SOLAR POND

Convective and Non Convective

CONVECTIVE SOLAR POND

- It is a system used for absorbing solar energy and storing it as heat.
- Simplest type- Shallow solar pond.
- Consists of a shallow basin with a blackened bottom.
- Under the pond, there is a bed of insulating material.
- A transparent plastic film is kept in contact with the top of the water so as to avoid the loss of water by evaporation.
- The incident energy is absorbed by the blackened bottom and transferred by convection.
- Large quantity of water can be heated using this method.

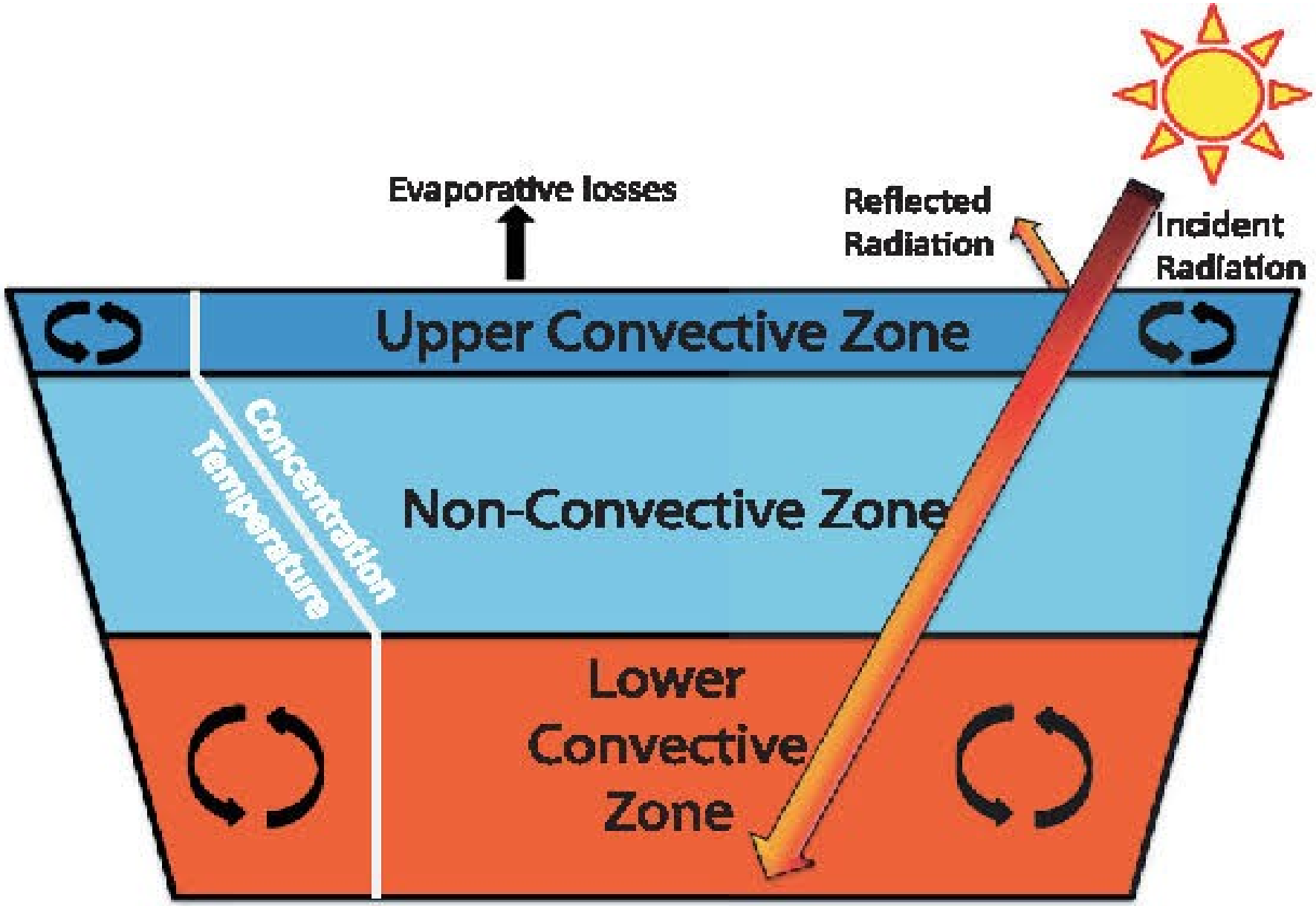
Withdrawal methods

1. Batch withdrawal
2. Closed cycle continuous flow
3. Open cycle continuous flow

NON CONVECTIVE SOLAR POND/ SALT GRADIENT SOLAR POND.

- In Convective solar pond or shallow solar pond, the major factor that restricts it’s efficiency is the **convective heat loses.**
- So we can take the idea of **salt density gradient.** Here the convective loses can be reduced.
- Salt density gradient- An increasing density with depth so that the warmer water at the bottom may not acquire low density and rise to the top by convection.
- Because of the salt content, the bottom water is denser than the cooler fresh water at the top and hence it does not tend to rise.

- 1-2 meter deep, large collection area.
- Dissolved salts of sodium chloride, magnesium chloride etc. are used to create layer of water with different densities.
- No membrane is used at the top of the pond.
- The salt concentration steadily increases with depth.


Evaporative losses
Reflected Radiation
Incident Radiation
Upper Convective Zone
Concentration
Temperature
Non-Convective Zone
Lower Convective Zone

- The diffusion of salt automatically creates a continuous gradient through the non convective layer.
- Difficult to maintain the density gradient for a long and therefore concentrated brine is added periodically to the Bottom.
- 2 types **partitioned salt stabilized pond and viscosity stabilized pond.**
- A flat plate collector of the same area would be twice as efficient but cost is ten times as much.

EXAMPLES

- The largest operating solar pond for electricity generation was the Beit HaArava pond built in Israel and operated up until 1988. It had an area of 210,000 m² and gave an electrical output of 5 MW.[3]
- India was the first Asian country to have established a solar pond in **Bhuj**, in Gujarat. The project was sanctioned under the National Solar Pond Programme by the Ministry of Non-Conventional Energy Sourcesin 1987 and completed in 1993 after a sustained collaborative effort by TERI, the Gujarat Energy Development Agency, and the GDDC (Gujarat Dairy Development Corporation Ltd). The solar pond successfully demonstrated the expediency of the technology by supplying 80,000 litres of hot water daily to the plant. It is designed to supply about 22,000,000 kWh of Thermal Energy annually .
- Thee 0.8-acre (3,200 m^2) solar pond powering 20% of Bruce Foods Corporation's operations in El Paso, Texas is the second largest in the U.S. It is also the first ever salt-gradient solar pond in the U.S.[5]

OPTICAL CONCENTRATORS

- Device used to concentrate incident solar energy onto a small area.
- Uses reflecting and refracting elements which results in an increased flux on the absorbing surface.
- A tracking arrangement is made for tracking the position of the sun for efficient absorption of the solar energy.


Courtesy of UCSD

Essential components

1. Focusing device
2. Absorber
3. Device for tracking the sun.

Temperatures up to 350 degree Celsius have been achieved using such a device.

- **Reflecting purpose-** mirrors of high quality
- **Glass reflectors (preferred)**
- **Aluminized plastic films**
- **Polished aluminum surfaces**
- **Stainless steels**
- **Etc…**

- **Absorber – should have HIGH MODULUS OF ELASTICITY, HIGH MELTING POINT, THERMAL INERTIA, LOW COST, EASE OF FABRICATION, CORROSION RESISTANCE etc.**

- **Cover materials over absorber-** High transparency to the incident radiation, reduced convective losses from the absorber etc.

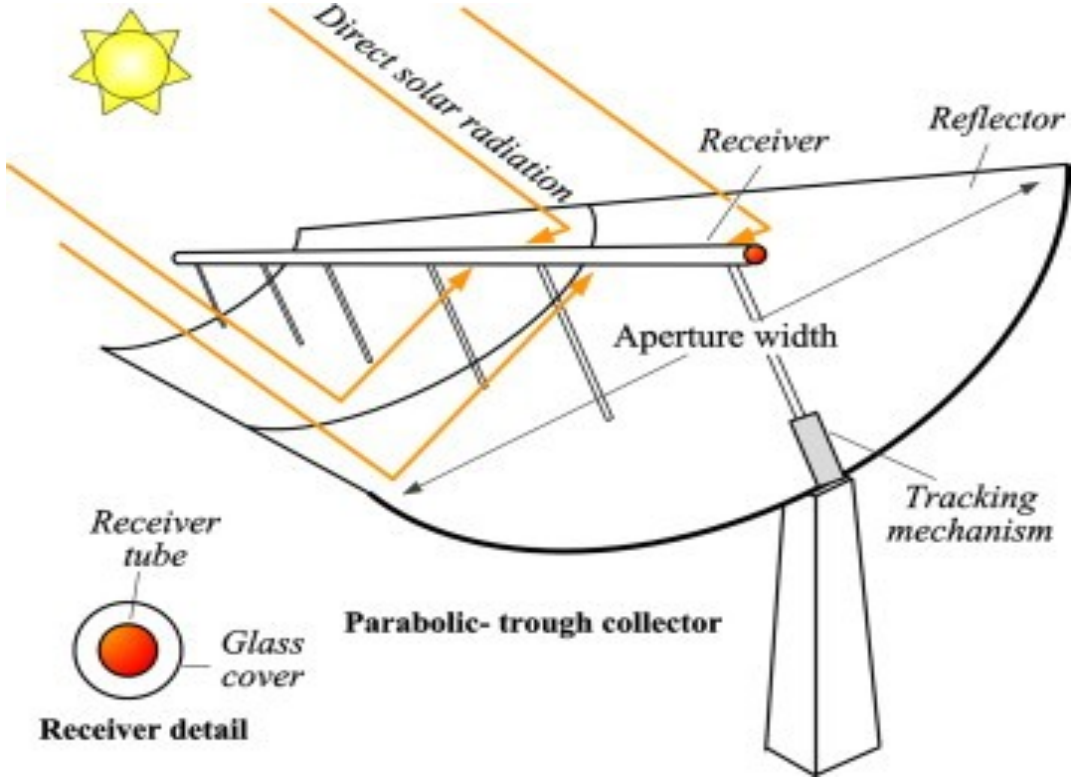
Glass and plastic films are commonly used.

- **Coating materials for absorber-** High absorbtivity, durability when exposed to weathering, cost effectiveness, etc....

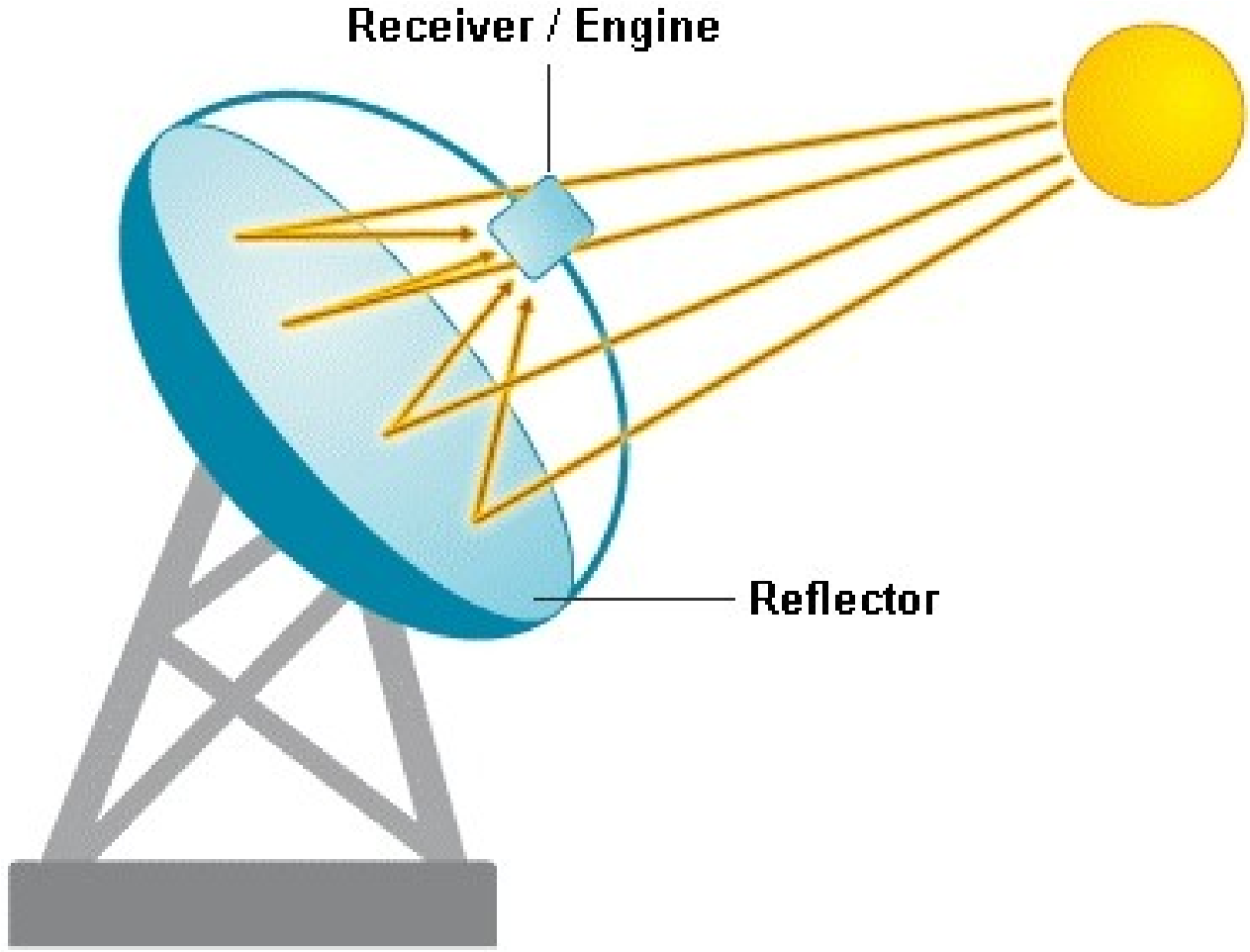
- **Heat transfer fluid-** High operating temperature, stability at high temperature, non corrosive, low vapour pressure,etc...
- **Non irradiated portions of the absorber are thermally insulated. (fibre glass, ceramics etc.)**

LINE FOCUSSING COLLECTOR & POINT FOCUSSING COLLECTOR

- Line focussing collector.



Point focussing collector



Concentrating collector

ADVANTAGES

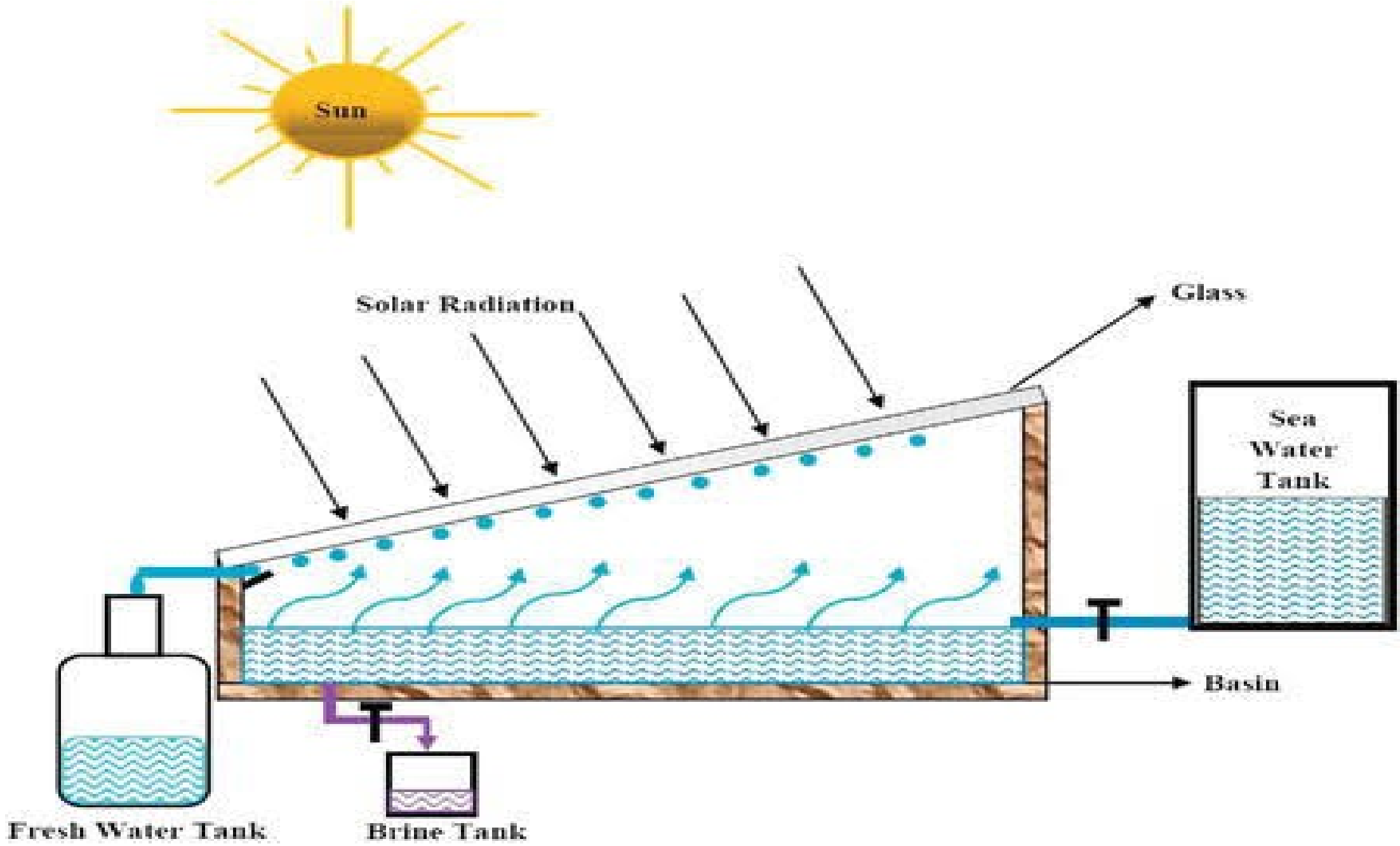
1. High intensity of the solar radiation due to large absorber area.
2. High delivery temperature resulting in better efficiency.
3. Reduced losses due to reduced heat loss area.
4. Reduced cost due to less material use in comparison with a flat plate collector.

Working of solar concentrators

- https://youtu.be/2WyNa_k9Z1E

SOLAR DESALINATION (SOLAR STILL)

- Distillation of brackish or saline water is a good method to obtain fresh water.
- Conventional methods are energy intensive techniques and are not feasible for large fresh water demands.
- **Solar distillation- simple technology, non requirement of highly skilled labors for maintenance work and low energy consumption.**
- Can be installed in any place without any problem.


Sun
Solar Radiation
Glass
Sea
Water
Tank
Basin
Fresh Water Tank
Brine Tank

Working of solar desalination

- https://youtu.be/J9MqzlMJOkQ

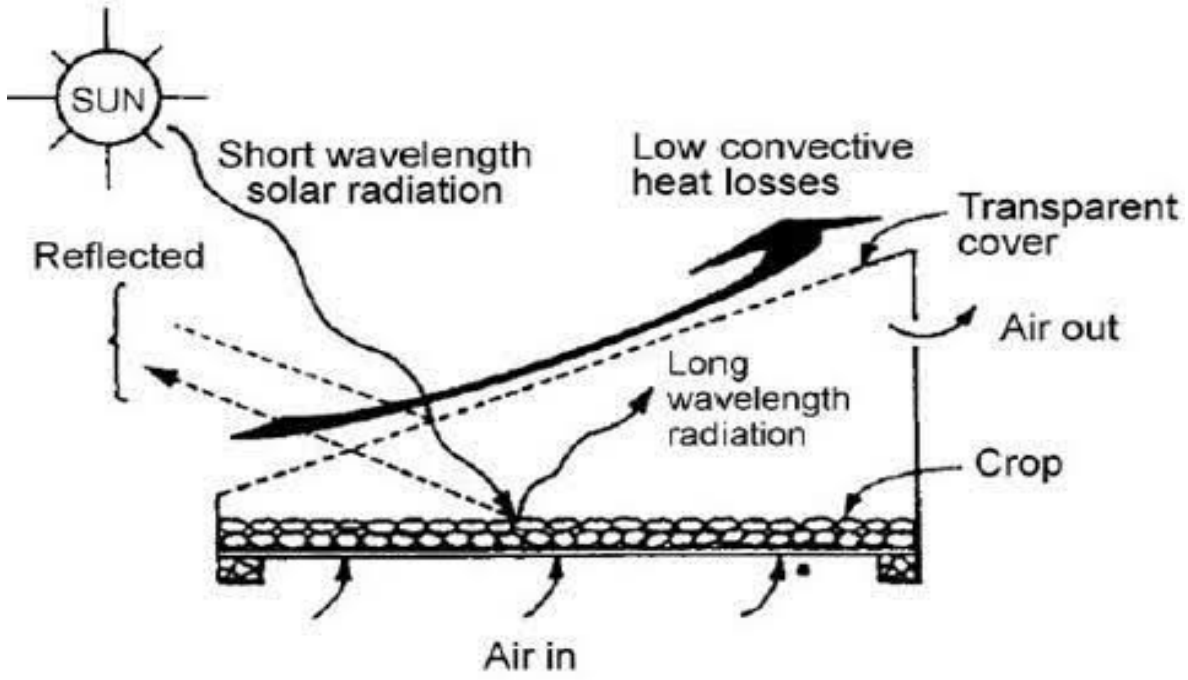
SOLAR DRYER

- Drying- traditional method of preserving food.
- Helps in trasporting because the dried food becomes lighter because of moisture loss.
- Drying provides germination and growth of fungi and bacteria.
- Traditional method- open sun drying or natural sun drying.
- But has serious drawbacks.
- So overcome these drawbacks, two techniques are developed – **DIRECT SOLAR DRYING & INDIRECT SOLAR DRYING.**

DIRECT SOLAR DRYING

- Consists of a container with a transparent cover.
- Bottom and the side walls are thermally insulated with a number of holes in it.
- A part of the solar radiation incident on the glass cover is reflected back to the atmosphere and the remaining is transmitted.
- Some part of this transmitted radiation is reflected from the surface of the crops.
- Remaining get absorbed. Temperature of the crop increases and the crop starts to emit long wavelength radiation, which is not allowed to escape to the atmosphere by the glass cover.

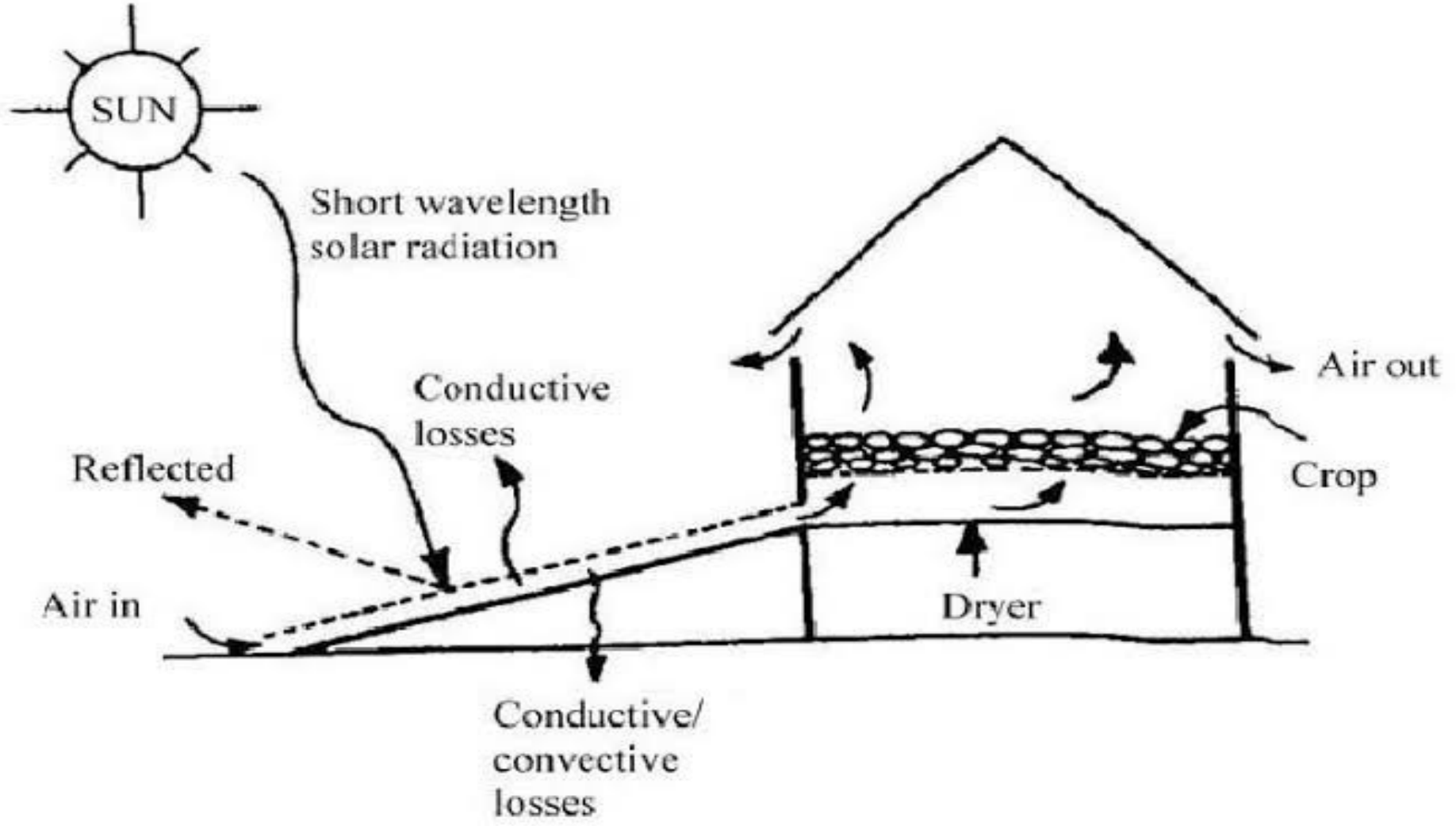
- The vapour formed by the moisture removal of the crops is carried away by the air entering from the bottom and escaping through the vent holes.



Disadvantages

- Very small capacity
- Discoloration of crops due to direct exposure to solar radiation.
- Moisture condensation inside the glass cover reducing its transmitivity.
- Insufficient rise in crop temperature affecting the moisture removal.

INDIRECT SOLAR DRYING



Solar dryer

- https://youtu.be/FRDEN8R6Qws

SOLAR COOKER

- Direct or focussing type
- Indirect or box type

DIRECT TYPE SOLAR COOKER

INDIRECT TYPE SOLAR COOKER

MERITS

- No attention is needed while cooking
- No fuel requirements.
- No pollution
- No maintenance
- The nutritious quality of the food is good.

Solar air conditioning

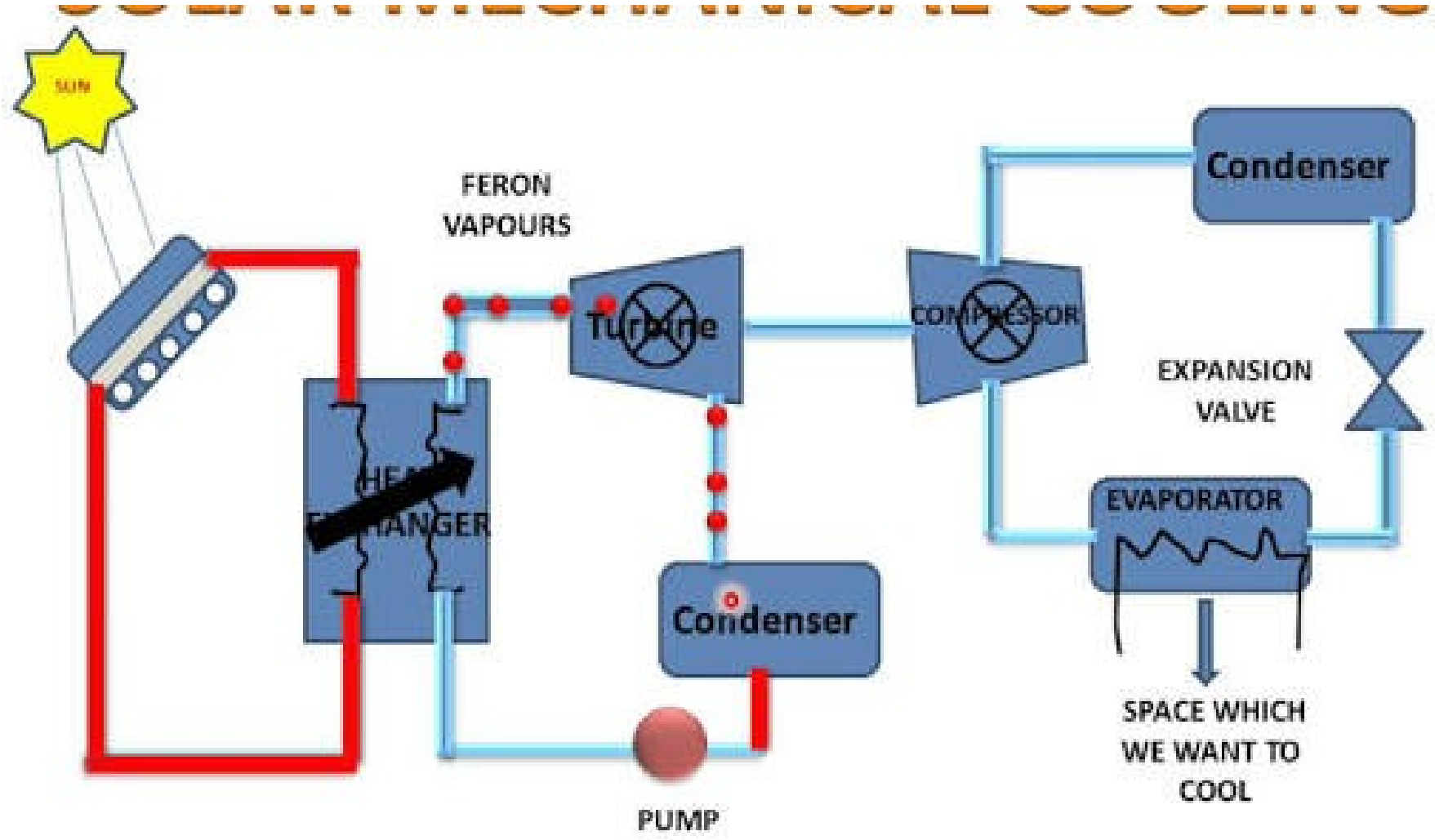
How an air conditioner work?

- An Air Conditioner has 3 components: compressor, condenser and evaporator. The core to the cooling of an air conditioner is a refrigerant that moves in the air conditioning system. The refrigerant comes in as a cool low-pressure gas in the compressor, which uses electricity to compress it to a high-energy hot gas. The fluid then goes into the condenser where it dissipates all the heat and converts into very cold liquid under high pressure. It then goes into the evaporator where it cools the room air, which is thrown out.
- In this whole process, the compressor consumes the highest amount of electricity to heat and compress the refrigerant.

Working

- https://youtu.be/gVLhrLTF878

SOLAR AIR CONDITIONING



Solar refrigerator working

- https://youtu.be/HBBa3TxT74M

SOLAR HEATING OF BUILDINGS

1. Passive heating of buildings
2. Active heating of buildings

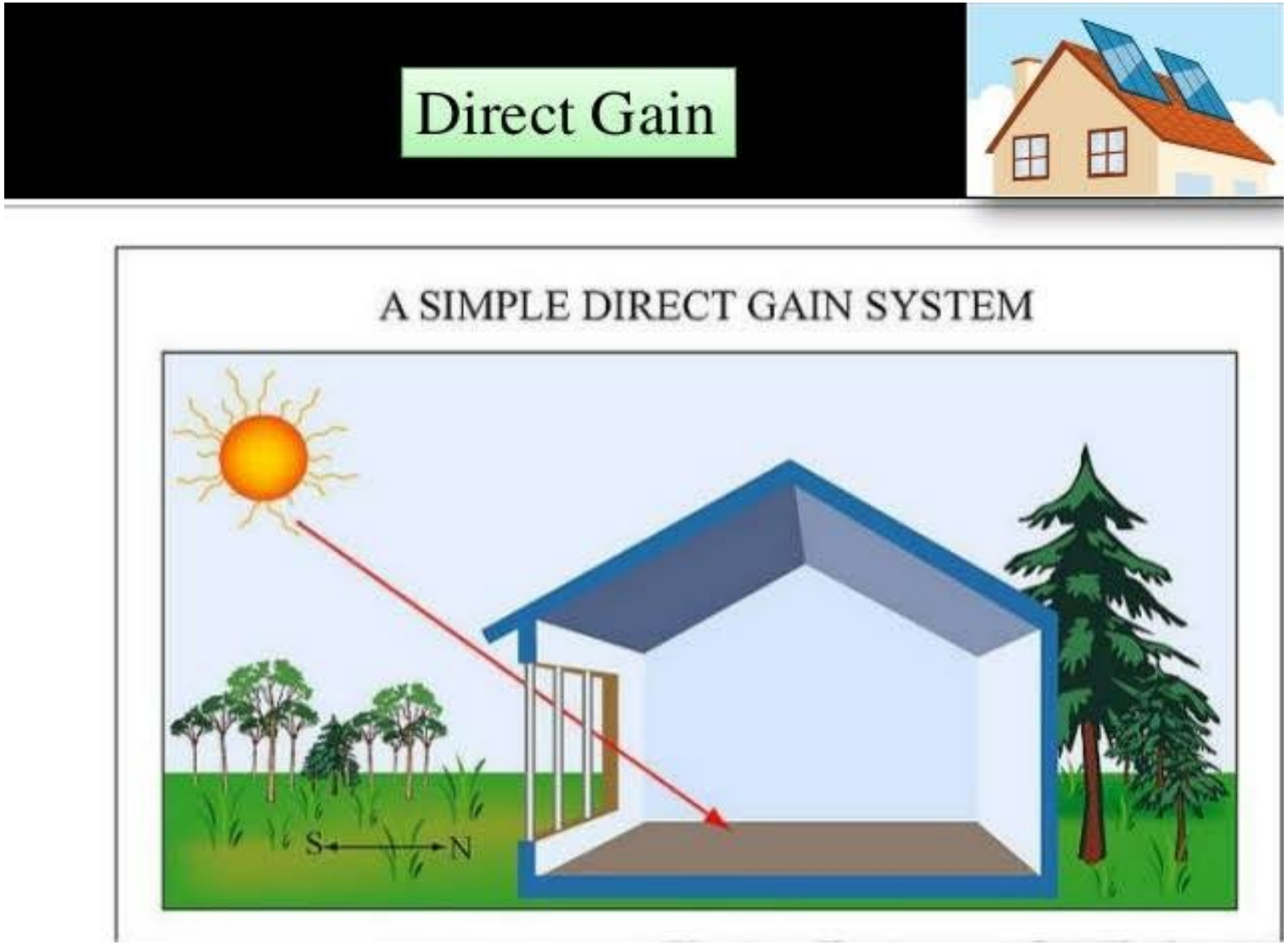
Passive heating

- Solar energy collection, storage and distribution are occurring naturally.
- No electrical, electronic or mechanical aid is needed.
- The building becomes an energy machine and it’s structural and architectural details become integral components of the energy system.
- Here, the natural on site energy sources (for heating) used are solar radiation.

Types of passive solar heating systems

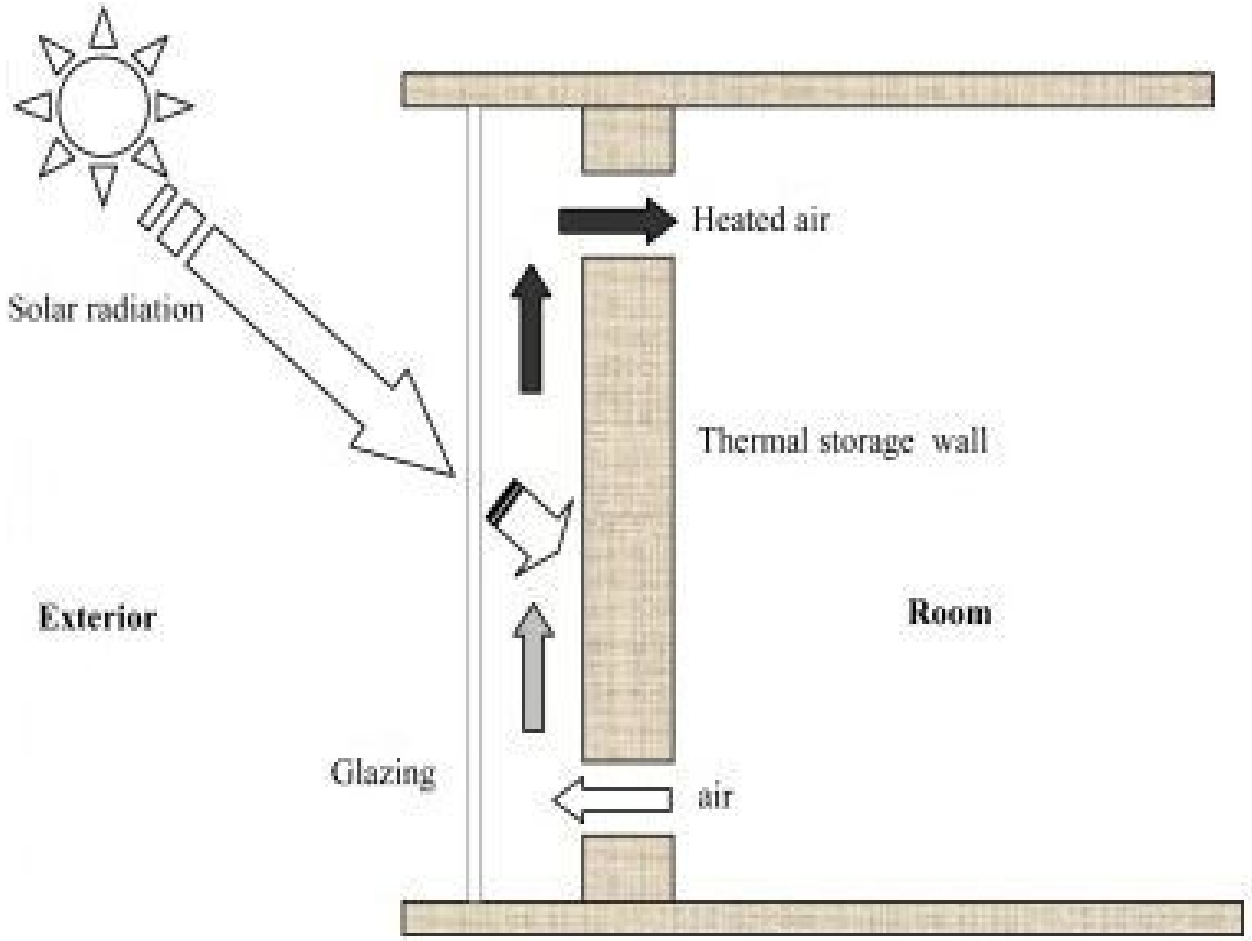
1. Direct gain type
2. Thermal storage wall type
3. Attached sunspace type
4. Thermal storage roof type
5. Convective loop type

Direct gain type



Double glazed windows

Thermal storage wall type



Attached sunspace type

- **Attached sunspaces** are **passive solar heat** collectors built onto the side of buildings. They are heated by the **sun**; the **heat** they generate is then transferred to adjoining rooms. Hence the term, isolated gain. (**Heat** is gained**in** an isolated space.)

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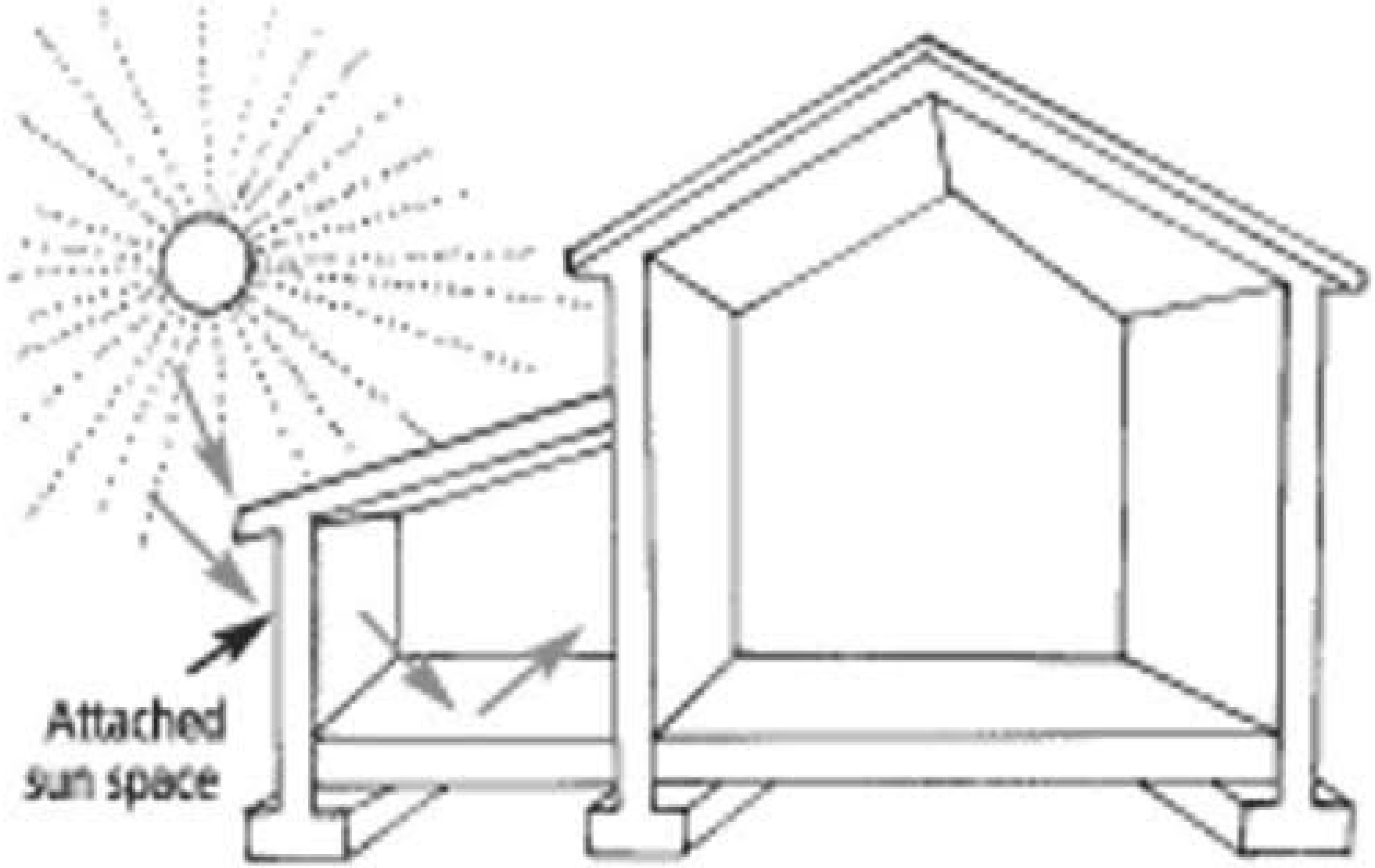

Thermal storage roof type

- Consists of a metal roof carrying a bag of water
- Heat is transferred to the water and hence to the rooms by conduction.

Convective loop type

- A separate flat plate collector is installed.

- https://youtu.be/qrZHKBOPy6Y