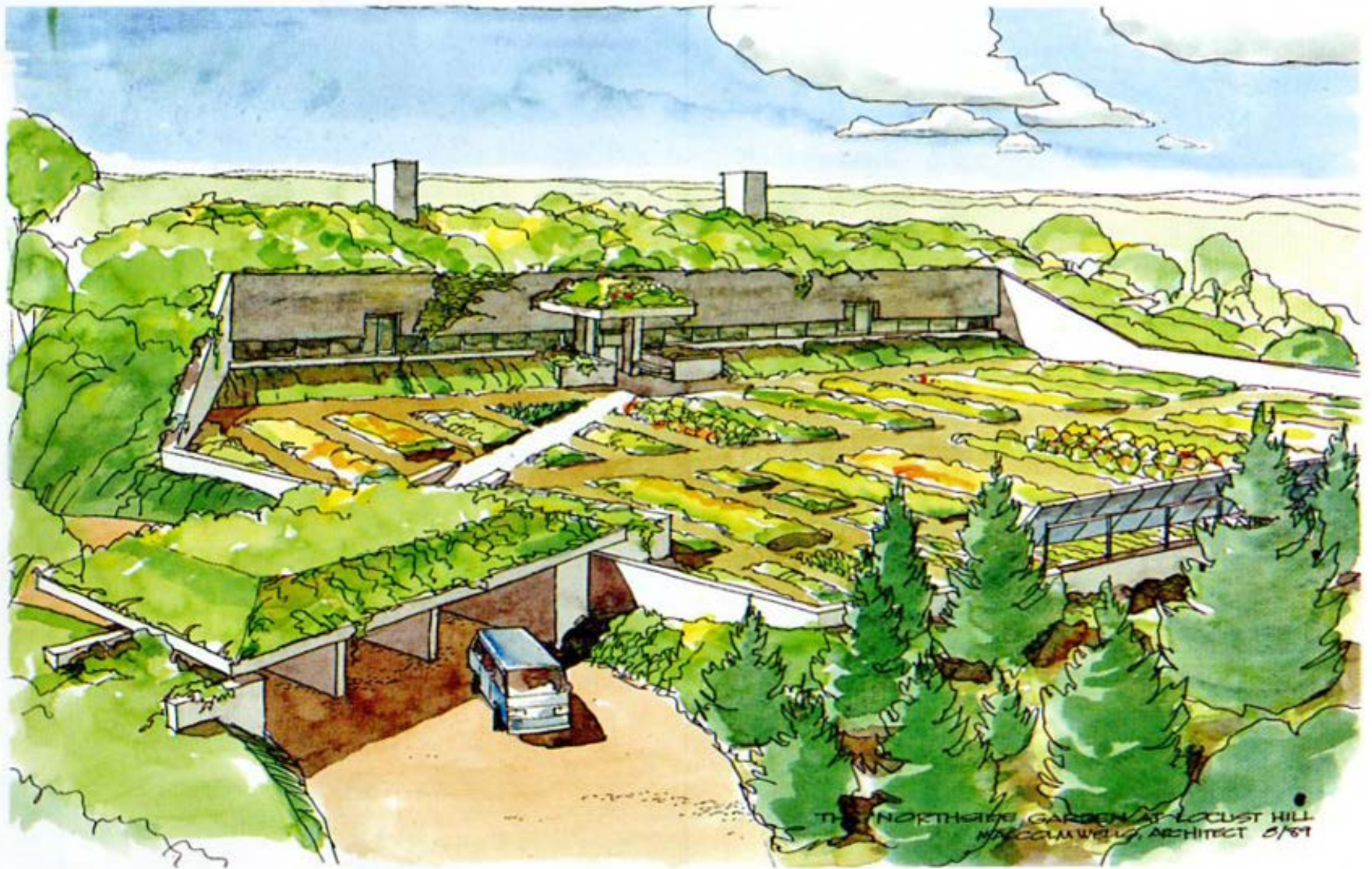
*From: The Earth-Sheltered House, by Malcolm Wells*





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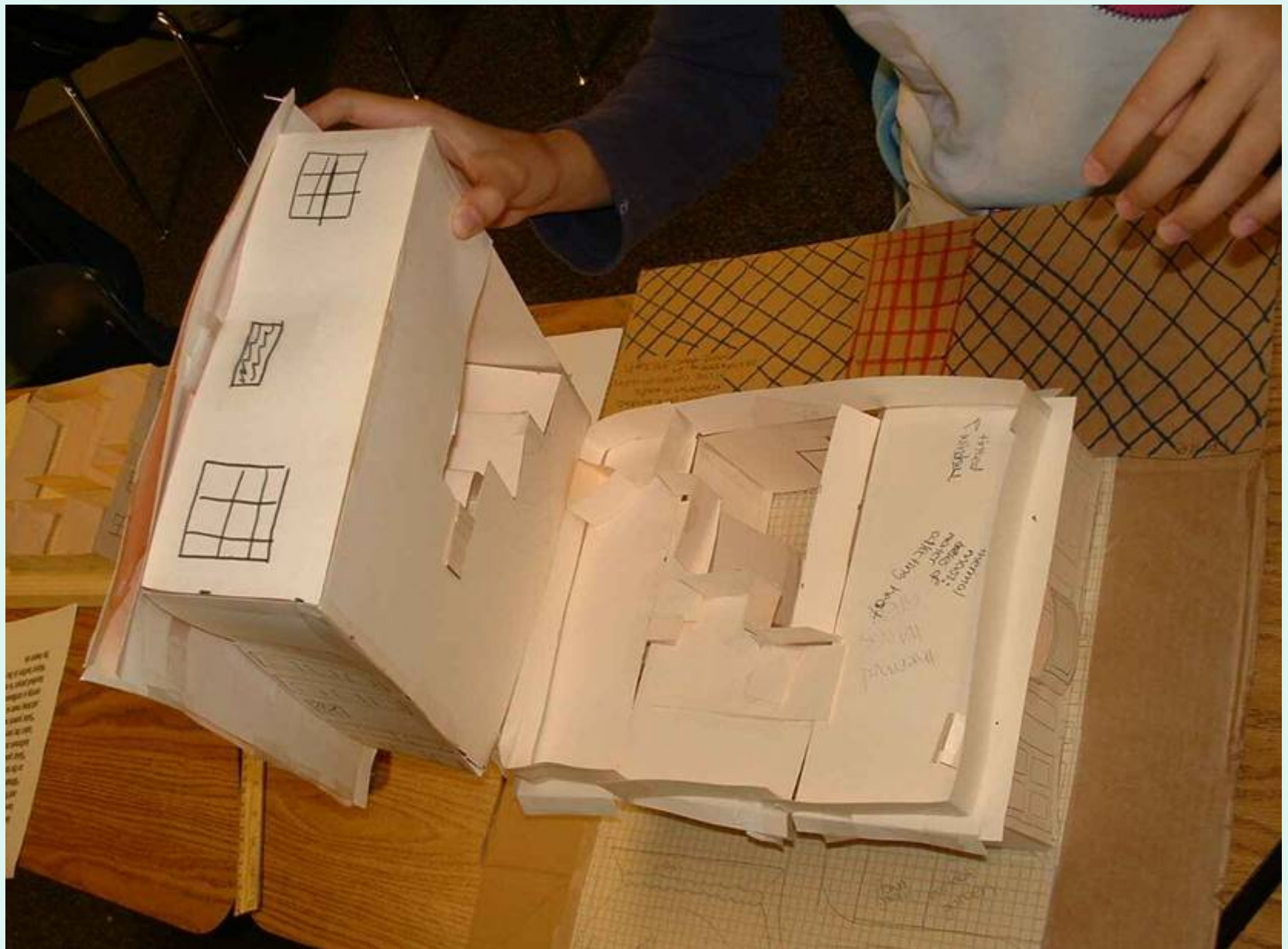
*From: The Earth-Sheltered House, by Malcolm Wells*

# *Solar Home Model*

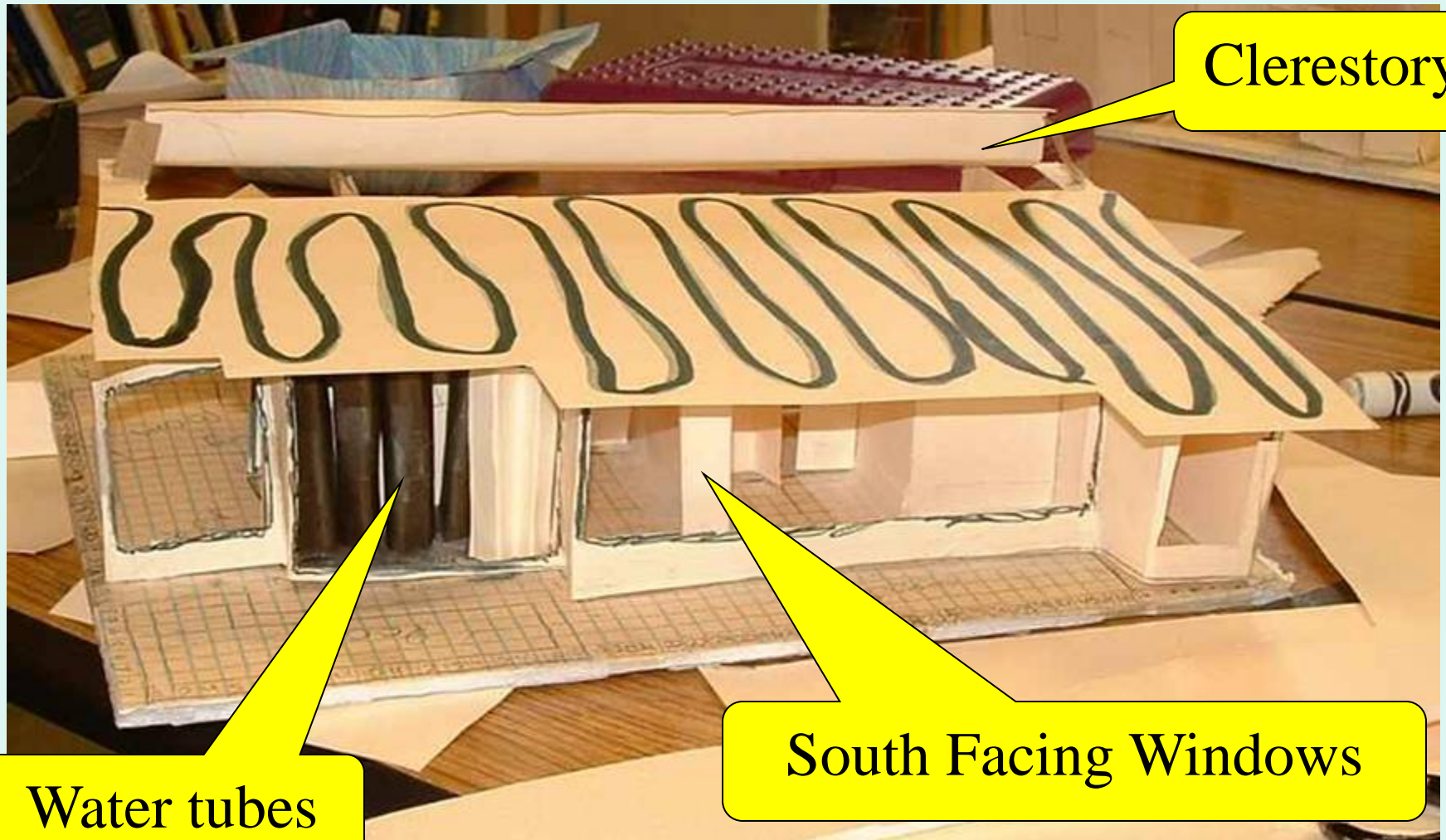


# *Student Projects*





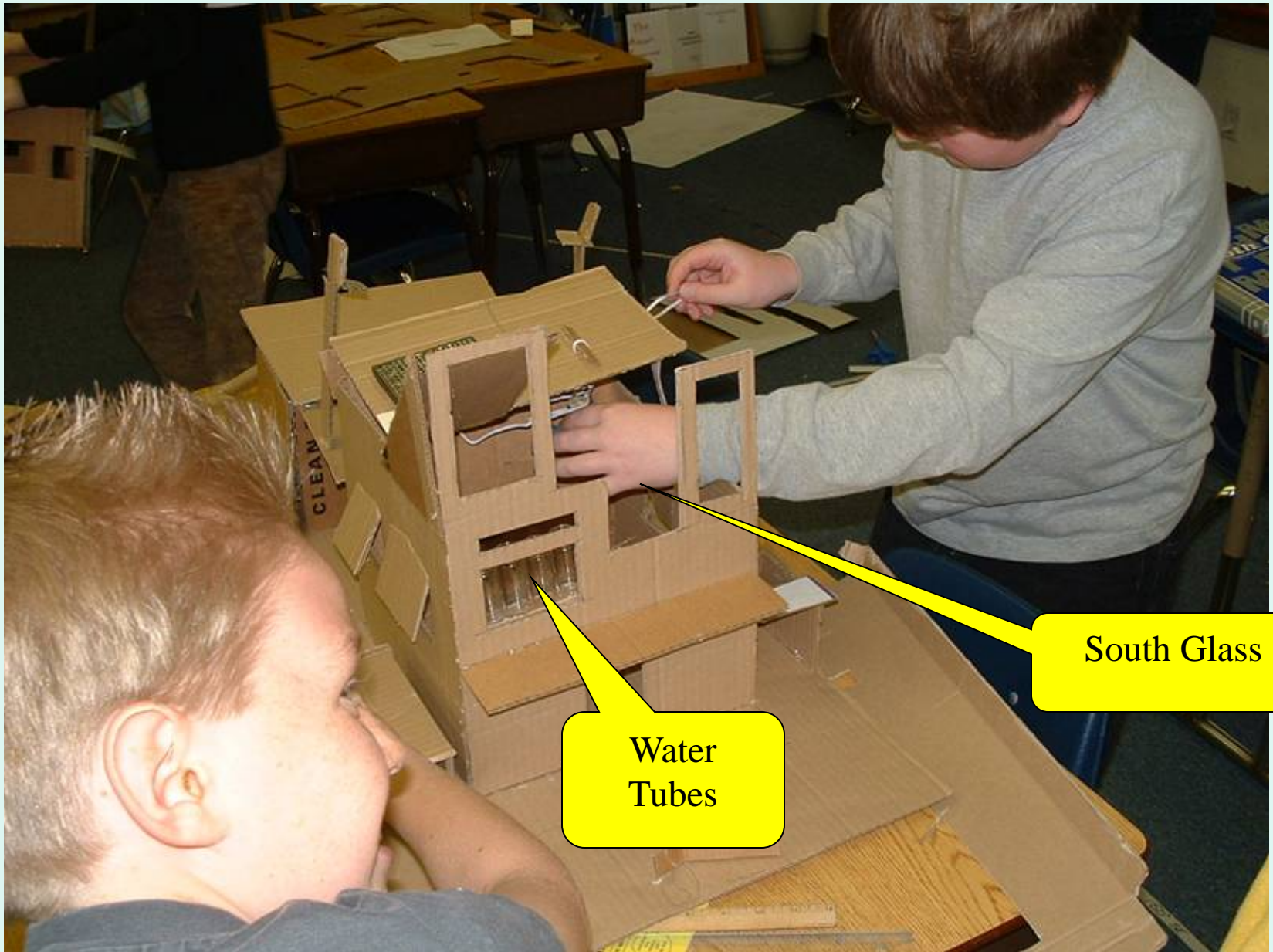




Clerestory

Water tubes

South Facing Windows



South Glass

Water  
Tubes





Attached  
Greenhouse



# *Landscaping & Solar Electricity*



# *Brawley High School Students' Berm House*



























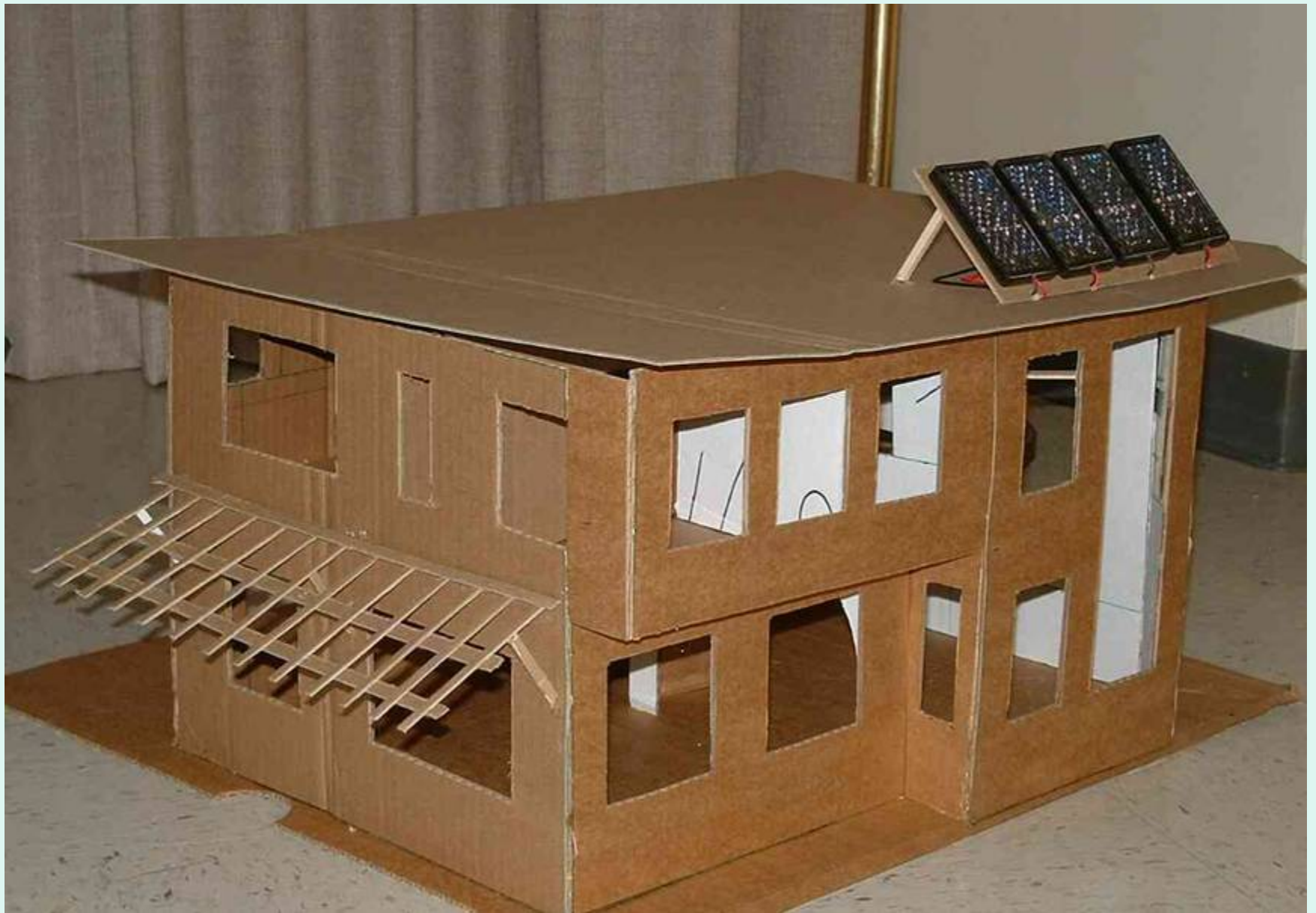


# *Teacher Projects*











# *Solar Home Village*

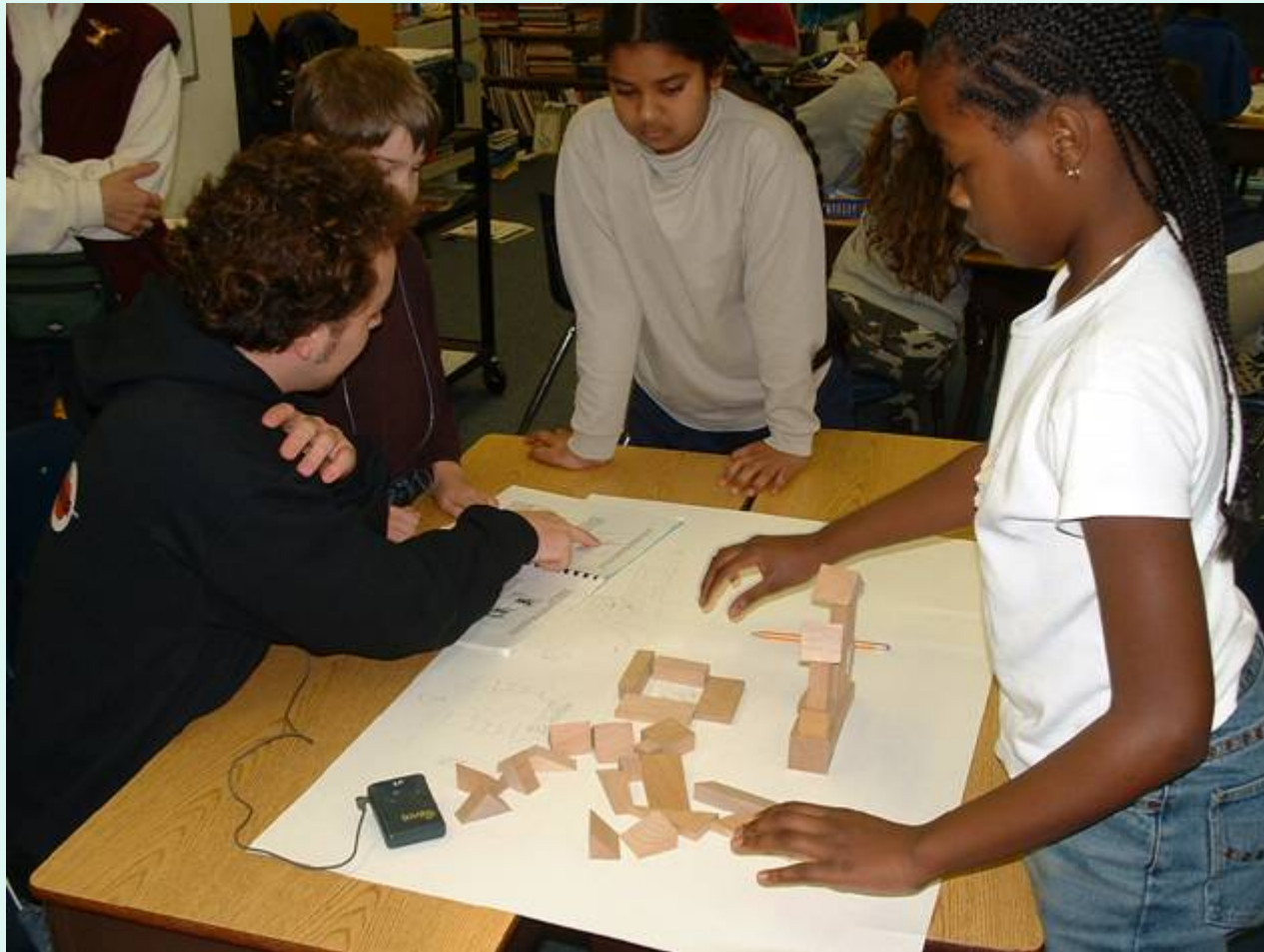




# ***DESIGN AND BUILD***



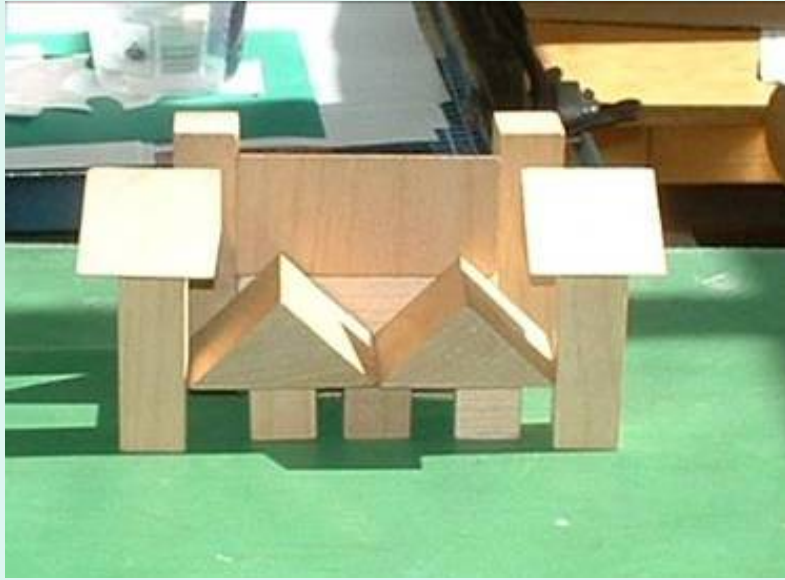
# *Use Blocks in Design Process*



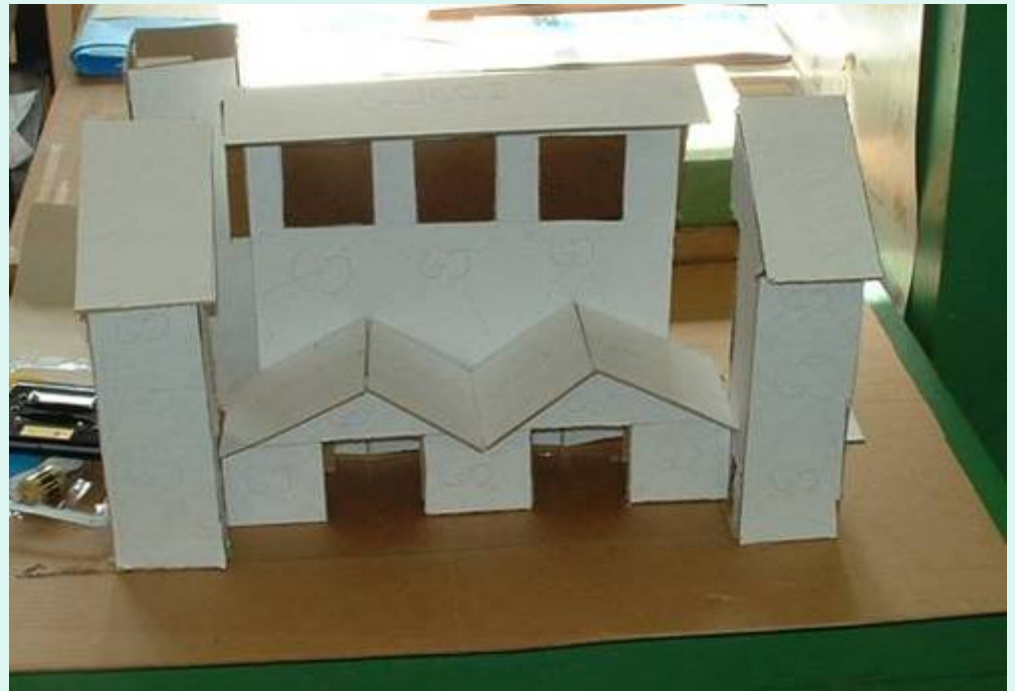




*From Blocks...*

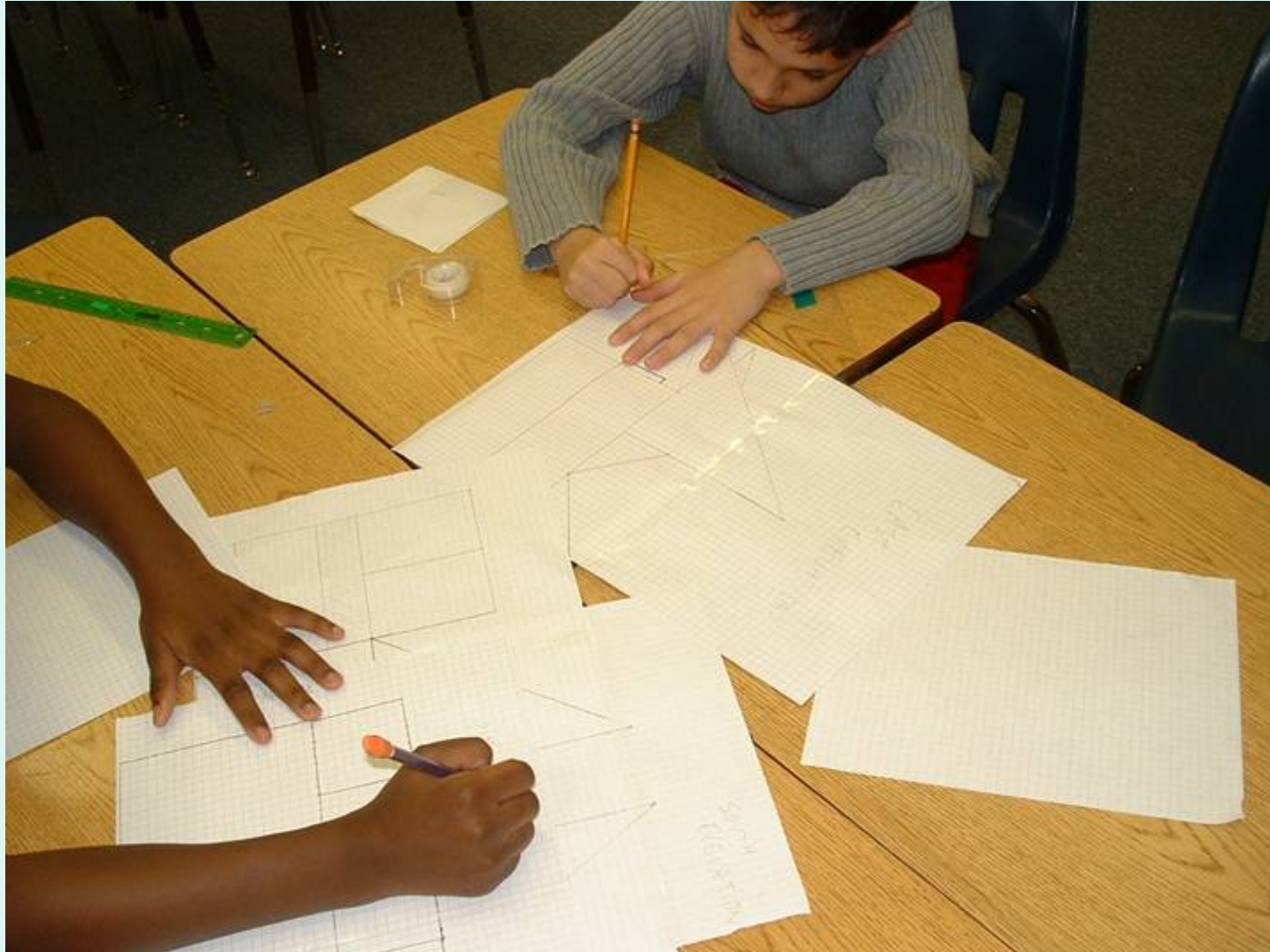


*...To Model*





# *Drawing Plans*



# ***HOUSE PLANS:***

- Floor plan
- South Elevation
- East Elevation
- North Elevation (optional)



# *Building to Scale*

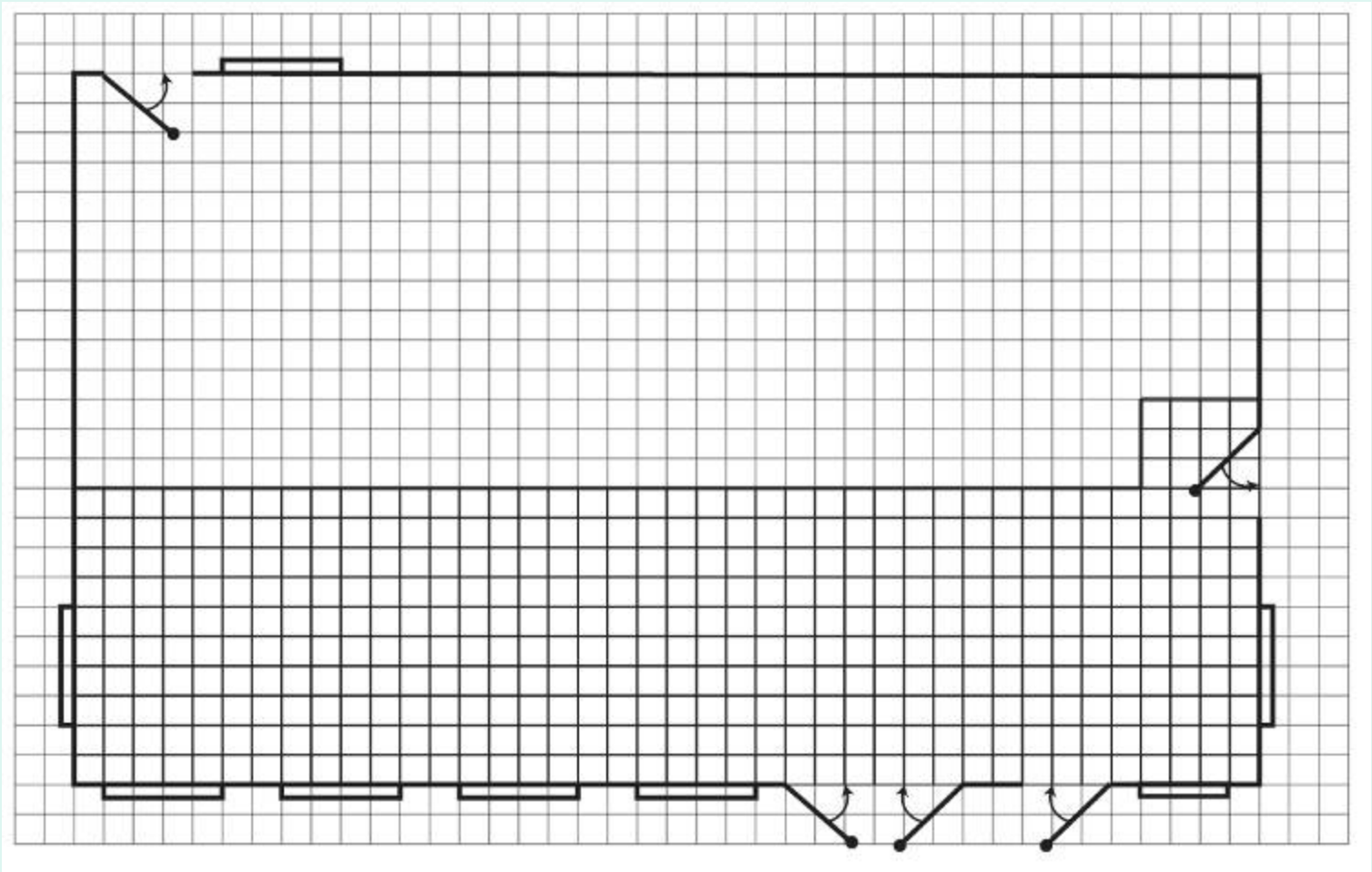


## ***$\frac{1}{4}$ Inch Scale:***

1 square = 1 foot by 1 foot

1 square inch = 4 foot by 4 foot

# ***FLOOR PLAN:***





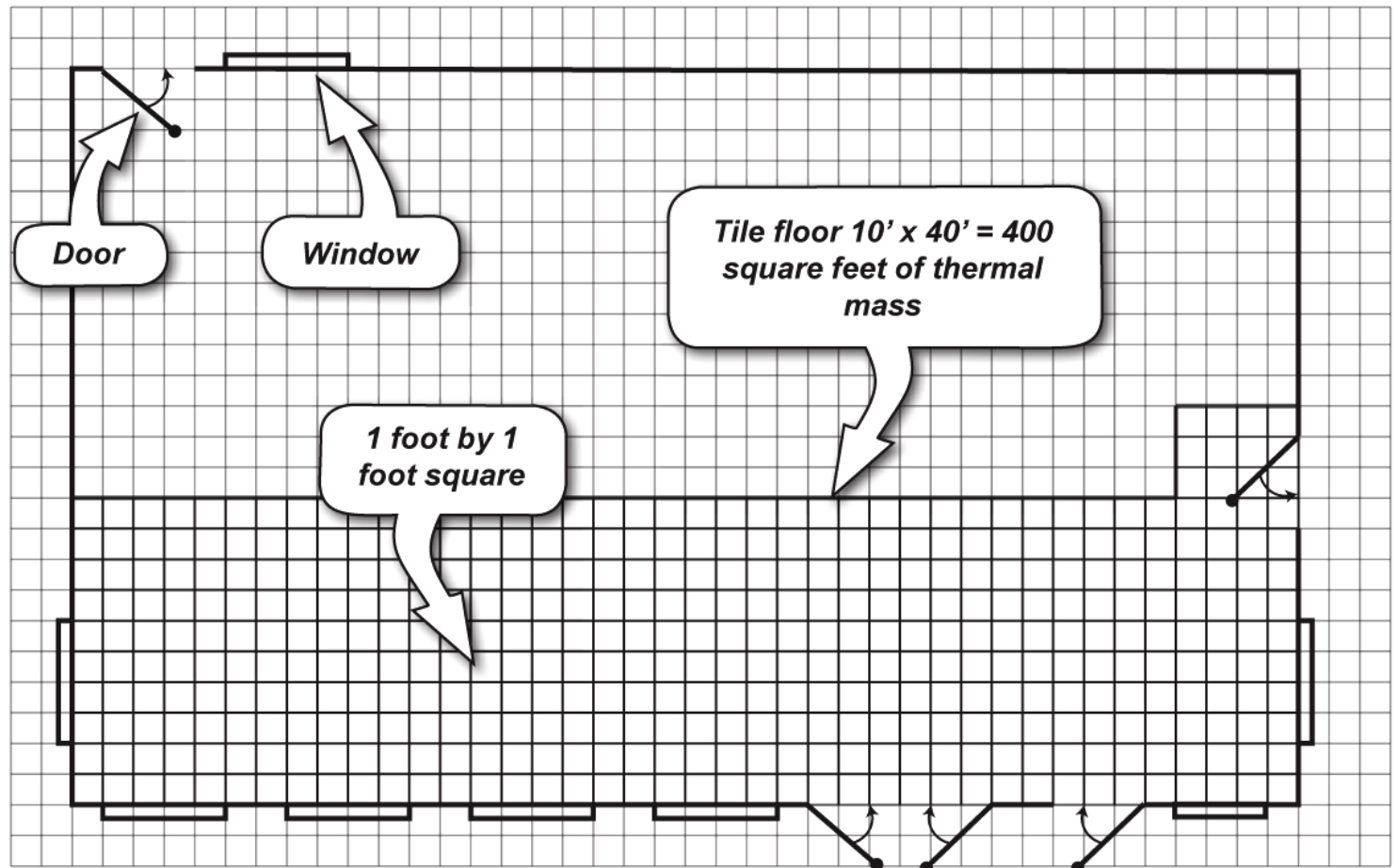
# ***FLOOR PLAN:***

- Orientation
- Layout & room type
- Floor materials
- Floor area for window calculations
- Thermal mass and calculation

**PLAN VIEW**

**40 feet long  
24 feet wide**

**South**



**Total area of first floor: 24' x 40' = 960 square feet**

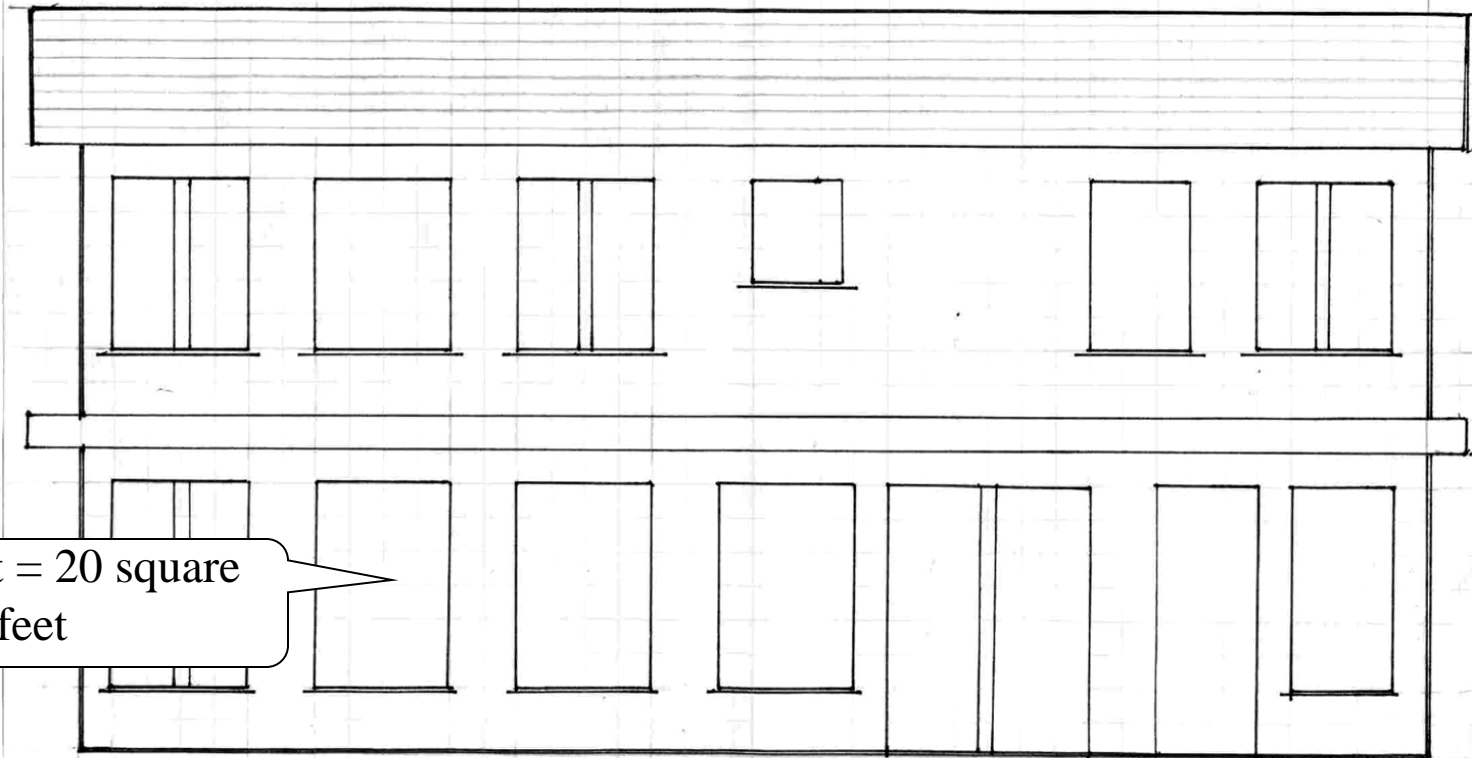
# Southern Elevation:

## Rule of Thumb:

**12 sq ft of glass for every 100 sq ft of floor**







4 x 5 feet = 20 square  
feet

SOUTH ELEVATION

$\frac{1}{4}'' = 1'-0''$

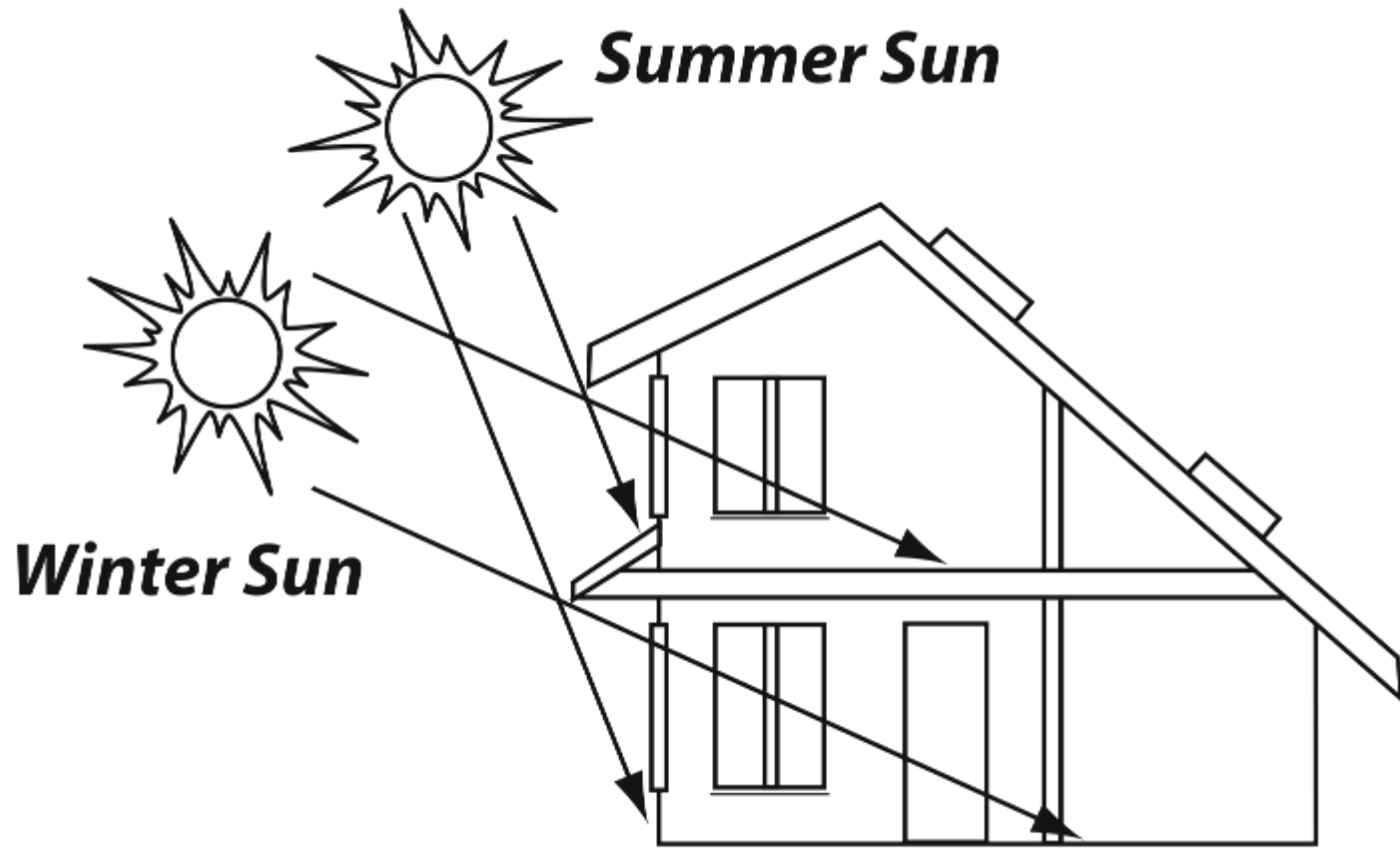
# East Elevation:

## To measure eaves:

### find winter & summer sun angles



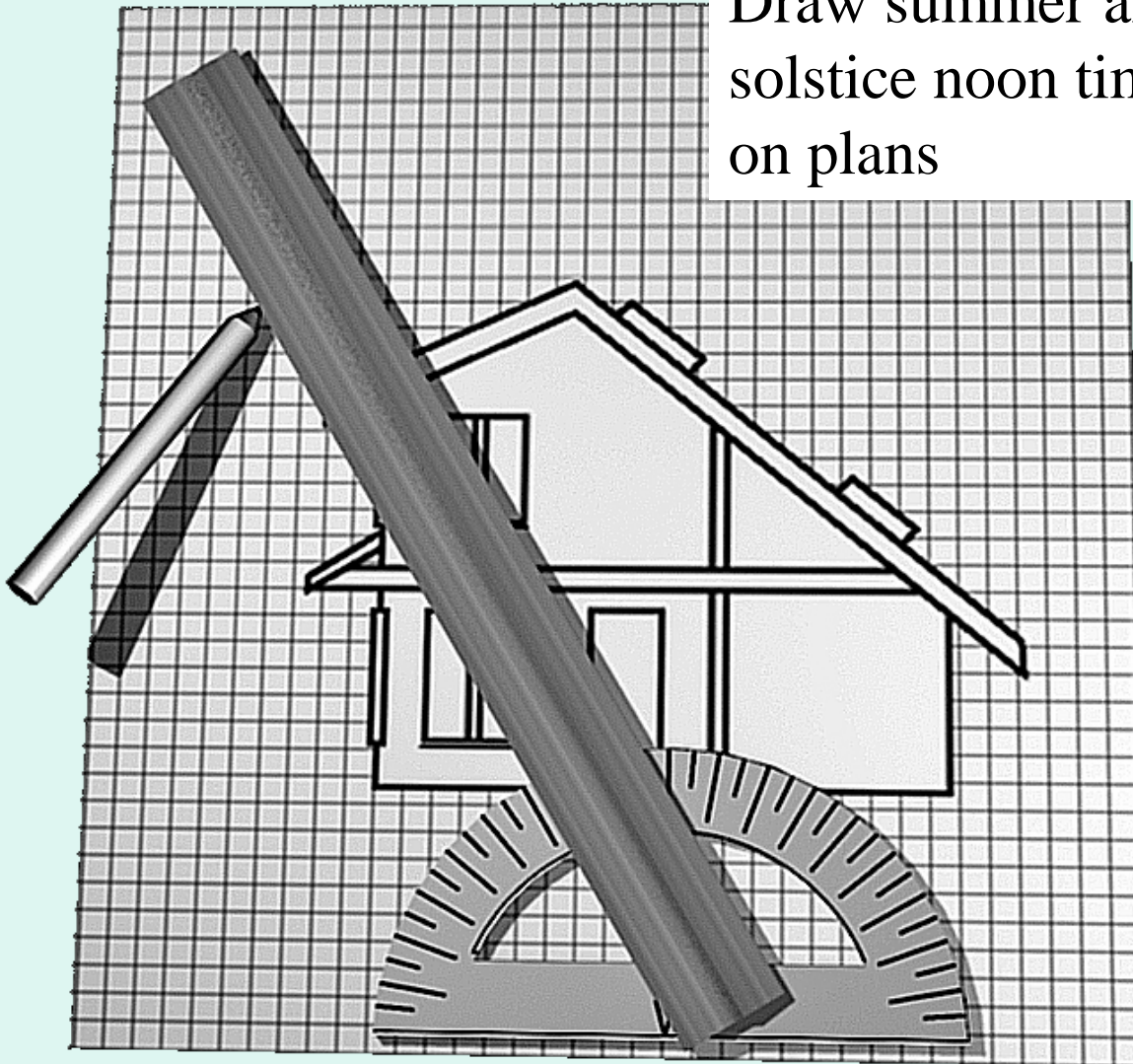
# Use Sun Angles to Calculate Overhangs





# Use Protractor to Calculate Overhangs

Draw summer and winter solstice noon time angles on plans



# Visit Permitting Office



# ***BUILD YOUR MODEL!***





# *Place your home in the Solar Village!*



# Complete Solar Home Project Plans in The Your Solar Home Guidebook



## Project #9

## Custom Solar Home Model - page 3

### Calculating the Amount of Thermal Mass

The area of thermal mass depends on many things too. A thermal mass area that's at least 3 times the south glass area is a good place to start. Having extra thermal mass is fine. This means we multiply the south glass area by 3.

$112 \text{ sq. ft. of south glass} \times 3 = 336 \text{ sq. ft. of thermal mass needed on the first floor}$

We have enough thermal mass with the 1st floor on the south side of the house:

$10 \text{ ft.} \times 40 \text{ ft.} = 400 \text{ sq. ft. of thermal mass (1st floor)}$

Repeat these steps to find the thermal mass needed for the 2nd floor.

### East Elevation

The east elevation shows the roof overhangs (eaves) so we can be sure the sun shines in during the winter, but not during the summer. To see how big an overhang we need, we have to know how high the sun will get in the summer, and how low it will be in the winter. The sun's height is an angle called the sun's altitude, and it depends on our latitude.

You can find the sun's highest altitude on any day of the year at the U.S. Naval Observatory website. Enter your city and the date, then find the highest altitude around 12 noon on that day.

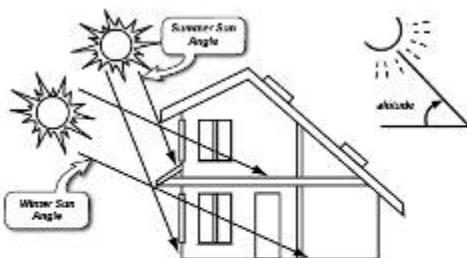
<http://www.navy.mil/danfo/danfo/AltAz.html>

You can also figure out the sun's highest and lowest altitude with these equations:

Sun's altitude at noon on summer solstice =  $90 + 23.5 + (\text{your latitude})$

Sun's altitude at noon on winter solstice =  $90 - 23.5 + (\text{your latitude})$

To find the latitude for your city, & a link to the U.S. Naval Observatory website, visit: [www.navy.mil/danfo/danfo/AltAz.html](http://www.navy.mil/danfo/danfo/AltAz.html)



East Elevation showing the sun's highest altitude at the window and summer solstices

The East Elevation (above) shows us that the winter sun will shine deeply into this building, and heat the 1st floor directly. The overhangs will block the summer sun.

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## Project #9

### Calculating

Example: Our sample house, about 35 ft. wide, find the sun's highest altitude.

$90 + 23.5 =$

Use a protractor and compass to draw the sun's path, and make a note of the window's position.

Draw a line along the sun's path to the window's position.

Use 90 - 23.5

### North Elevation

The main part of this house is the building.

