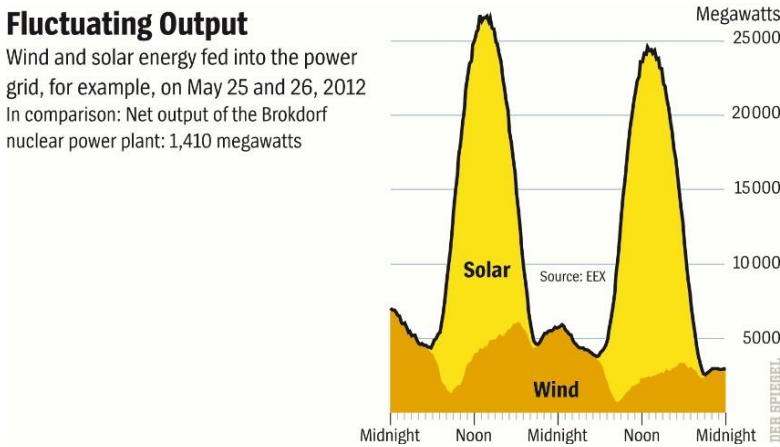
Solar Energy Storage

Introduction

- Solar energy is time dependent and intermittent
- Energy demand also varies with time
- Need of storage
  - Captures energy at the times of high insolation
  - Delivers short picks of power load exceeding plant capacity
  - Improves reliability of the plant



Size of storage capacity

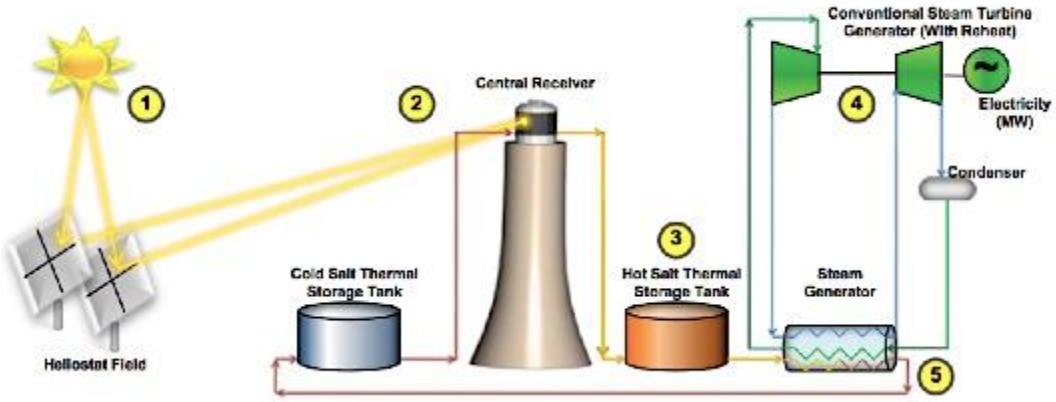
- Expected time dependence of solar radiation
- Nature of loads
- Degree of reliability needed
- Auxiliary plant
- Size of the system
- Cost of stored energy
- Capital cost involved
- Environmental and safety conditions

Possible ways of storage

- Sensible heat of solids or liquid
- Chemical energy of compounds
- Potential energy of fluids

Solar Energy Storage

- Thermal Energy storage
  - Sensible heat
    - Water storage
    - Pebble bed storage
  - Latent heat
- Electrical storage
  - Capacitor storage
  - Inductor storage
  - Battery storage

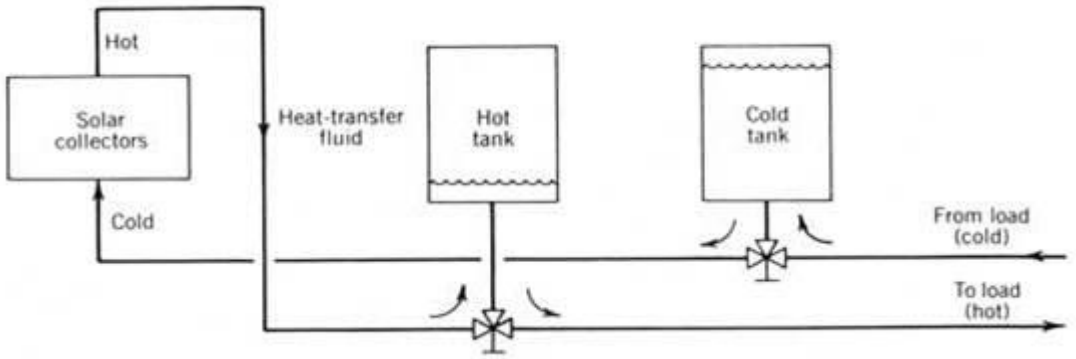


Solar Energy Storage

- Chemical storage
- Mechanical energy storage
  - Pumped hydro electric storage
  - Compressed air
  - Flywheel
- Electro-magnetic energy storage

Thermal storage

- Energy can be stored by heating, melting or vaporisation of material
- 1. Sensible heat storage
  - It involves the material that undergoes no change in phase
  - It operates over finite temperature difference

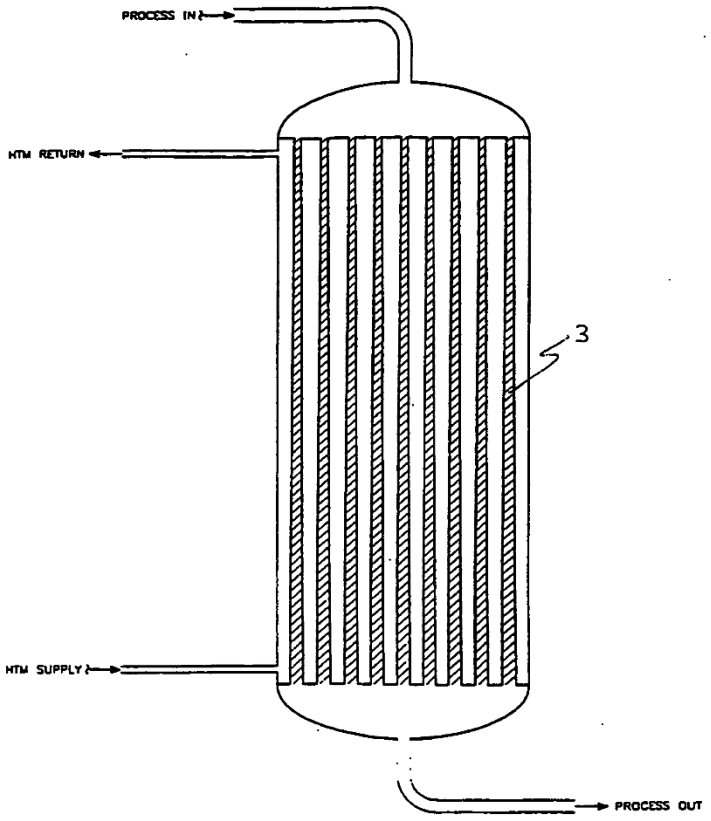


Sensible heat storage

- 1.1 Water storage
  - Hot water is stored in well insulated tank
  - Sizing of the tank is trade of between volume and surface area
  - Inexpensive and easily available
  - High sensible heat
  - Working fluid itself works as storage medium, so less conversion losses

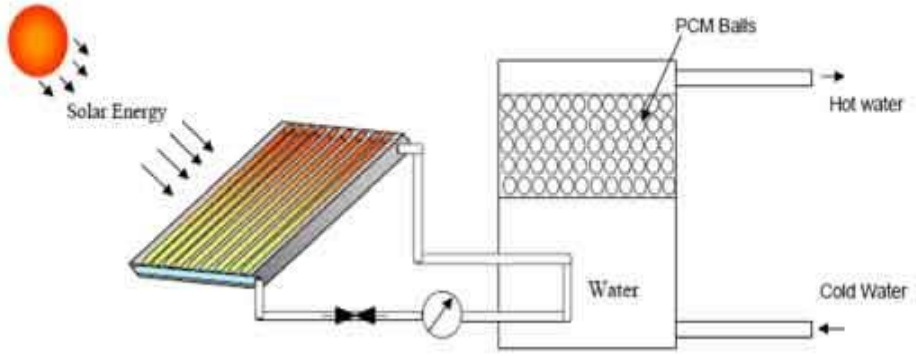
Sensible heat storage

- 1.2 Packed bed exchanger storage
  - Air as working fluid transfers energy to solid particles, which provide large surface area for more heat transfer rate
  - Direct heat transfer
  - Can be used for higher temperature
  - Low specific heat of rock



Latent heat storage

- Phase change involved
- High heat transfer capacity
- So small amount of material can store the energy
- Materials:
  - Glauber's salt (Na_2SO_4 $10H_2O$
  - Water
  - $Fe(NO_3)_3$ $6H_2O$
  - Salt eutectics



Latent heat storage

- Glauber's salt (Na_2SO_4 $10H_2O$)(sodium sulphate decahydrate) is converted from solid to liquid
  - It decomposes at 32°C with heat of fusion 243 kJ/kg
  - Mainly for storing domestic heat
  - More compact
- Refractory materials (MgO, Al_2O_3, SiO_2) are also suitable for heat storage
- Chlorides of sodium and magnesium are steadily increasing their share in this type of use

Electric storage

- Theoretically **capacitors** can store large amount of electrical energy for long periods
- But electric field strength is limited by the breakdown strength of the dielectric
- Mica is best available material for that
- There are conduction losses also, so not suitable for storage more than 12 hrs
- So limited use

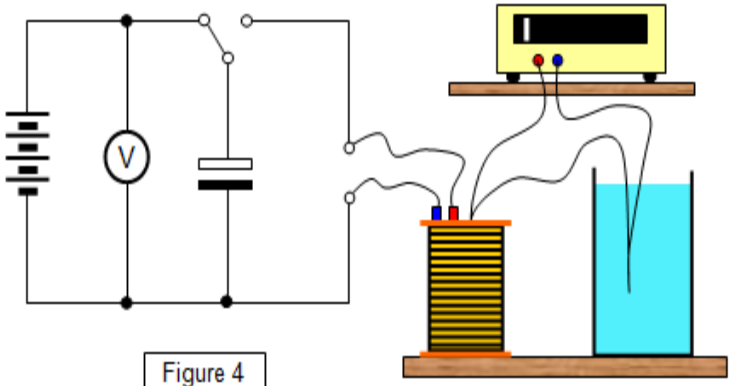
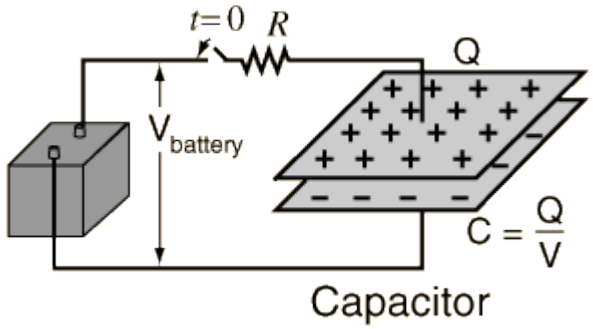


Figure 4



Electric storage

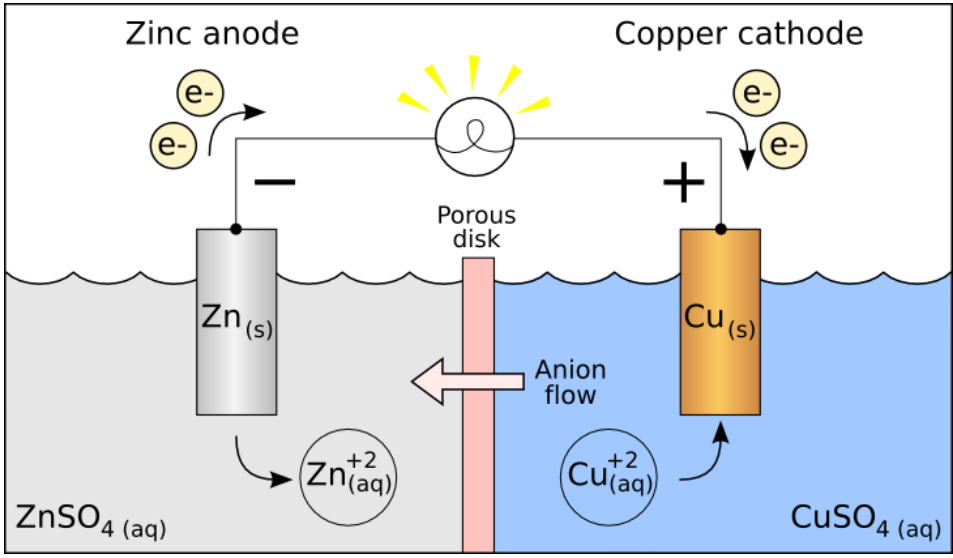
- In contrast to capacitors, **Inductors** require high current and low voltage energy
- This will create high magnetic field and consequently large mechanical forces, which should be supported by strong structures
- Reverse operation of discharging is another problem

Battery storage

- It’s the set of number of cells
- A cell is made up of electrolytes and materials as electrochemical energy saver
- Secondary batteries, which are rechargeable, are of primary interest for solar electrics
- E.g. nickel-cadmium, nickel-hydrogen, sodium-sulphur etc.

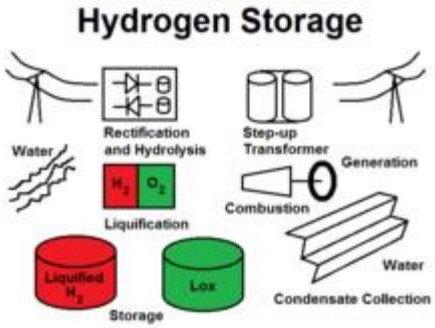
Battery storage

- A general cell is made of two electrodes called the anode and cathode
  - When an electric load is connected between the electrodes, charge separation occurs
  - Electron flows through an external load and ion through electrolyte



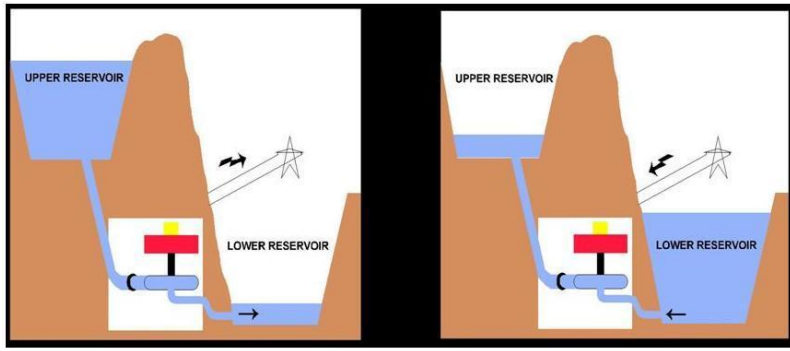
Chemical storage

- Storage in the form of fuel:
  - Energy can be stored and transported in the form of the hydrogen
  - The electric power output from solar cell can directly given to the electrolyte tank of water
  - This will create the hydrogen and oxygen
  - The hydrogen can be used to run the fuel cell, to gain back the electricity
  - It is very efficient way to store the energy



Mechanical energy storage

- Pumped hydroelectric storage
  - Electric power in excess is used supply water from lower reservoir to higher reservoir
  - When power demand exceeds the supply, it is flown back through hydroelectric turbine
  - It inherently avoids heat losses and gives ac power directly
  - It needs to be near large water bodies for make up water



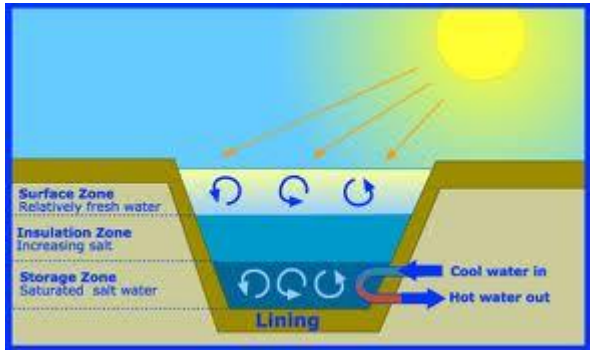
pumped hydro operating principals

Mechanical energy storage

- Compressed air storage
  - Pressurized air into storage tank
  - Drive air turbine
  - Use when no wind blowing and generate electricity
- Flywheel storage
  - Mechanical rotational energy
  - High energy recovery efficiency (about 90%)
  - In vacuum use (super flywheel)
  - Magnetic bearing

Solar Pond

- An artificial body of water for collecting, absorbing and storing solar radiation energy by preventing convection
- A pool of very salty water in which convection is inhibited, allowing accumulation of energy from solar radiation in the lower layers

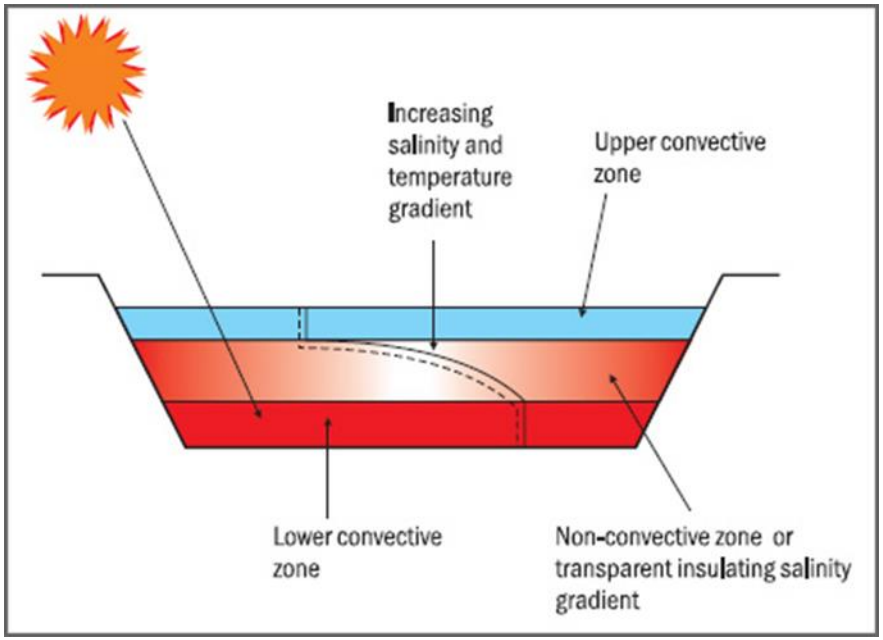


Solar Pond

- At the bottom of the pond, black thick plastic liner of butyl rubber, black polyethylene and hypalon reinforced with nylon mesh is used
- Salts like magnesium chloride, sodium chloride or sodium nitrate are dissolved in the water

Solar Pond

1. Heating and cooling of buildings
2. Production of power
3. Industrial process heat
4. Desalination
5. Crops drying
6. Heat for biomass conversion




Thank you!