Solar Thermal Collectors and Application

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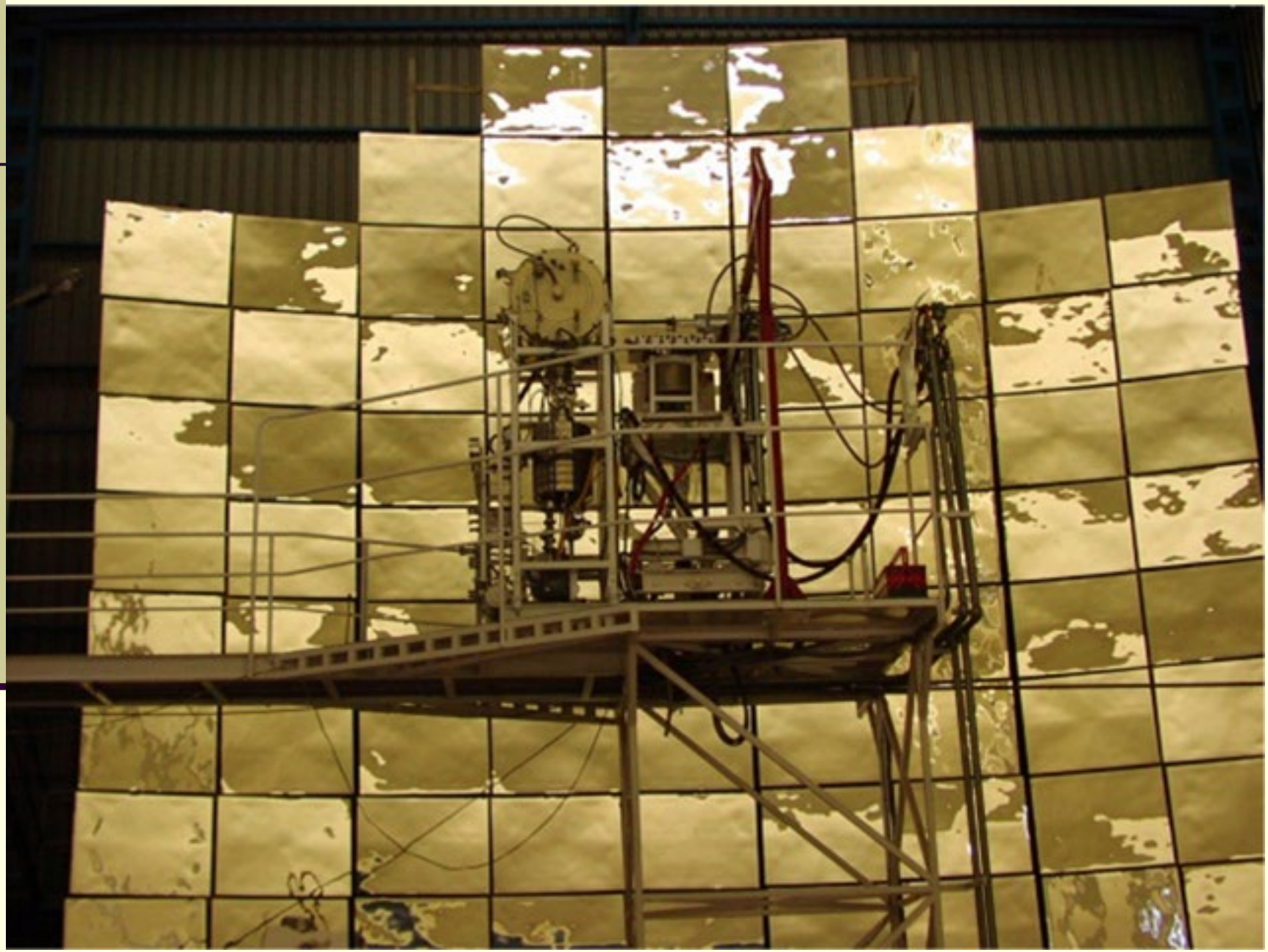
Thermal Collector Mechanics

Solar energy is absorbed, transformed, and concentrated in a solar thermal collector over a time or spatial gradient to produce usable energy

Thermal Collector Technologies

- Solar Cookers
- Parabolic Troughs
- Parabolic Dish
- Central Receiver System
- Solar Chimney
- Solar Distillers
- Solar Water Heaters



Solar Cookers

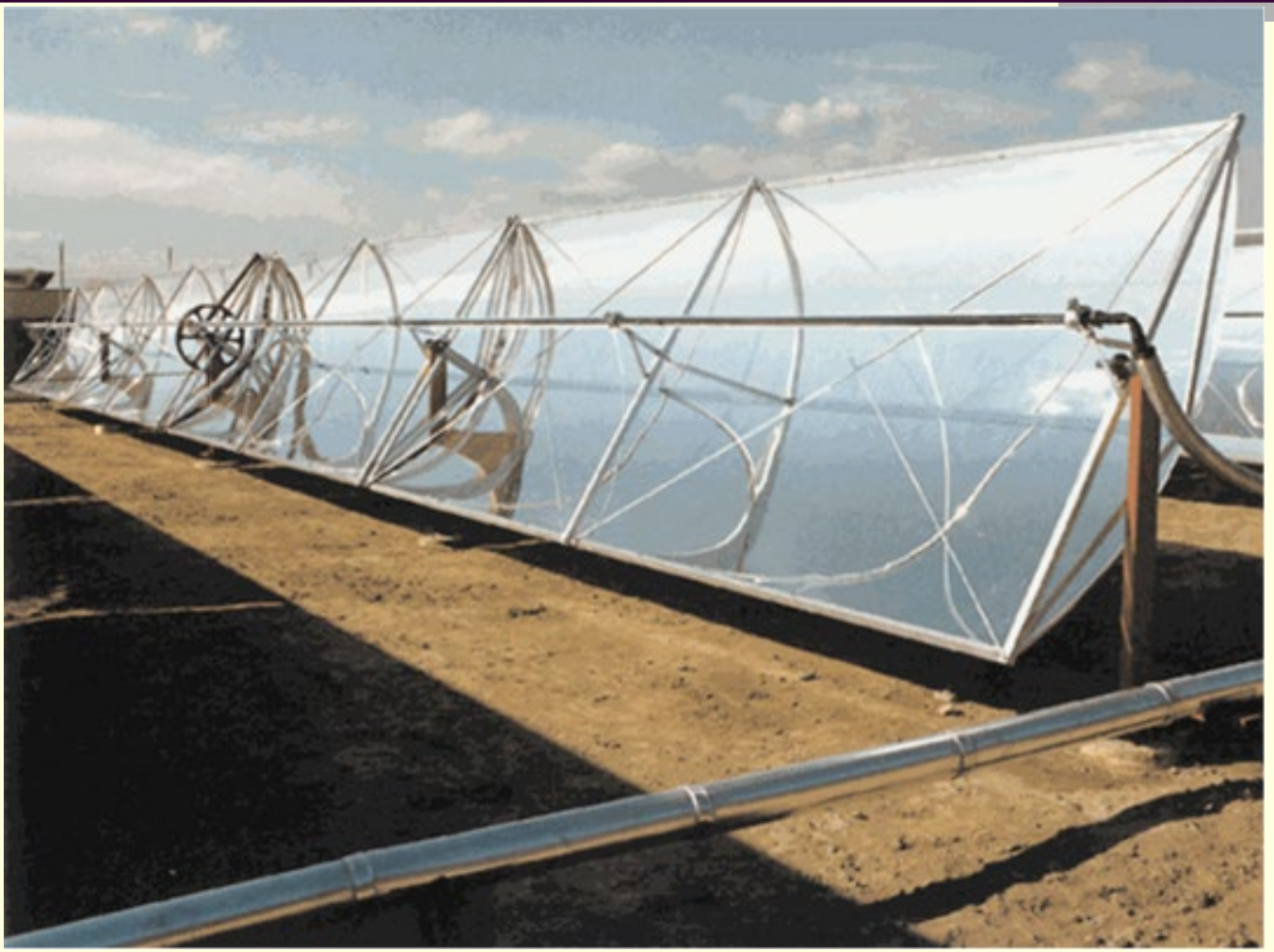
- Solar cookers or ovens are primarily used in developing nations as a primary method for cooking using passive solar heat to cook primary meals
- Insulated box that collects solar radiation enhanced by reflectors attached to each side
- Helps combat deforestation

Solar Oven in Nepal

Parabolic Trough

- A parabolic trough concentrates sunlight along a spatial gradient into a linear focal point
- A fluid acts as a thermal sink as it passes through dewar tubes along the focal point
- Parabolic troughs are used to generate electricity but are susceptible to seasonal changes

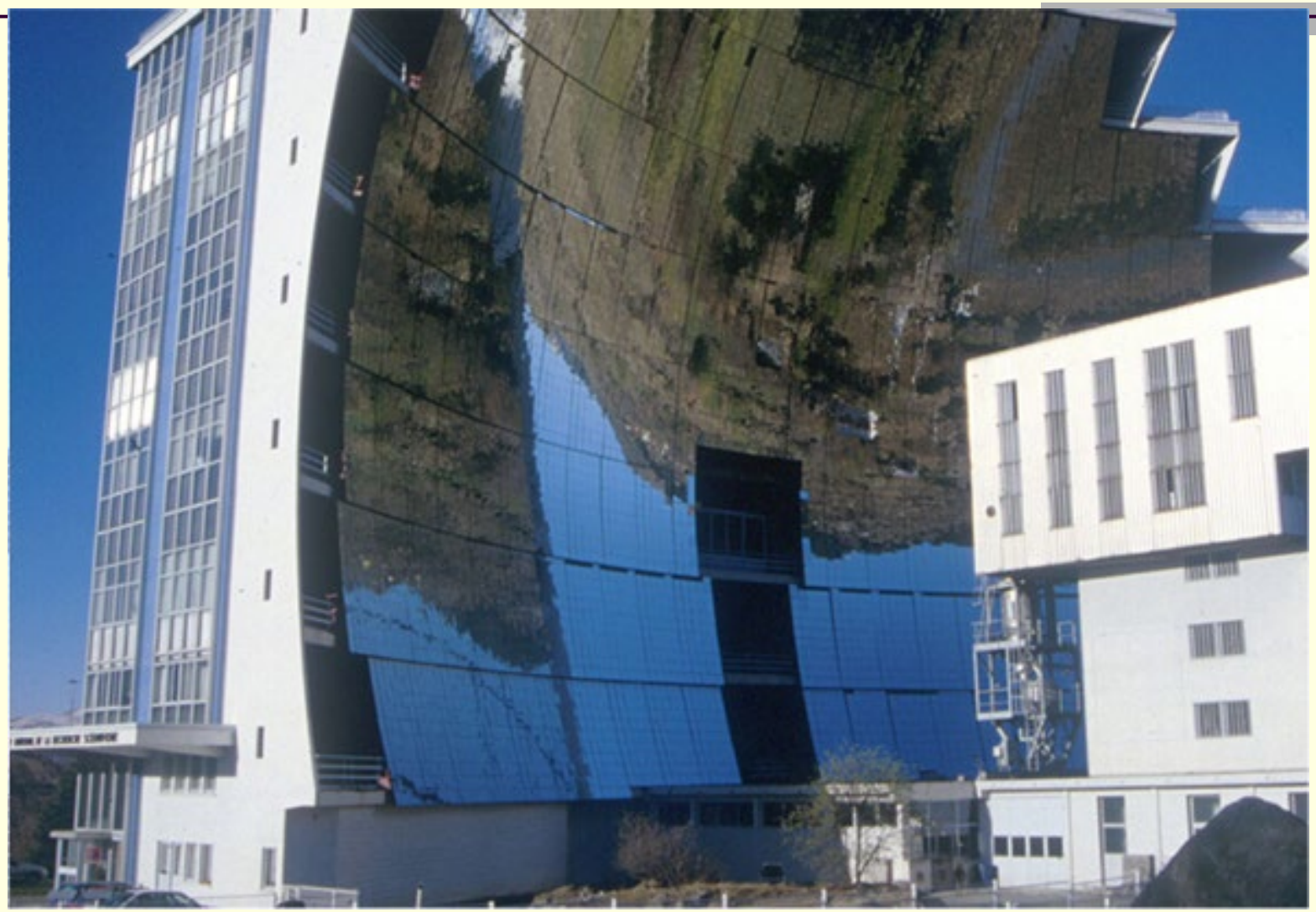
Industrial Parabolic Trough



Parabolic Dish

- A parabolic dish or solar furnace is a large reflector that concentrates thermal energy into a single focal point
- The focal point can contain a Stirling Engine to generate electricity or the energy can be focused and used in industrial processes
- On a small scale, a reactor can be used in the same way a solar oven is used

Research Solar Furnace in France



Central Receiver System

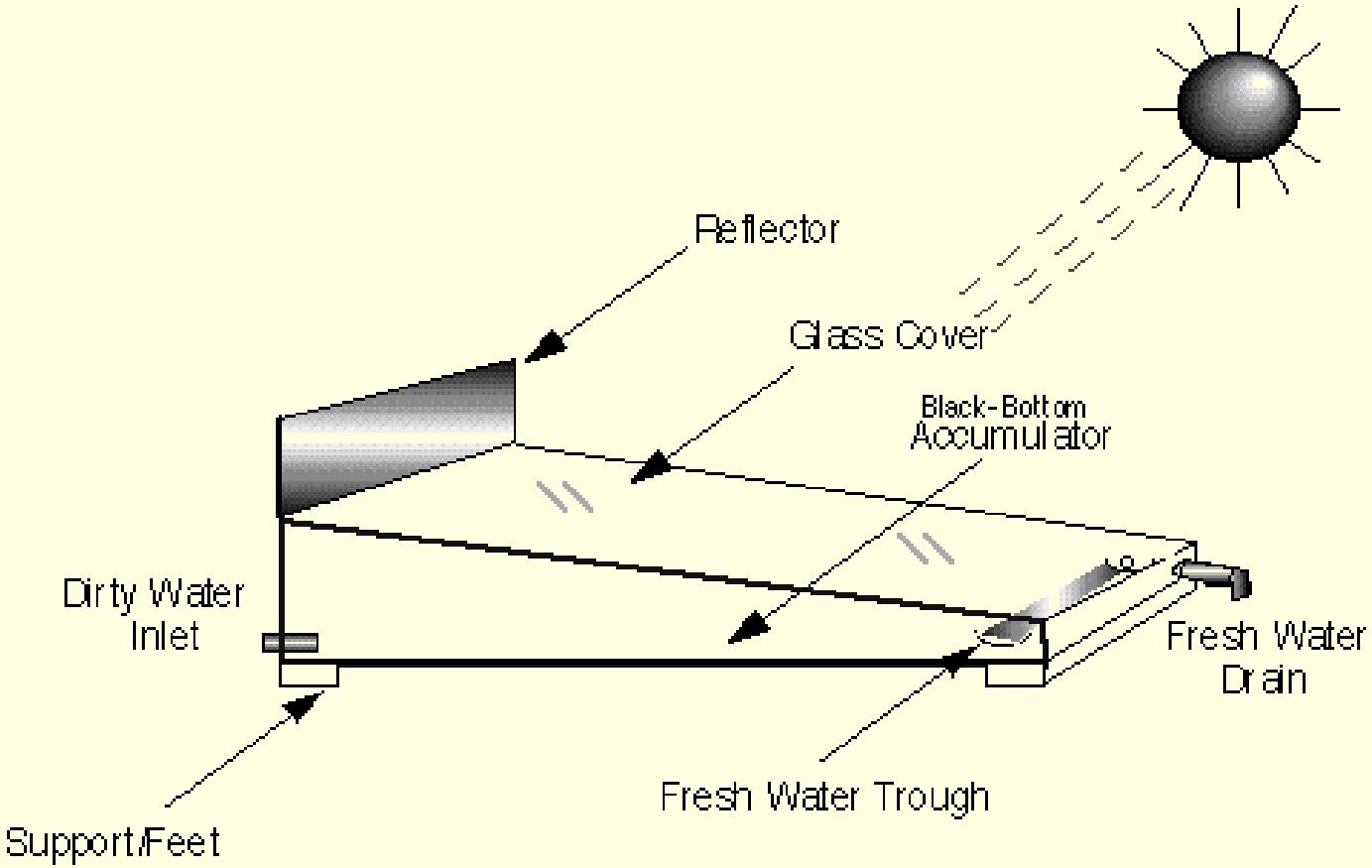
- Uses a series of sun tracking mirrors called heliostats to concentrate sunlight onto a focal point
- Focal point contains salt that when molten generates electricity in a steam generator for large scale energy production
- Capable of producing electricity over a 24 hour cycle due to salt's ability to retain heat

Central Receiver System

Solar Distiller

- Solar radiation heats up the contaminated water and allows the water to evaporate, leaving the contaminant behind
- System design collects distilled water for use
- Technology purifies water and can serve from one person to a community depending on the size of system installed

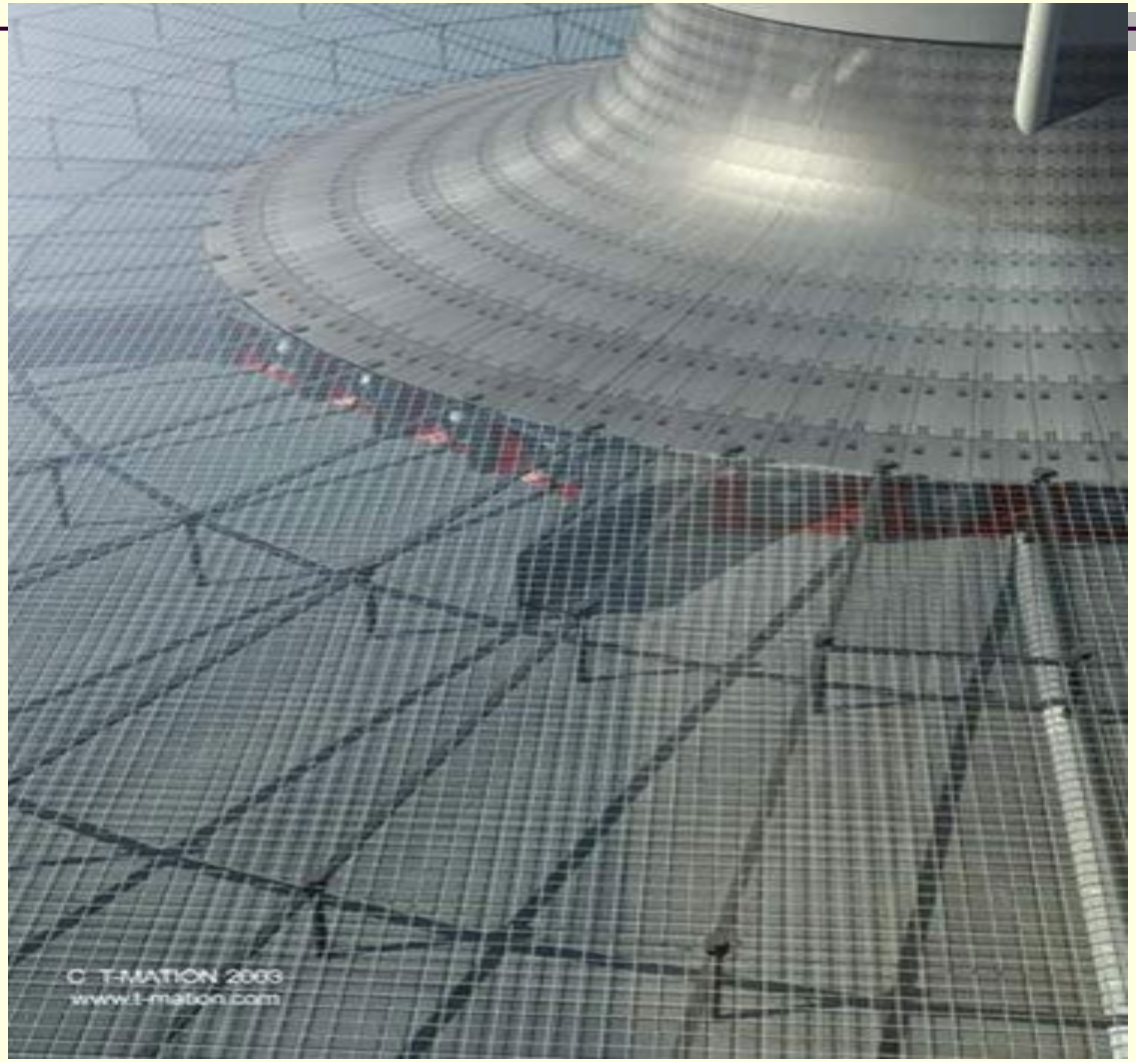
Solar Distiller Technology



Solar Chimney

- Ambient air collected within the chimney rises as it is heated though solar radiation and drives the turbine and that generates electricity.
- Base captures heat through absorption of a black surface and trapped by a greenhouse interface
- Very inexpensive solar collector technology

Solar Chimney



Solar Water Heater - Overview

- A solar water heater concentrates solar energy over a time gradient
- Common usage ranges from pool heaters to hot water for showering and domestic use
- The most popular solar collector
- Heavily used in Florida until World War 2 increased the demand for copper

Solar Water Heater - Components

- Conductive thermal collectors (painted black to aide absorption)
- Transparent cover to capture solar radiation
- Pipes for water flow
- Insulation
- Water body

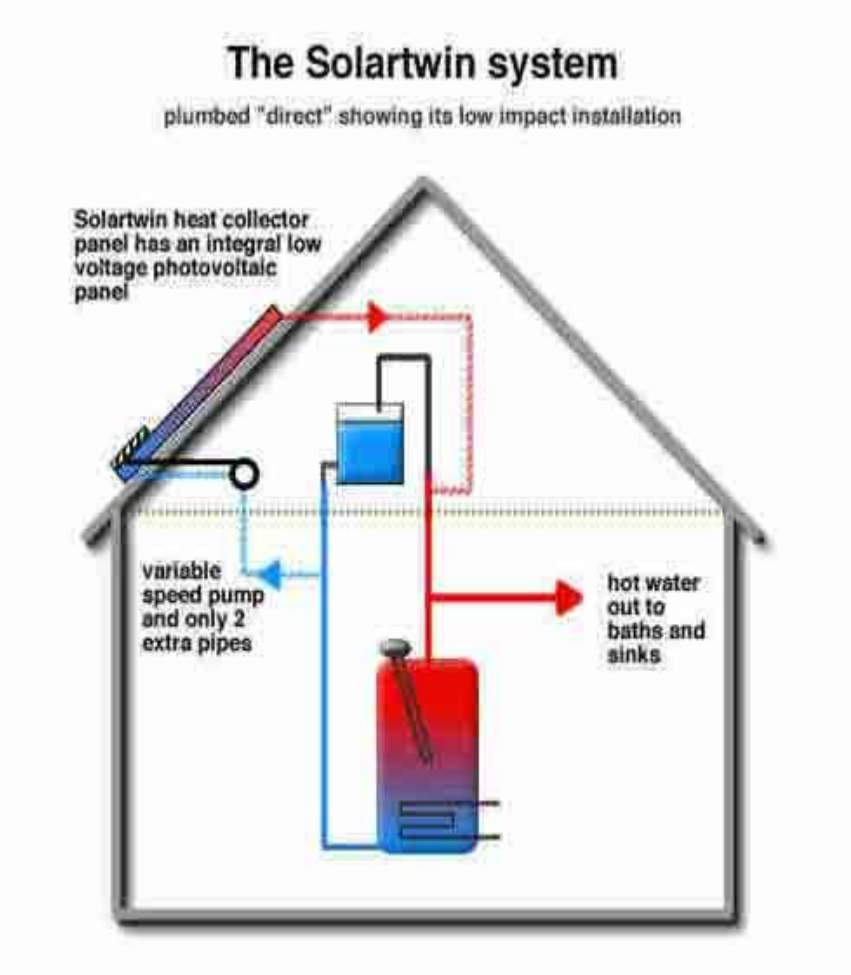
Solar Water Heater - Passive Design

- Passive design uses thermal convection to circulate heat in the water system
- The water body needs to be above the solar collector
- As water heats up it rises into the water body pushing cold water down

Passive Solar Water Design

Solar Water Heater - Active Design

- Uses pumps to circulate hot water
- Spends electricity lowering the energy savings



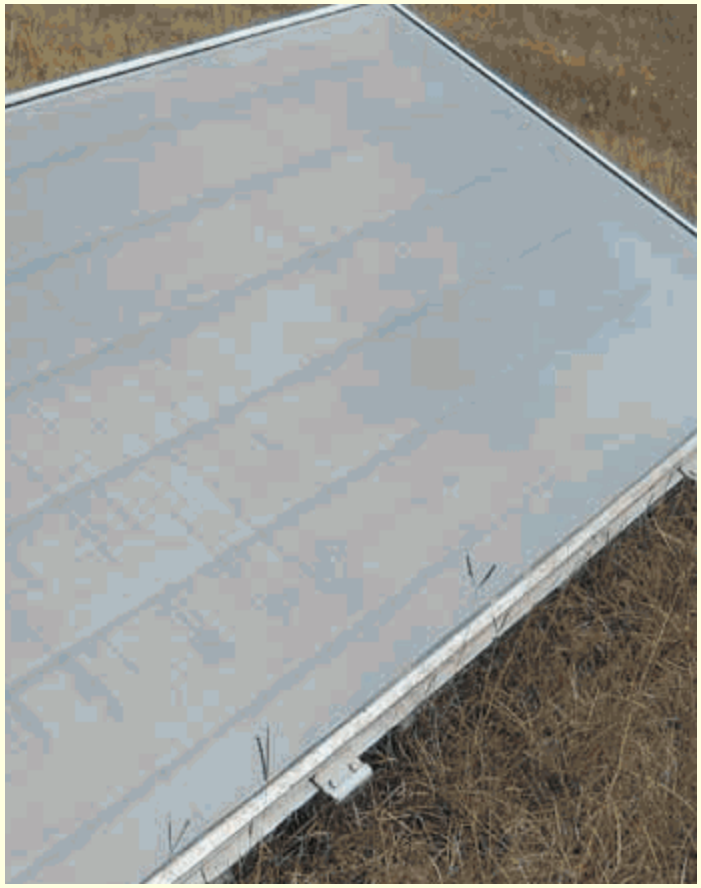
UF Intern Solar Water Heater

- Two used Solar Water Heaters came from Energy Conservation Systems (ECS) in Gainesville, Fl
- Scott Davies from ECS came in to explain solar water heater technology
- Solar Water Heater repair and testing was a hands on intern activity

Interns Learning and Working

Solar Water Heater Activities

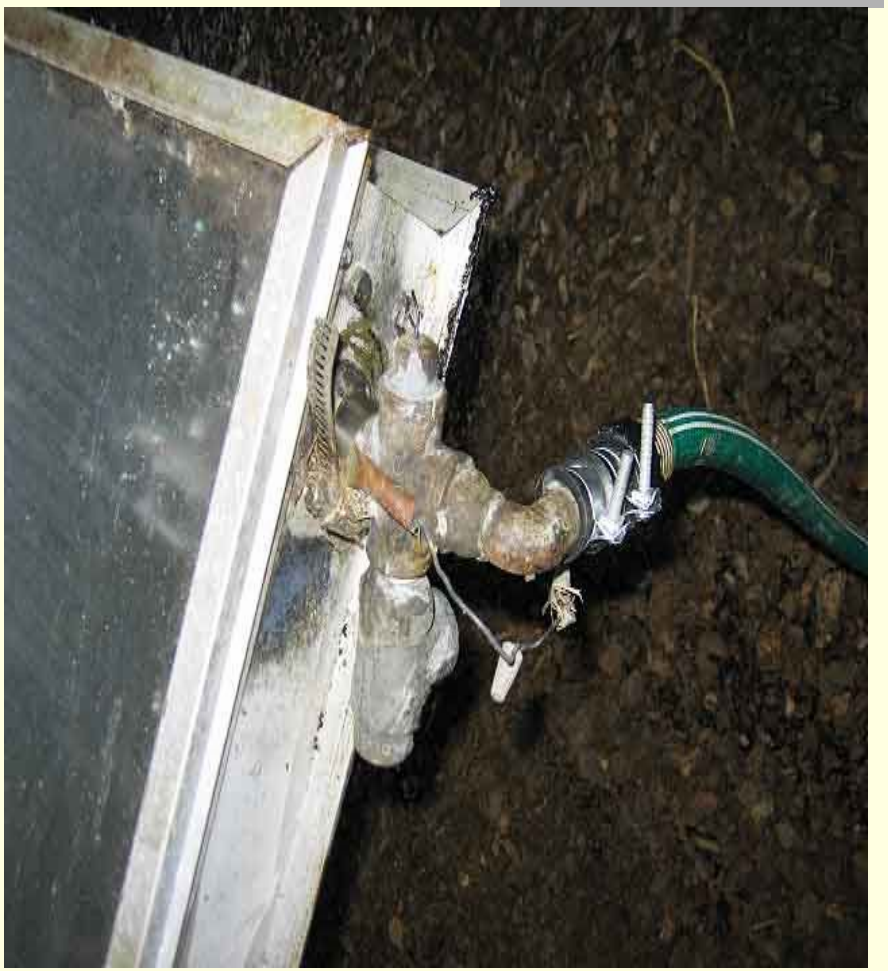
- Disassembly
- Testing
- Repair and cleaning
- Reassembly
- Application



Disassembly and Testing

- The panel cover and casing was removed to access the copper piping and aluminum thermal collectors, insulation was easily visible as well
- Testing was done by attaching a pressure gauge to the Solar Water Heater and applying pressure at 45 psi for 2 hours
- Any leaks would cause a decrease in pressure, no leaks were found

Disassembly and Testing



Disassembly and Testing

Repair, Cleaning, and Reassembly

- The covering was cleaned and paint scraped or dissolved off
- The thermal collectors were given a fresh new coat of car engine black spray paint
- The Solar Water Heater was reassembled and propped up on a pallet

Cleaning Cover

Reassembly

Application

- In a household heating and cooling costs are among the most energy intensive domestic activities
- A Solar Water Heater can replace the costs of heating water for either a pool or hygienic uses
- To demonstrate the ability of a solar water heater to offset domestic uses Interns will set up a solar water shower and hot tub

Solar Water Heater Reservoir

Application

- The second Solar Water Heater can be used to provide heating for another internship activity
- Heating can be provided to a bioenergy activity to increase efficiency of process or make the process more energy independent

Applying Solar Water Heating

- The solar collector should be placed facing South and at an angle equal to that of the latitude
- For increased efficiency angle should be increase by 15 degrees during the winter season and decreased by 15 degrees in the summer
- This makes the angle to the sun closest to 90 degrees during seasonal changes

The End