Solar Thermal Energy

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Contents

1. The Source

- Potential

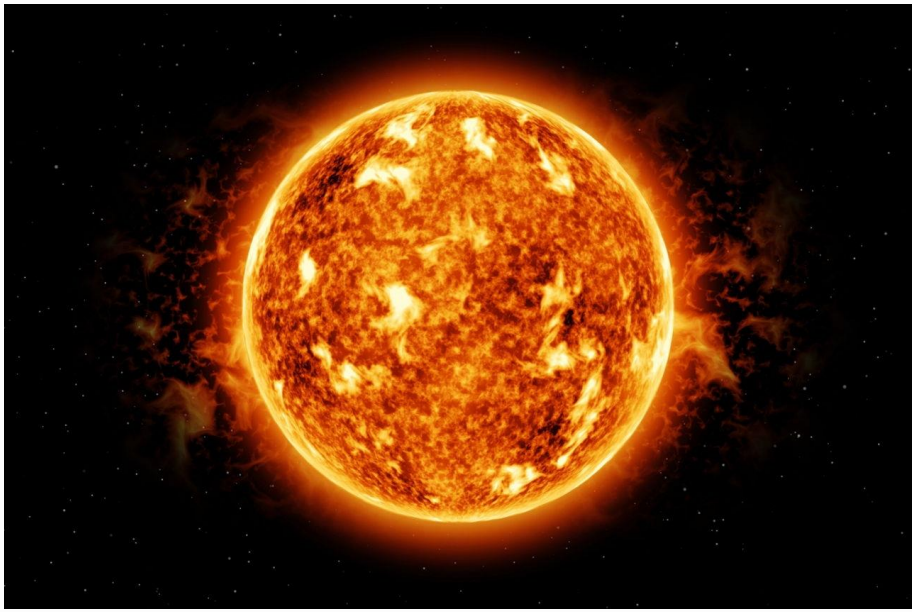
2. The Collector

- Technologies

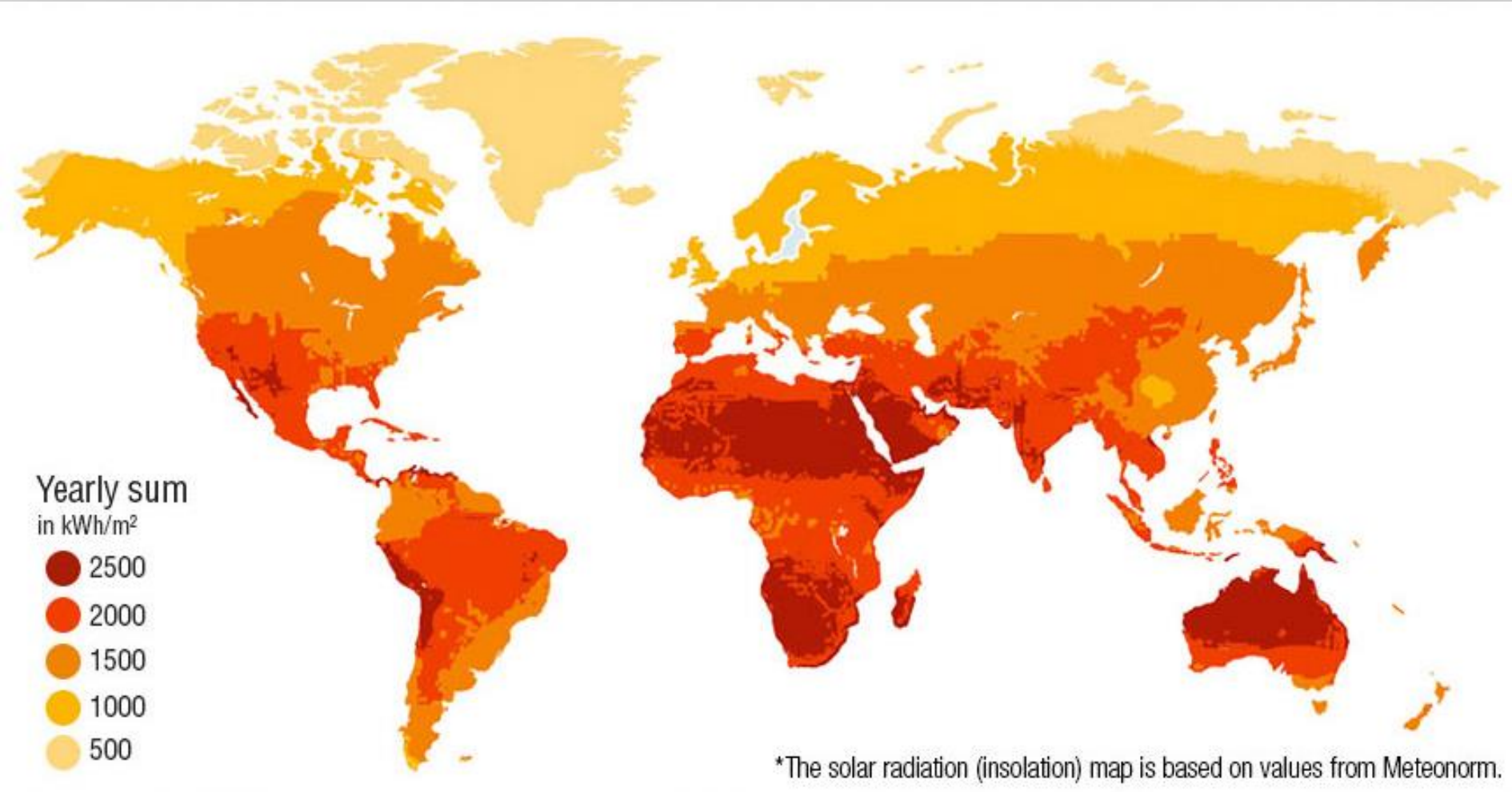
3. Application

- Practical Application
- Challenges

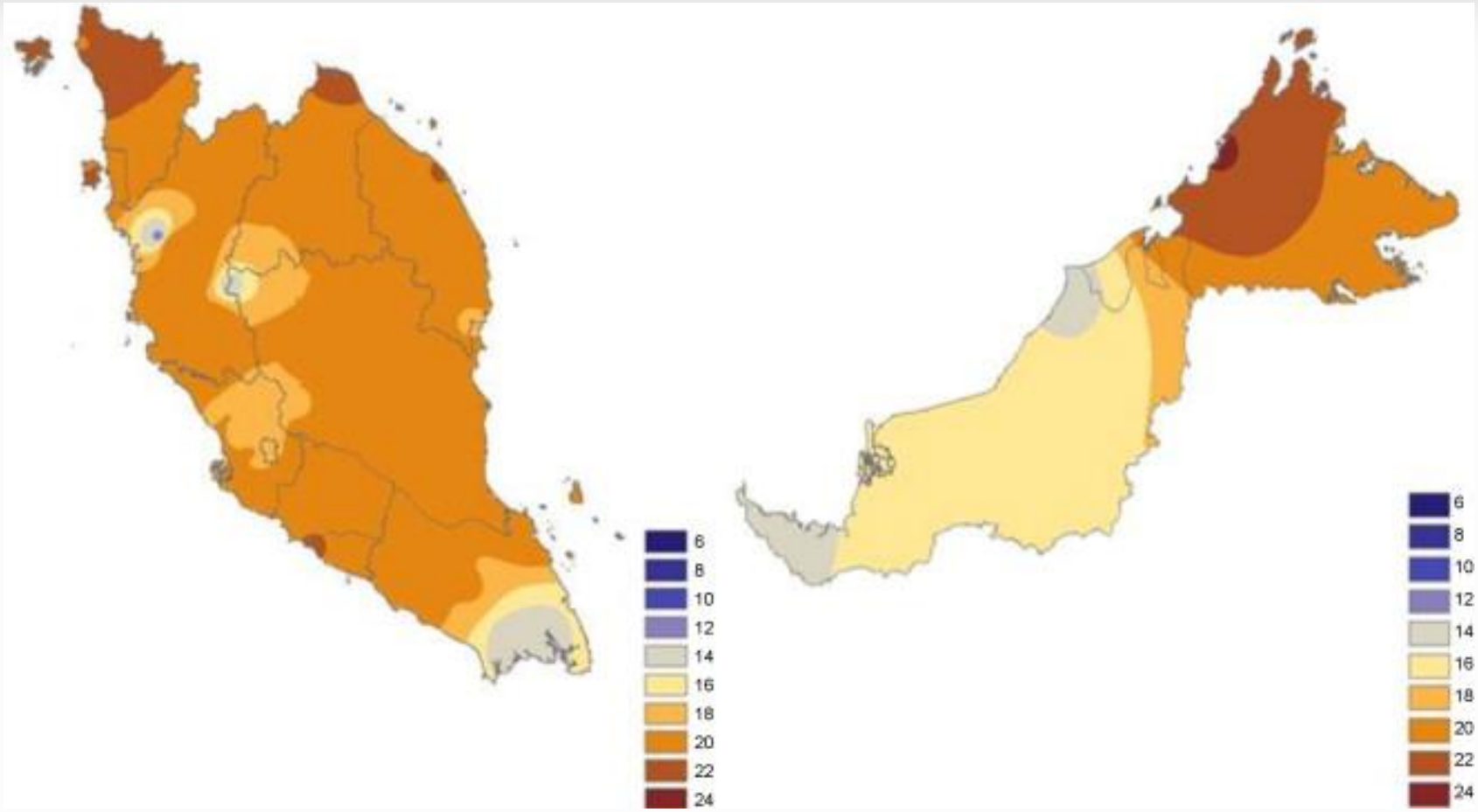
THE SOURCE



Solar Energy Potential



Solar Energy Potential



Monthly solar radiation in Malaysia is approximately around 400–600 MJ/m^2.

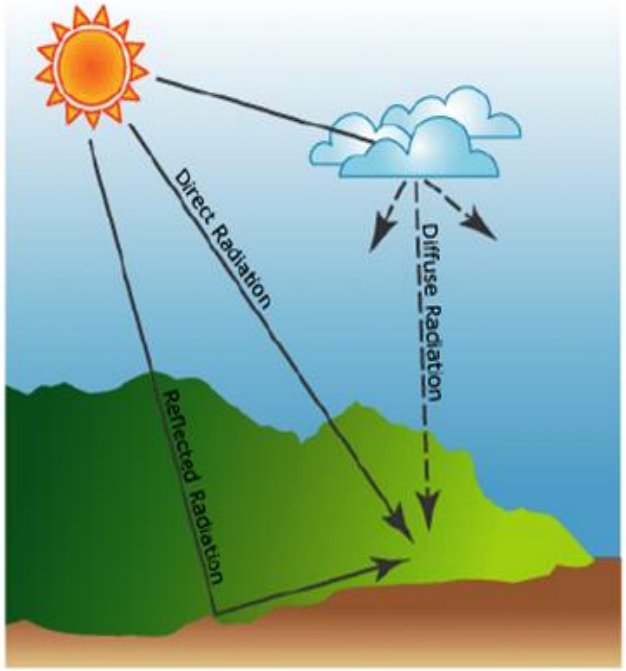
Solar Irradiance

- Direct Normal Irradiance (DNI)

- Diffuse Horizontal Irradiance (DHI)

Source: nrel.gov

- Global Horizontal Irradiance (GHI)



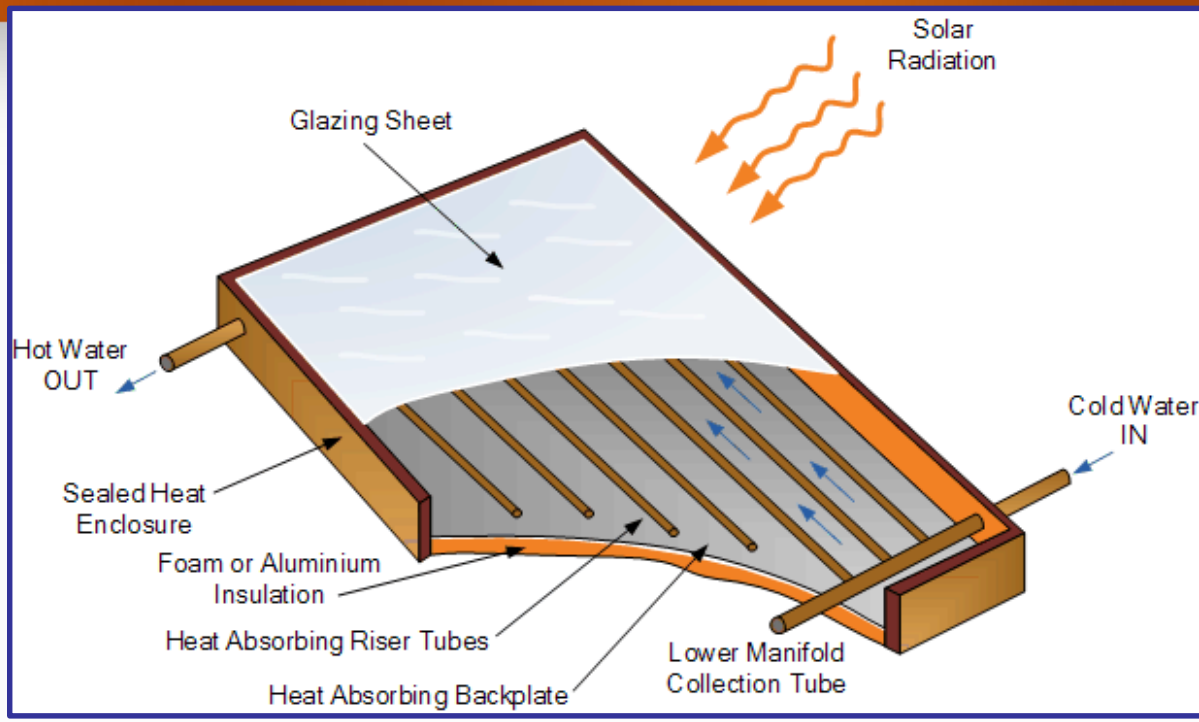
Source: esri.com

Typical Insolation for Kuala Lumpur (Direct & Diffuse):
Peak Intensity: 0.55-0.73 kW/m^2
Energy: 4.17 – 5.42 kWh/m^2.yr

The average sunshine duration was found to be in the range of 4–8 h/day

COLLECTOR

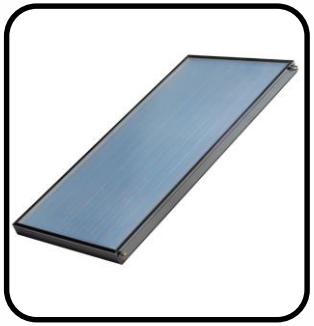
PRINCIPLES



Converts solar irradiation energy either to the thermal energy of the working fluid in solar thermal applications,

The heat carried by the working fluid can be used to either provide domestic hot water/heating, or to charge a thermal energy storage tank from which the heat can be drawn for use later (at night or cloudy days).

Type of Solar Collector



Flat Plate Type

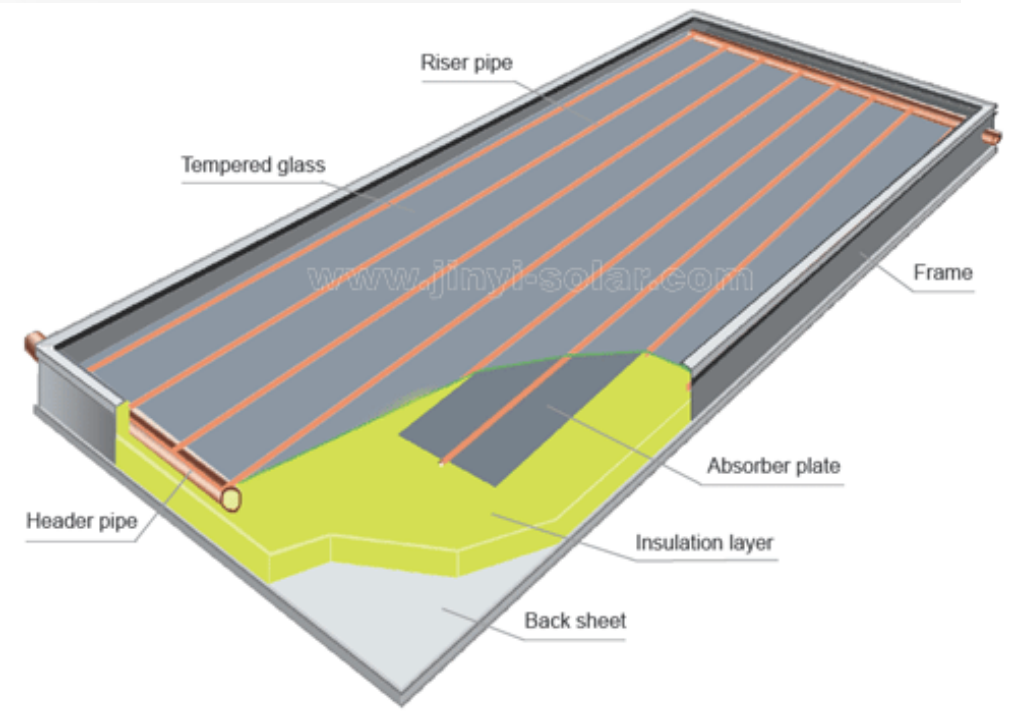
Evacuated Tube

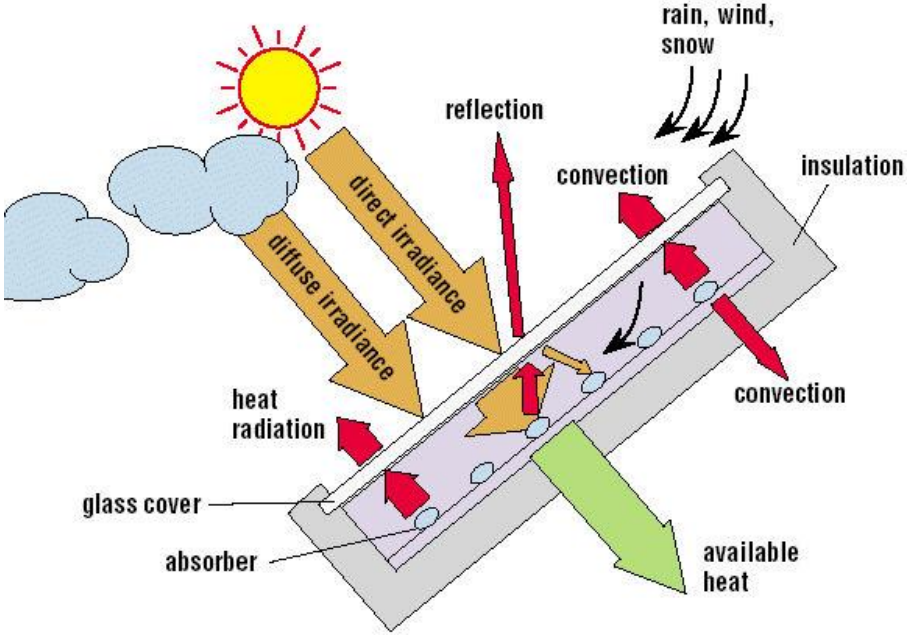
Heat Pipe Evacuated Tube

Parabolic Trough

Parabolic Dish

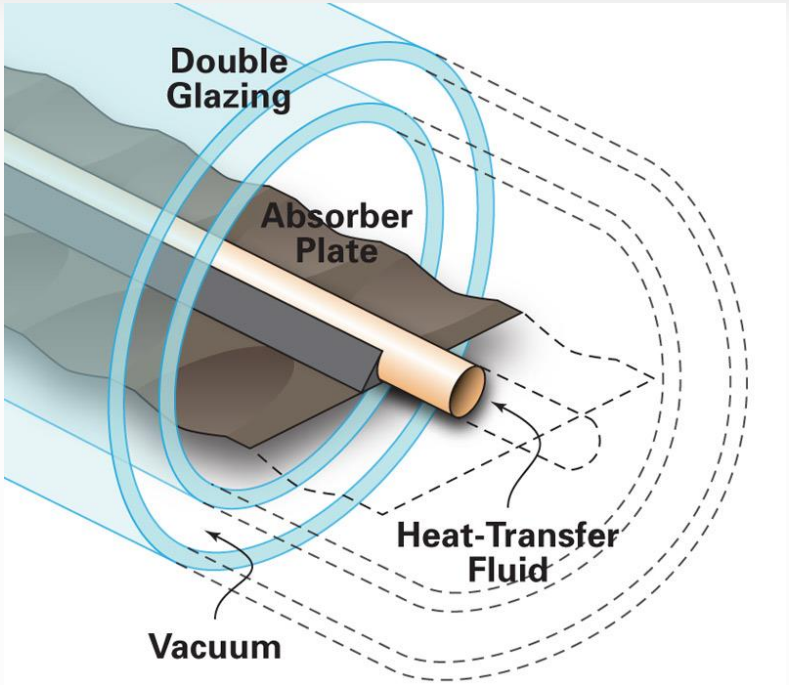
Flat Plat Type





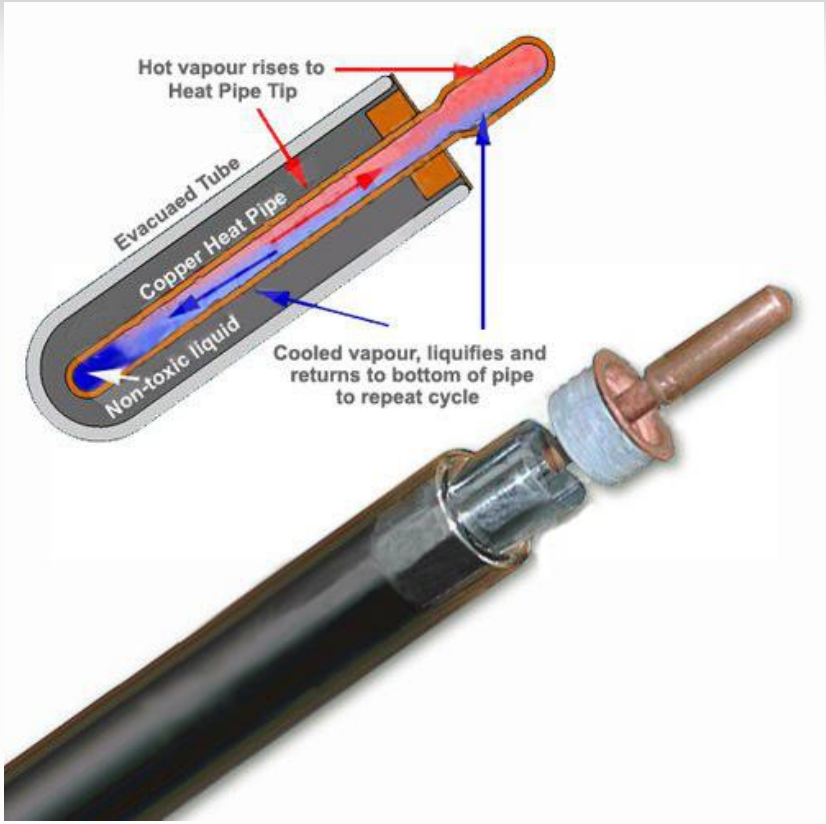
- Flat-plate collectors are the most common solar thermal technology.
- Relatively cheap compared to other collectors.
- Less efficient.
- Typical temperature output up to 60^{o}C.
- Construction variants: Glazed and unglazed type

Evacuated Tube



- Vacuum inside evacuated tube prevent heat loss to ambient. Water tube inside the evacuated tube.
- Higher efficiency relative to flat plate type.
- Typical temperature output up to 90^{o}C.

Evacuated Tube (Heat Pipe)



- Similar outer construction with evacuated tube but with heat pipe inside filled with refrigerant.
- Higher efficiency relative to flat plate type.

Parabolic Trough Collector

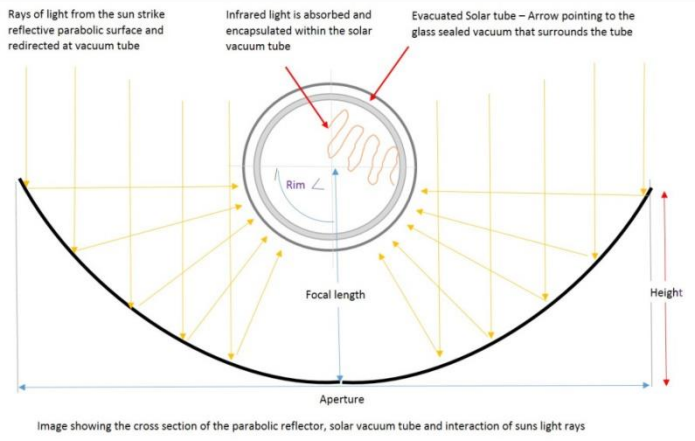
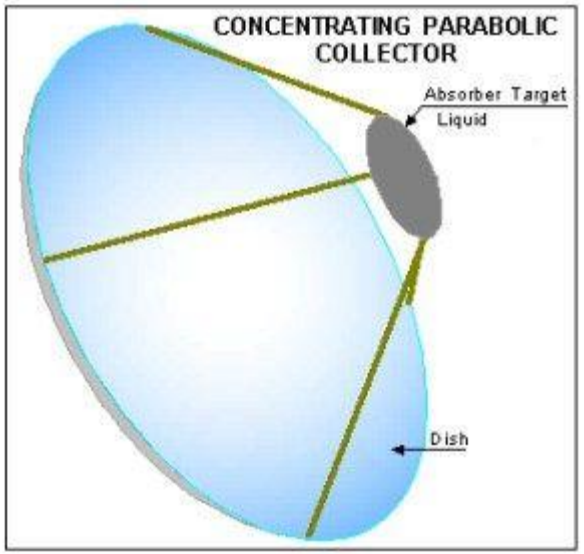


Image showing the cross section of the parabolic reflector, solar vacuum tube and interaction of suns light rays

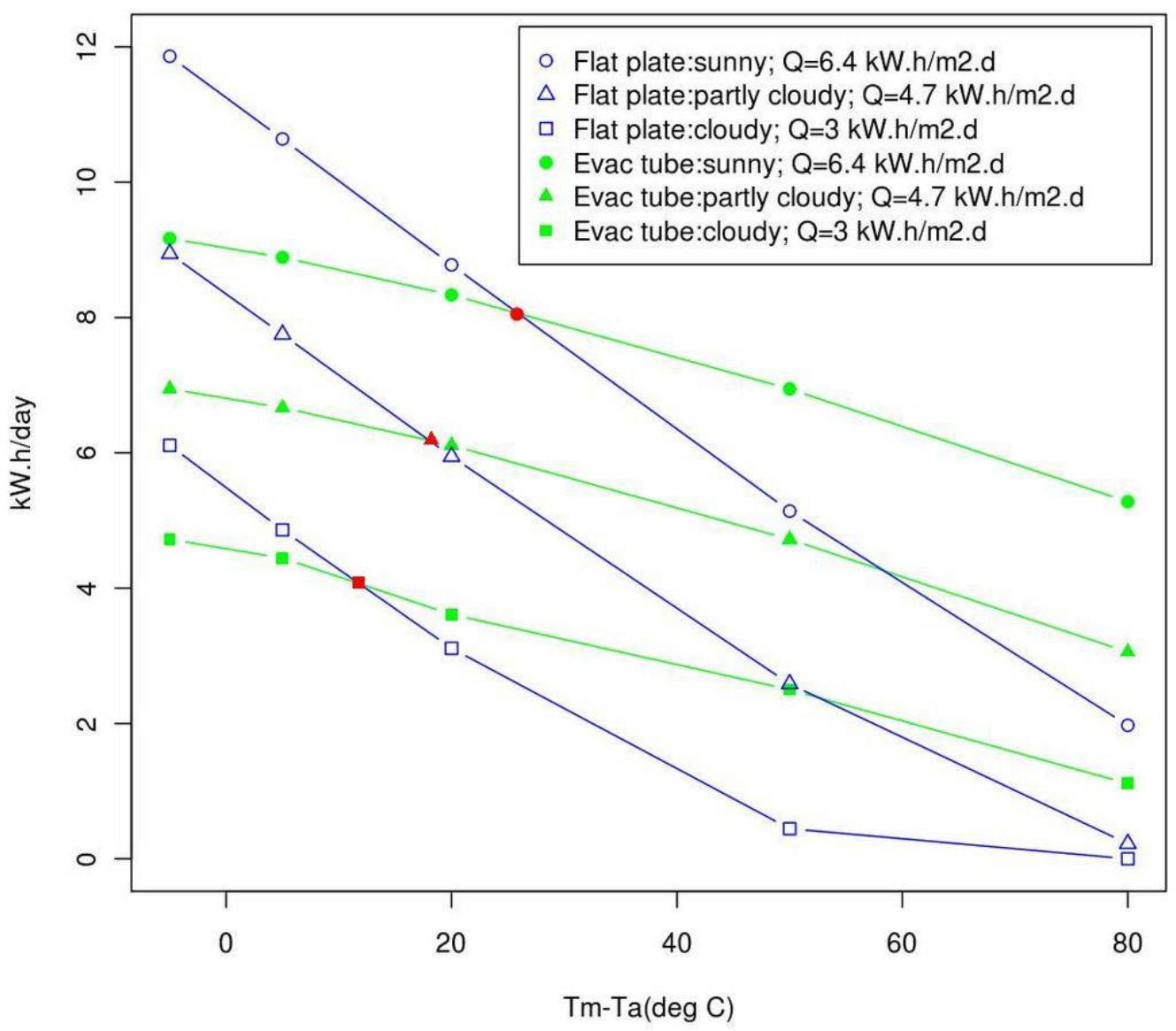
- Tracking and non tracking type
- Higher efficiency and temperature output.
- Widely used for power generation.
- Suitable for low cloud cover (high direct radiation)

Parabolic Dish Collector



- Tracking and non tracking type
- Higher efficiency and temperature output.
- Widely used for power generation.
- Suitable for low cloud cover (high direct radiation)

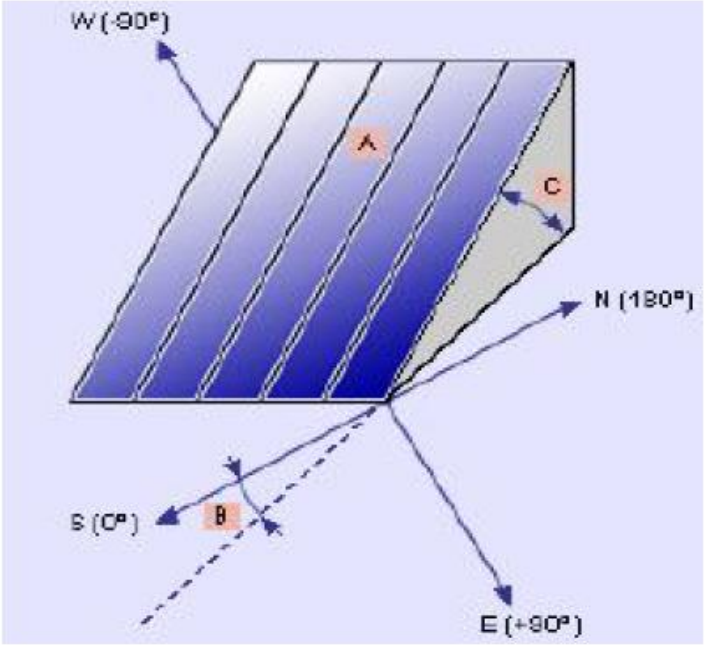
Efficiency Comparison



- Flat plate type better efficiency at lower ambient temperature.
- Evacuated tube higher efficiency at higher ambient temperature.

Solar Collector Orientation

- **Tilt angle**
  - The angle at which a solar collector is set to face the sun relative to a horizontal position.
  - The tilt angle can be set or adjusted to maximize seasonal or annual energy collection.
  - Normally, for Solar Thermal Panel, the minimum tilt angle is 15^{o} to let the Thermosiphon process happen (Natural Convection)
- **Azimuth angle**
  - The face direction of solar panel.
  - It can be North, South, East, West or in the angle values.
  - By Rule of Thumb, the recommended Azimuth Angle for solar panel in Malaysia is facing south
- **Effect**
  - The Tilt Angle and Azimuth Angle will affect the performance or the amount of energy that can be gathered by Solar Panel



Optimum point for Malaysia is 10^{o} tilt angle and facing North

APPLICATION

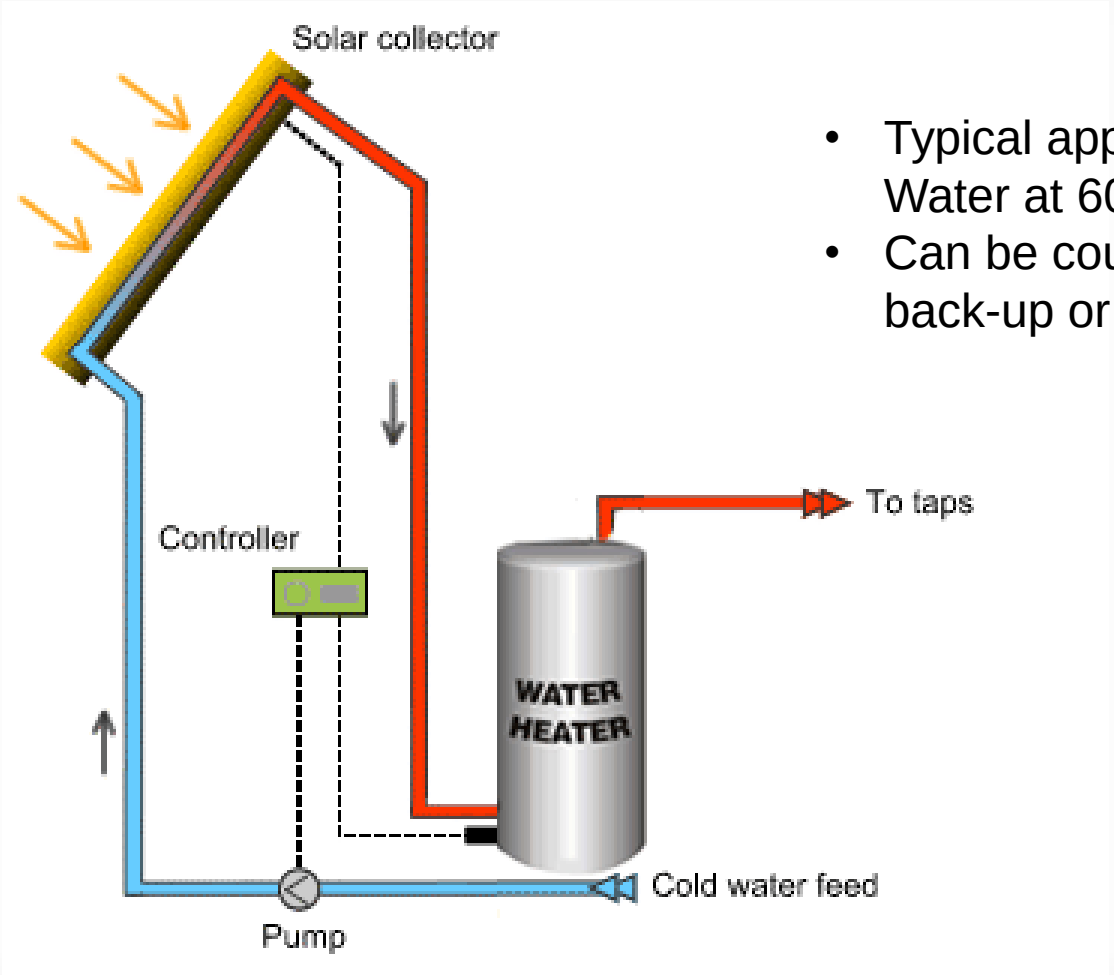
Application type

Hot Water Production

Air Conditioning System (Thermal Chiller)

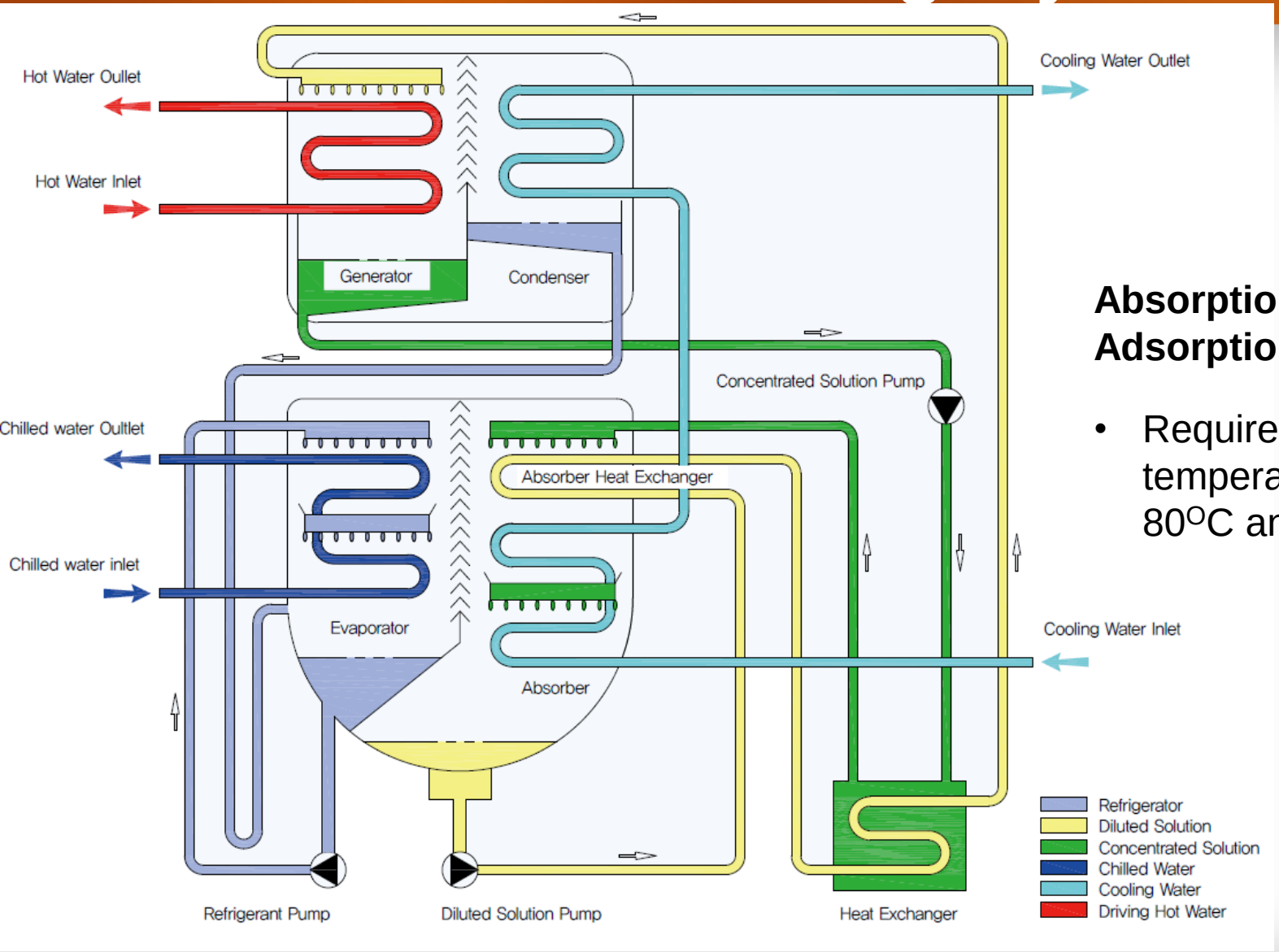
Power Generation

Domestic Hot Water Production



- Typical application for Domestic Hot Water at 60^{o}C temperature.
- Can be couple with heat pump for back-up or auxilliary heating.

Air Conditioning System



Absorption and Adsorption Chiller

- Require hot water temperature around 80^{O}C an above.

Application Challenges

- High capital cost compared other technologies.
- Inconsistency in solar radiation requires back-up system resulting in higher capital cost.
- Building Integration. Orientation and footprint issue.

Conclusion

- Huge opportunity to utilize abundant solar energy in Malaysia.
- Green and matured technology.
- Economic barrier need to be removed to promote application.

Thank You

CONCLUSION