ME 476
Solar Energy

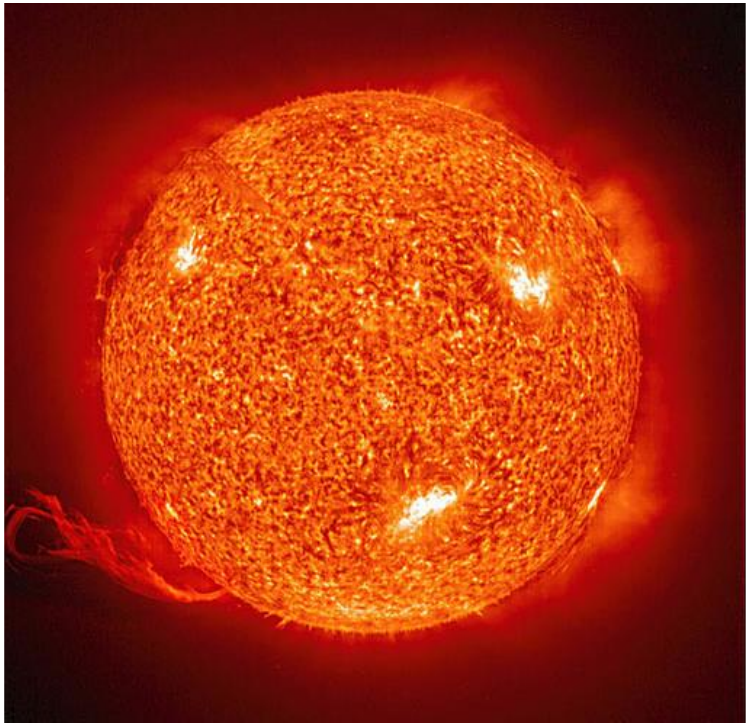
UNIT ONE
INTRODUCTION

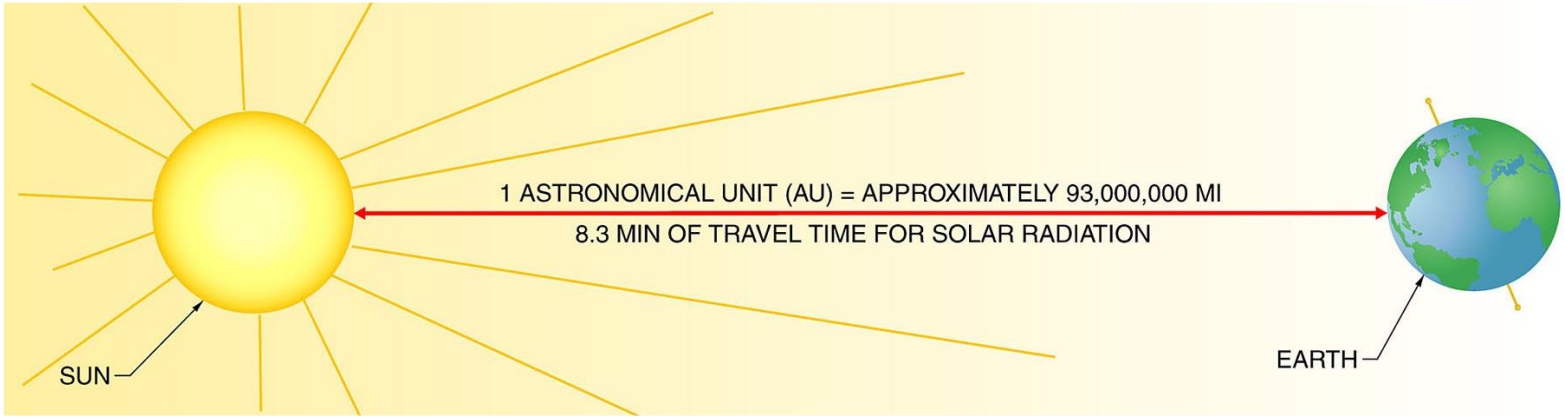
Unit Outline

- What is solar energy?
- Why is solar energy important?
- How can solar energy be utilized?
  - Power generation
  - Water heating
  - Refrigeration
  - Desalination
- Limitations and challenges of solar energy

What is Solar Energy?

- Solar Energy is the radiant energy emitted from the surface of the Sun and received by Earth
- The amount of energy emitted by the Sun is approximately 3.84×10^{26} J/s.
- The amount of energy the Earth's surface receives from the Sun is roughly 9×10^{16} J/s





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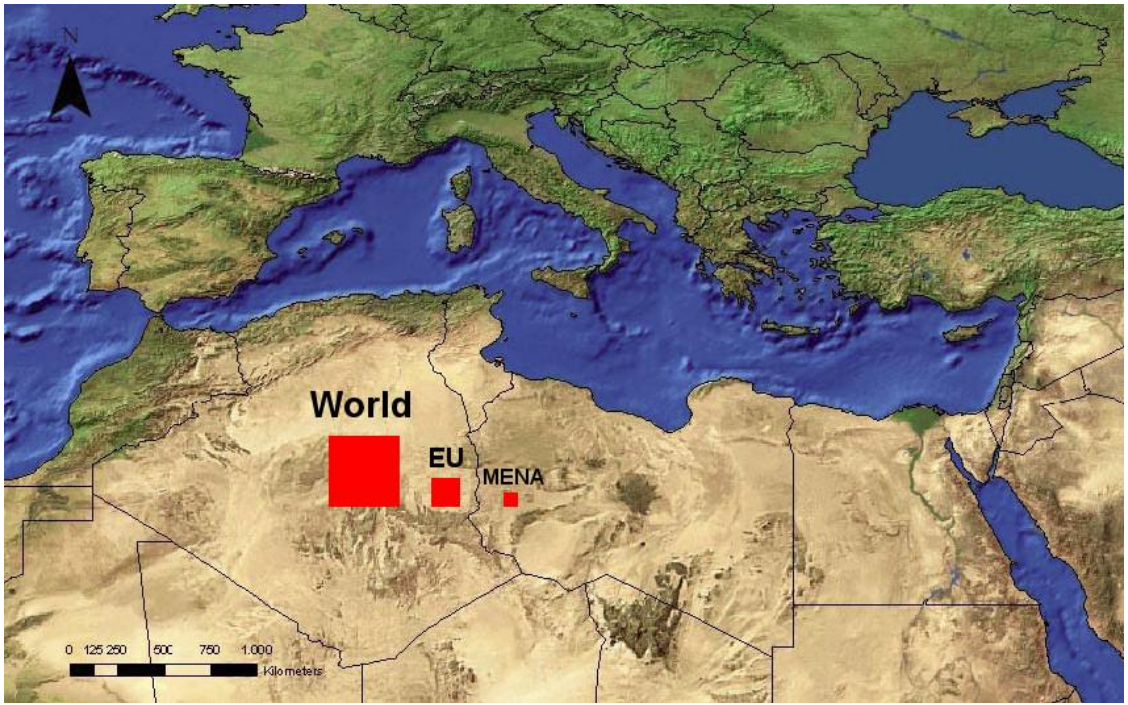
Why is Solar Energy Important?

- The amount of solar energy the Earth receives is huge
- Solar energy is free and renewable
- Solar energy is clean (no carbon emissions)
- Less than 0.01% of this energy can provide electricity to the entire world population



Why is Solar Energy Important?

- Solar energy reduces the consumption of fossil fuels
- Fossil fuels can be a valuable resource for other industries
- Fossil fuels contribute to the pollution problem

Why is Solar Energy Important?

- Saudi Arabia produces approximately 10 million barrels of oil every day
  - **About 3 million barrels are consumed locally for power generation and transportation**
  - **About 600,000 barrels of oil are consumed locally for power generation**
- The cost of one barrel of oil sold to the Saudi Electricity Company is about $4.5
- The price of one barrel of oil sold internationally is more than $100
- Saudi Arabia loses more than SR 80 billion for this difference
- Solar energy can help reduce this problem

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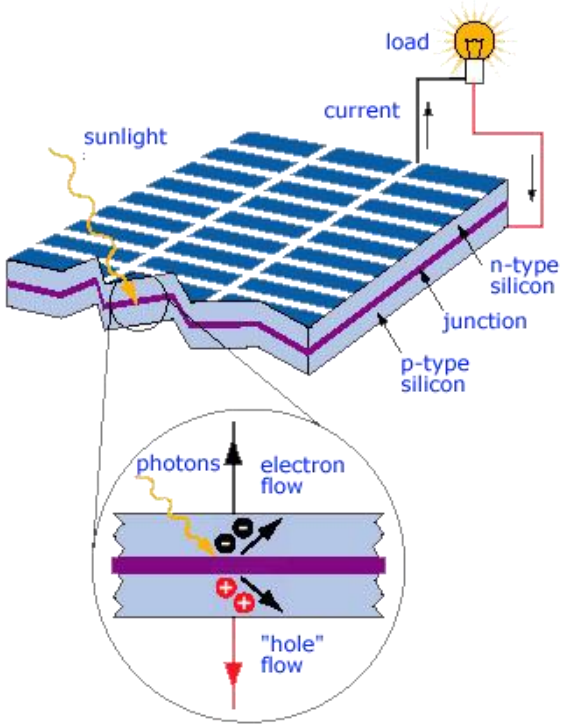
How Can Solar Energy Be Utilized?

Power Generation

Photovoltaic Panels

- Photovoltaic panels convert part of light directly to electricity.

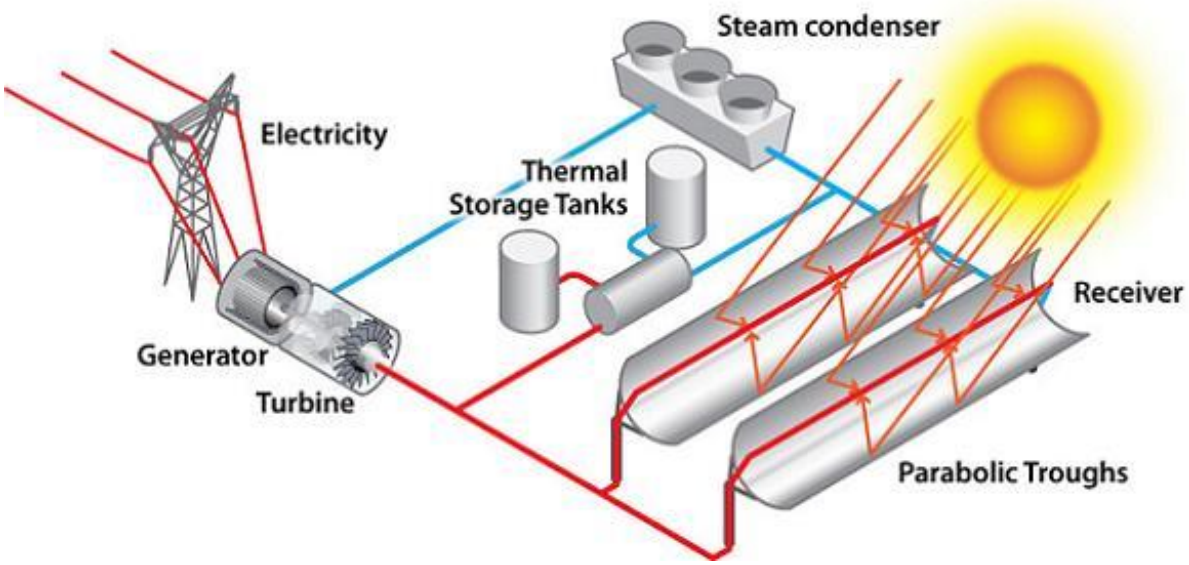


How Can Solar Energy Be Utilized?

Power Generation

Parabolic Trough Collector (PTC)

- PTCs concentrate sunlight on a single tube to heat a fluid
- This fluid is used to generate steam
- The steam drives a turbine



How Can Solar Energy Be Utilized?

Power Generation

Central Receiver Systems

- Mirrors track the sun to focus sunlight on a single point instead of a line.

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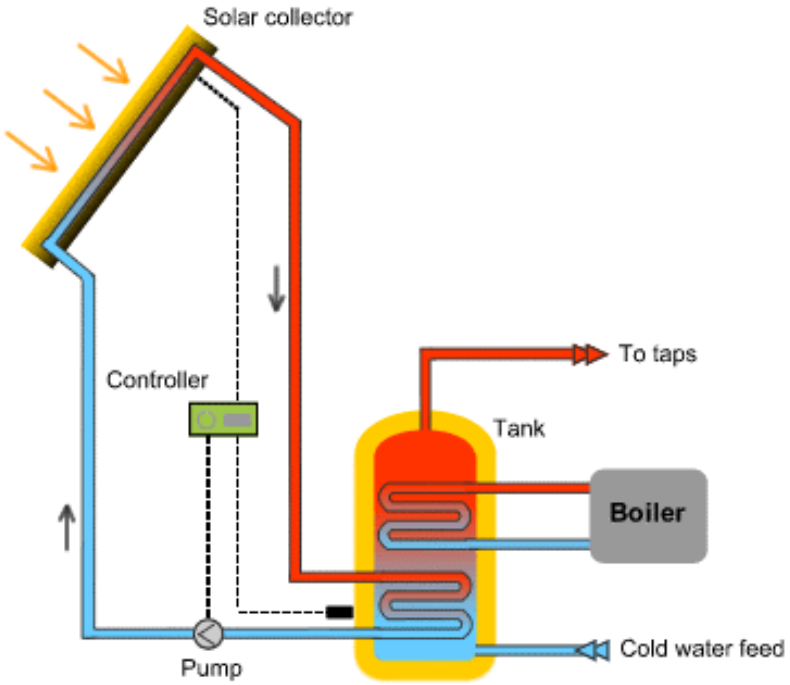
How Can Solar Energy Be Utilized?

Water Heating

- Usually stationary collectors are used on roof tops
- The collectors absorb sunlight and transfer it to the water (or other fluid) flowing inside the tubes



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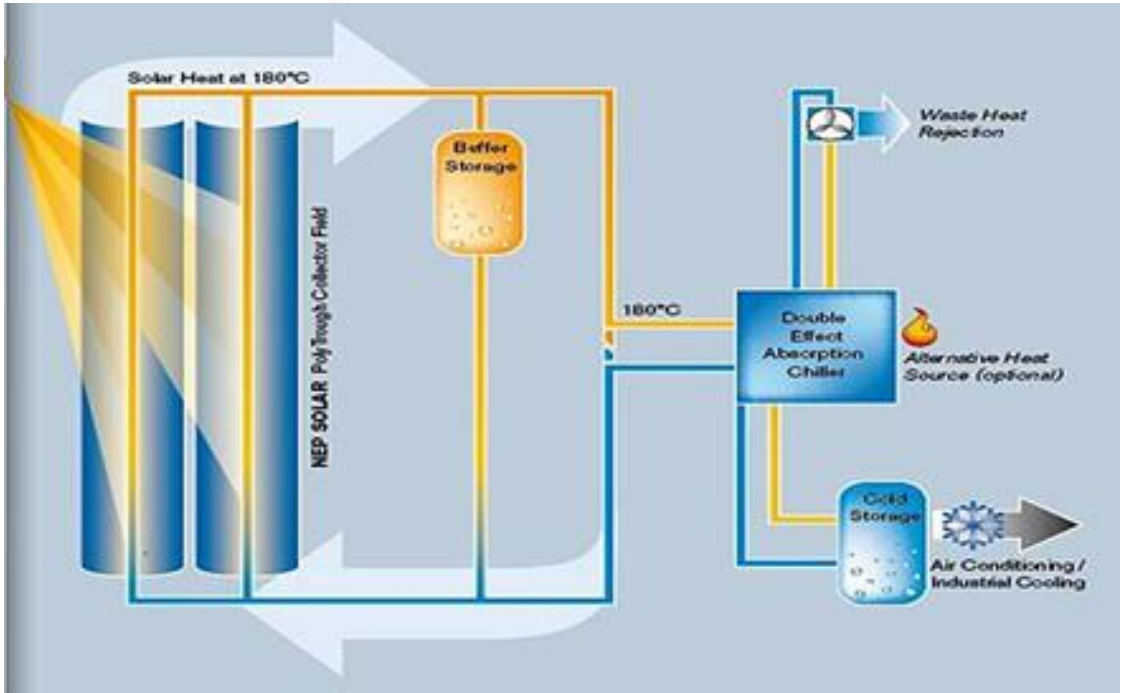
How Can Solar Energy Be Utilized?

Refrigeration

- Electricity can be used directly to operate conventional vapor compression systems
- Alternatively, a fluid is heated to drive an absorption refrigeration system



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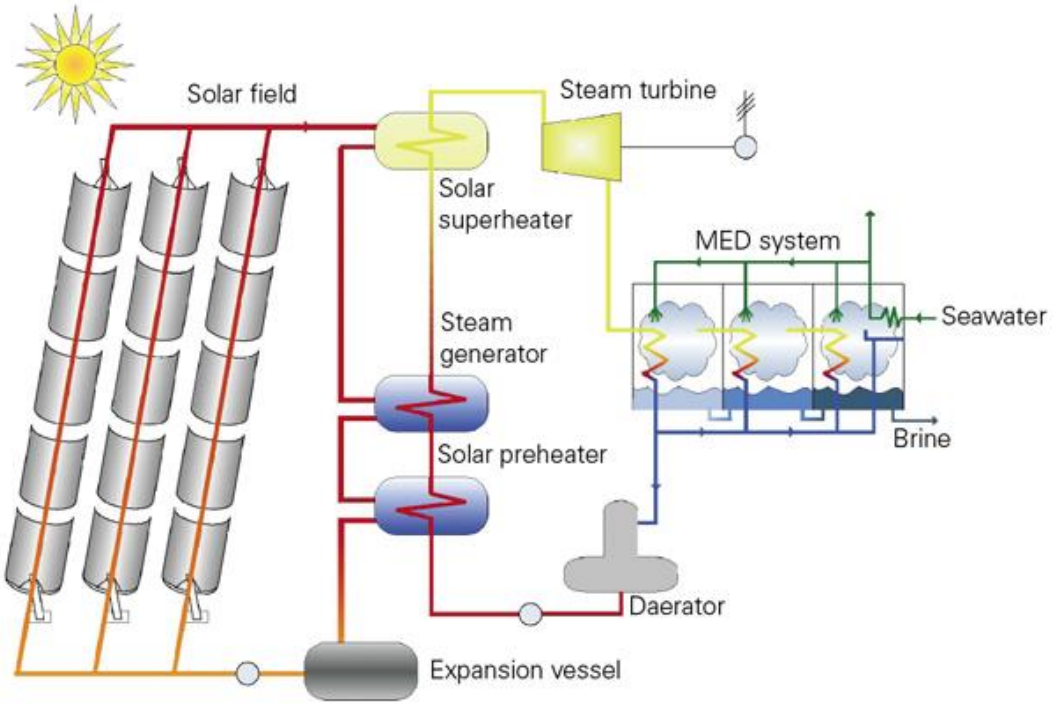
Desalination

- Electricity can be used directly to operate a reverse osmosis (RO) system.
- Alternatively, a fluid is heated to provide steam to a thermal desalination system



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Limitations and Challenges

- Solar energy is intermittent
  - **Not available at night**
  - **Limited availability on cloudy, rainy, or dusty days**
  - **Amount received in the early morning and late afternoon is limited**
- System cost is still relatively high compared to fossil fuels (especially when fossil fuel prices are too low)
- Cleaning of collectors is necessary to avoid reduction in performance due to dust