

# **21ME0110T: Energy Systems for Sustainable Buildings**

## **Unit II: Solar heating & cooling**

**(General principles of passive solar heating, Key design elements of passive heating)**

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- Key design elements of passive heating
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- Water walls, evaporative cooling- convective air loops and solar chimney effects, Thermal Bridge and barrier
- Thermal insulation, load control, air infiltration- Odor removal and heat recovery in large buildings

## Passive Solar Heating & Cooling

- Passive solar design **uses a solar radiation to heat and light buildings without any mechanical or electrical devices**. Heating the building through the use of **solar energy involves the absorption and storage** of incoming solar radiation which will be used to meet the heating requirements of the space.
- Heating: A successful passive solar building needs to be well insulated in order to make best use of the sun's energy.
- Cooling: Passive solar design can also achieve summer cooling and ventilating by making use of convective air currents which are created by the natural tendency of hot air to rise.

## General principles Passive Solar heating

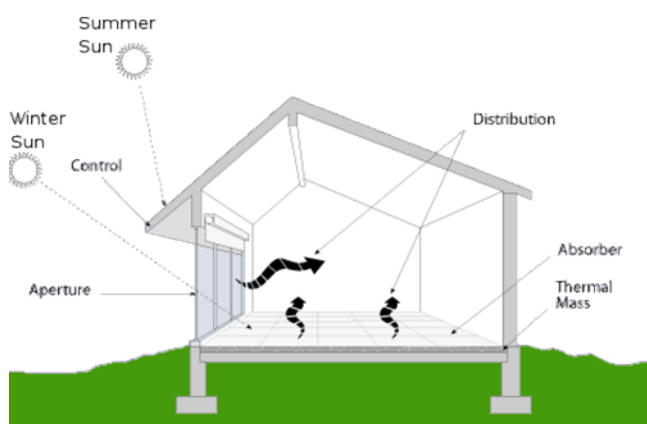


- Passive solar heating systems make a **use of the building components to collect, store and distribute the solar heat gains** to reduce the demand for space heating.
- A passive solar system **does not require the use of mechanical devices** because the heat flow takes place by natural means such as **radiation, convection and conduction and the thermal storage is in the structure itself**.

## Objectives of Passive space heating

- Minimizing the heat loss through the building by proper **insulations, air tightness and surface area to volume ratios**
- better architect **design of the building, heat retention and less space for heating purpose**
- Building should be designed in such way that to **harvestings the heat energy**
- **Utilize very less amount of energy from mechanical devices**

## Elements of Passive Solar heating



- **Aperture (Collector):** the large glass (window) area through which sunlight enters the building.
- **Absorber:** the hard, darkened surface of the storage element.
- **Thermal mass:** the materials that retain or store the heat produced by sunlight.
- **Distribution:** the method by which solar heat circulates from the collection and storage points to different areas of the building.
- **Control:** roof overhangs can be used to shade the aperture area during summer months.

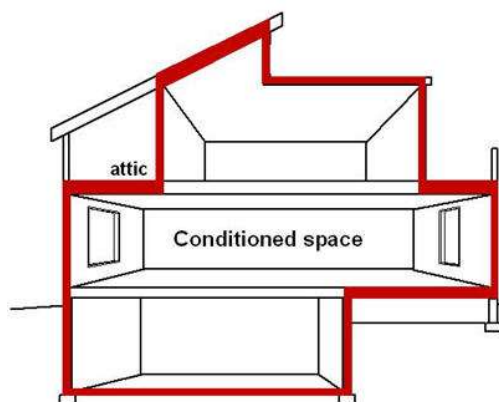
## Passive solar heating strategies

- **Passive solar heating works better in smaller buildings** where the envelope design controls the energy demand.



## Passive solar heating strategies

- Careful attention should be paid for constructing a ***durable, energy-conserving building envelope.***



• **Insulation:** Proper insulation keeps heat inside when it's cold outside and keeps it cool inside when it's warm outside

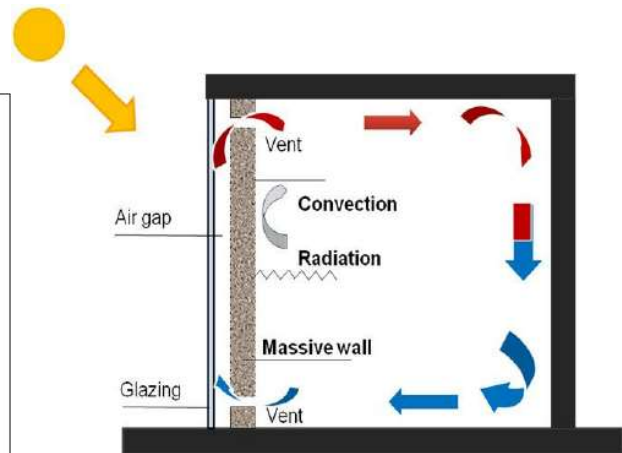
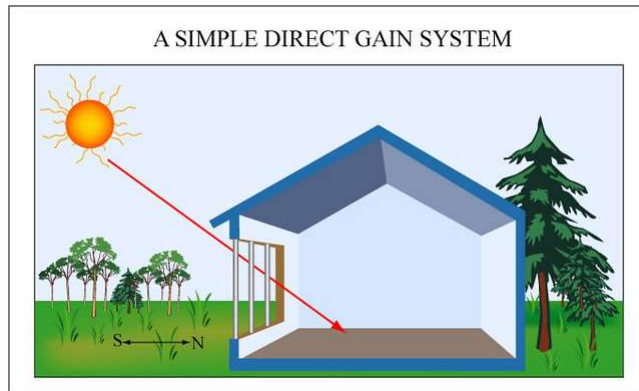
• **Good Windows:** Energy efficient windows and doors can reduce your home energy costs

• **Ventilation:** Heat recovery ventilator (HRV) that provides significant fresh air into the building while minimizing heat loss or effective natural ventilation

• **Air Leaks:** Airtightness (sealing) is critical to reduces leakage of air between indoors and out.

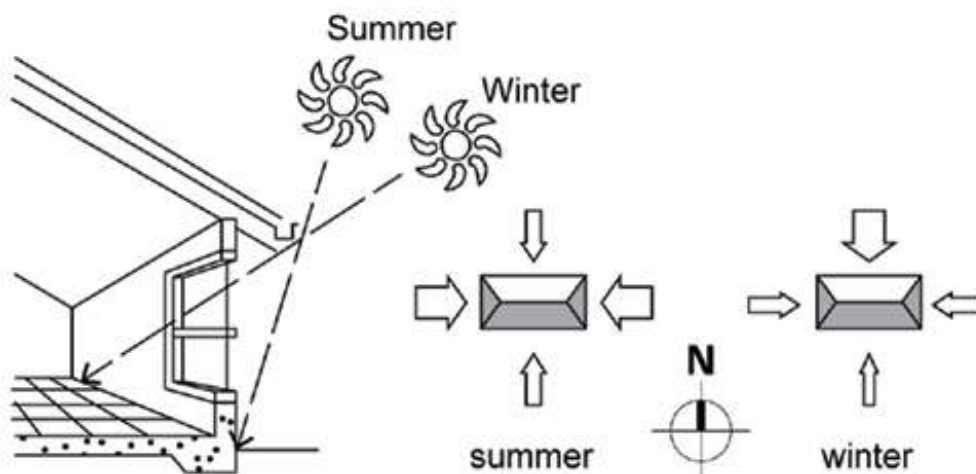
## Passive solar heating strategies

- Some of the most attractive passive solar heated buildings incorporate the elements of both **direct and indirect heat gain**.



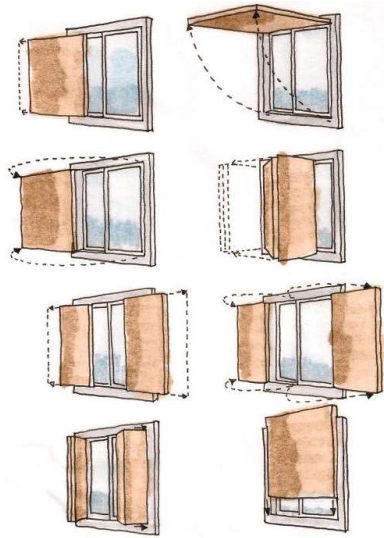
## Passive solar heating strategies

- If possible, construct the building along the east-west axis to **maximize the south-facing elevation** and the **number of south-facing windows** can be incorporated.



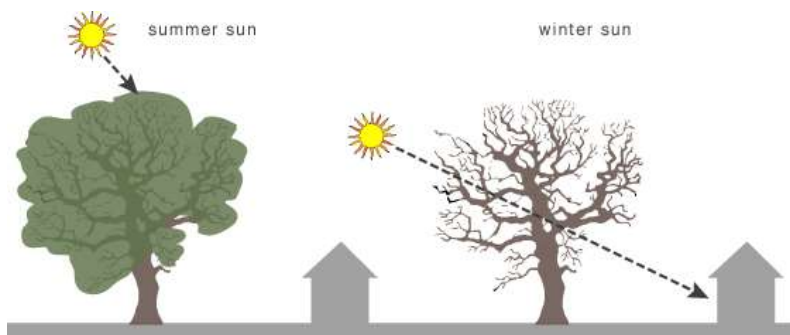
## Passive solar heating strategies

- Improve building performance by employing either **high-performance moveable insulation** to reduce heat loss from glass at night.



## Passive solar heating strategies

- Include **overhangs or other devices**, such as trellises or deciduous trees for shading in summer.



Trellis



## Passive solar heating strategies

1. **Passive solar heating works better in smaller buildings** where the envelope design controls the energy demand.
2. Careful attention should be paid for constructing a **durable, energy-conserving building envelope**.
3. **Specify windows and glazings that should have low thermal transmittance values (U values)** for admitting significant levels of incoming solar radiation.
  - ✓ For large buildings with high internal heat gains, passive solar heat gain is a liability because it increases cooling costs more as compared to space heating.
4. Design for **natural ventilation** in summer with required windows.
5. Provide **natural light to every rooms**.
6. Some of the most attractive passive solar heated buildings incorporate the elements of both **direct and indirect gain**.

7. If possible, elongate the building along the east-west axis to **maximize the south-facing elevation** and the **number of south-facing windows** can be incorporated.
8. Plan to build an **active living or working areas on the south** and less frequently used spaces such as storage and bathrooms on the north.
9. Improve building performance by employing either **high-performance moveable insulation** to reduce heat loss from glass at night.
10. Include **overhangs or other devices such as trellises or deciduous trees** for shading in summer.
11. Make sure there is **much quantity of thermal mass**.
12. Design the building to avoid sun glare. **Room and furniture layouts needs to be planned to avoid glare from the sun** on equipment such as computers and televisions.

## Physics of Heat transfer

- As per the fundamental heat transfer law, heat transfer will takes place from hot region to cold region.
  - Conduction is the way heat moves through materials, traveling from molecule to molecule.
  - Convection is the way heat circulates through liquids and gases.
  - Radiant heat moves through the air from warmer objects to cooler ones. There are two types of radiation important in a passive solar design: *solar radiation and infrared radiation*.
    - ✓ When radiation strikes an object, it will be absorbed, reflected, or transmitted depending on the properties of object.

**Thank you**