

Solar Panels for Solar Thermal Energy

MSE 395: Materials for Renewable Energy

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Outline

- Solar Panel Technologies
- How they work
 - Collection
 - Transfer
 - Storage
- Types of Collectors
- Types of transfer and storage materials (heat exchange)
- Challenges

Solar Thermal Technologies

- Low Temperature Systems
 - Used to heat air and water for:
 - Space heating in housing
 - Domestic or industrial hot water
 - Pool heating
 - Crop drying
 - Costs
 - Capital costs: \$1500 - \$3000
 - Operating life: 15 – 40 years
 - Payback period: 4 – 14 years

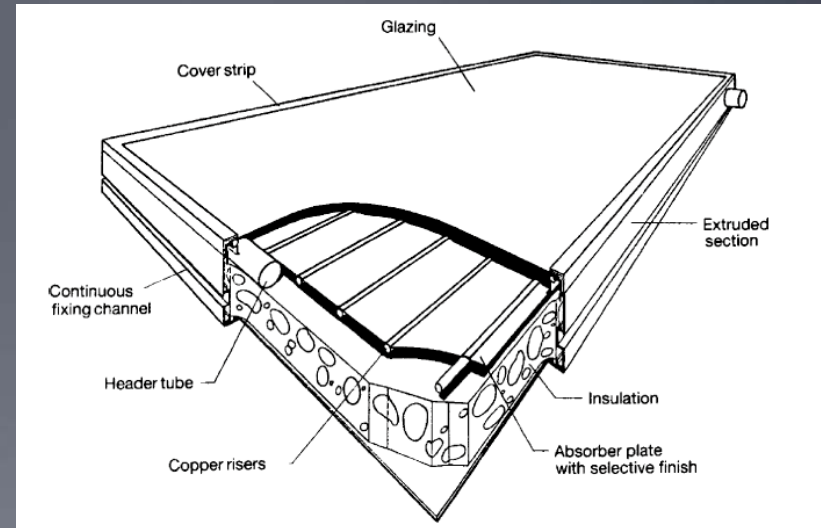


Solar Thermal Technologies

- High Temperature Systems
 - Used to create steam to:
 - Drive electric turbine generators
 - Power chemical processes (production of hydrogen)
 - System of mirrors and reflective surfaces to concentrate solar radiation
 - Costs:
 - Capital cost: \$2500 – 3500 /kW
 - Operating life: 20 years
 - Levelized cost: \$0.8 – 15/kWh

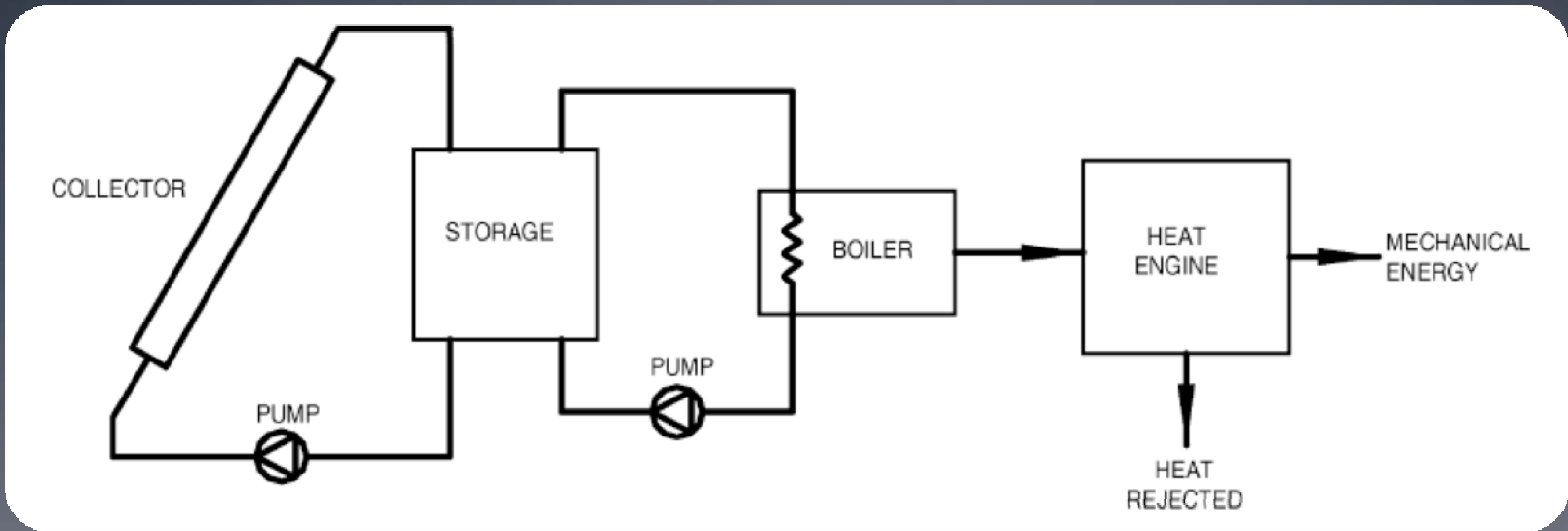


Flat-plate Collector



- Glazing: one or more sheets of glass (radiation-transmitting material)
- Tubes: To conduct or direct heat transfer fluid
- Insulation: To minimize heat loss

How they work



1. Collecting Heat

2. Transferring Heat

3. Storing Heat
Electricity

4. Converting Heat to

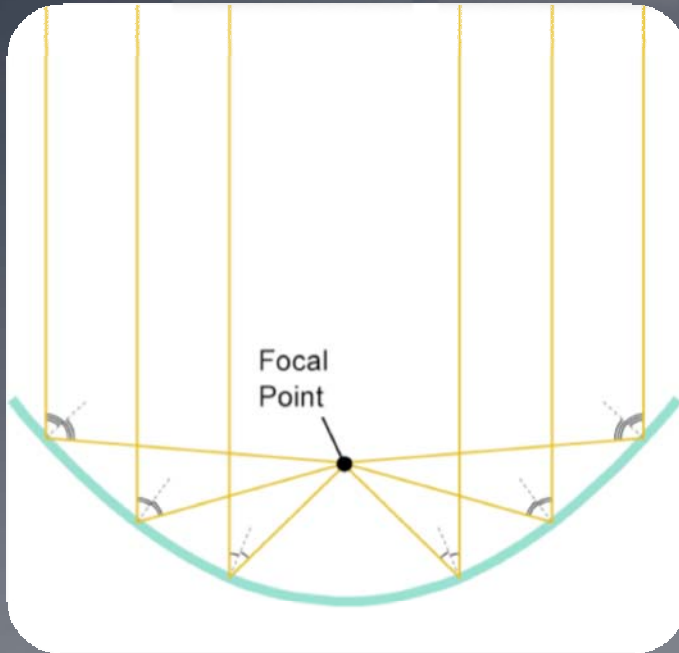
Types of Collectors

Parabolic Trough

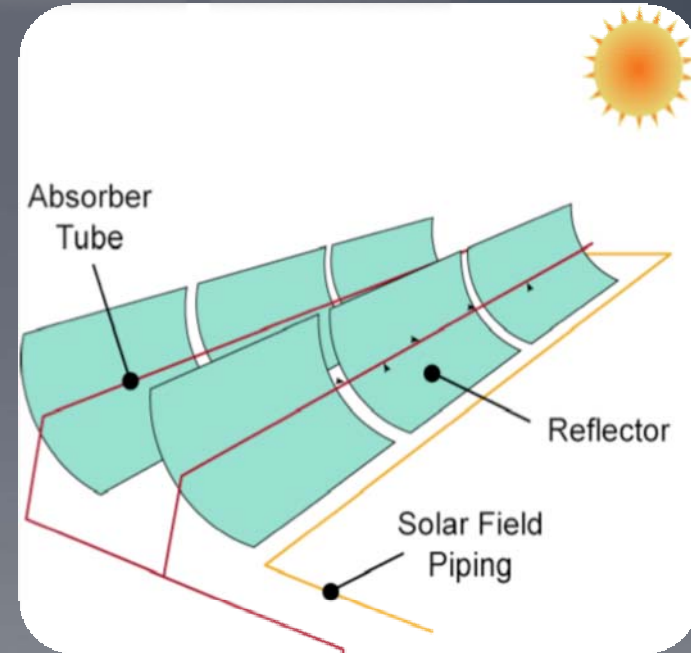
Linear Fresnel Reflectors

Paraboloidal Dishes

Solar Tower



- Grid-connected electric plants
- Relatively low temperature output



- Mechanically flexed thin glass backed with silver
- Aluminum used for evacuated tubes

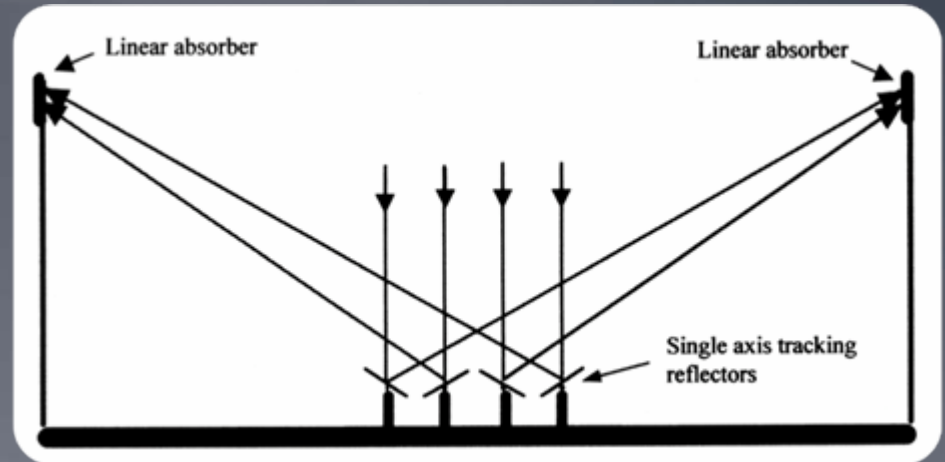
Types of Collectors

Parabolic
Trough

Linear
Fresnel
Reflectors

Paraboloidal
Dishes

Solar Tower



- Absorber fixed in space above mirror field
- Many reflectors focused collectively on a receiver
- Low cost solution

- CFLR removes blocking and shading issues
- Produces at electrical efficiency of 19%

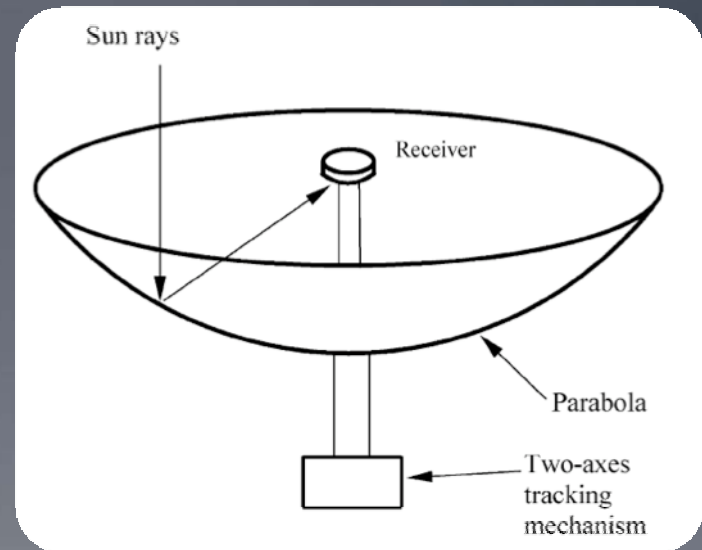
Types of Collectors

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Solar Tower



- Two-axis technology
- Dish engines operated using natural gas

- Challenges include low capital costs, long life, and higher conversion efficiency

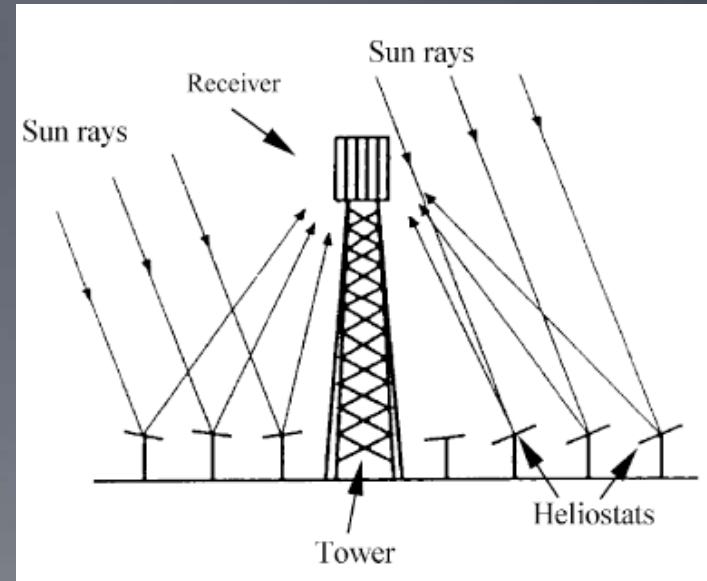
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Solar Tower



- High Temperature generation ($\sim 800^{\circ}\text{C}$)
- Low land usage efficiency

Heat Transfer Medium

- Typical fluid for low temperature system is water or oil ($\sim 350^\circ\text{C}$)
- High Temperature systems use molten salts
 - Molten-nitrate-salts (565°C)
 - Liquid-fluoride-salts ($700 - 850^\circ\text{C}$)
 - Thermodynamically stable at high temp
 - High boiling points
- Important material properties
 - Melting temperature
 - Heat capacity
 - Thermal conductivity
 - Viscosity

Coolant	T_{melt} ($^\circ\text{C}$)
LiF–NaF–KF (46.5–11.5–42)	454
NaF–NaBF ₄ (8–92)	385
NaNO ₃ –KNO ₃ ^c (66.3–33.7)	221
Sodium	97.8
Lead	328
Helium (7.5 MPa)	
Water (7.5 MPa)	0
Graphite	

Heat Storage

- Allows for time delay and available power between production or availability of energy
- Security of Energy Supply
- Thermal Energy Storage (TES)
 - Branched into heat exchanger development and materials research
- Materials:
 - Graphite
 - Phase change materials (PCMs)

Conclusion

- To improve solar thermal technology
 - Reflector designs optimized
 - Heat exchange fluid improvements
 - Efficient Heat Storage
- Solar thermal tech currently integrating with photovoltaic technologies

Solar thermal + PV

