Technology Overview

Today, the process of converting sunlight to electricity is primarily accomplished using concentrating solar thermal and photovoltaic technologies. This section presents a broad overview of these technologies and resources for understanding them.

A. Solar Thermal Technology

Concentrating solar power (CSP) plants use mirrors or lenses to concentrate the energy from the sun, creating high enough temperatures to drive traditional steam turbines or engines that create electricity. The most cost-effective size of CSP plants is hundreds of megawatts (MW). This technology is as ancient as the skaphia used to concentrate the sun's rays to ignite the Olympic torch.

General Solar Thermal Technology Links

NREL CSP Overview: http://www.nrel.gov/learning/re_csp.html
Solar Energy Industry Association CSP Fact Sheet: http://seia.org/galleries/pdf/factsheet_csp.pdf
Sandia National Laboratory CSP overview: http://www.sandia.gov/csp/cspoverview.html

1. Parabolic Trough Technology

Parabolic trough systems use curved mirrors to focus the sun's energy onto a receiver tube that runs down the center of a trough. In the receiver tube, a high-temperature heat transfer fluid (e.g., synthetic oil) absorbs the sun's energy, reaching temperatures of around 700° F, and passes through a heat exchanger to heat water and produce steam. The steam drives a conventional Rankine cycle steam turbine power system to generate electricity.

Parabolic Trough Technology Links

Troughnet, NREL Parabolic Trough Solar Power Network: http://www.nrel.gov/csp/troughnet/

2. Power Tower Technology

Seeking higher operating temperatures for greater efficiencies, other plant designers opt for a central receiver system. Computer-controlled flat mirrors (called heliostats) track the sun along two axes and focus solar energy on a receiver at the top of a high tower. The focused energy is used to heat a transfer fluid (800° F to 1,000° F) to produce steam and run a central power generator. Other advanced designs are experimenting with molten nitrate salt for its superior heat-transfer and energy-storage capabilities.

Power Tower Technology Links

Additional links to be provided after the forum.

B. Photovoltaic Technology

Photovoltaic (PV) technologies directly convert energy from sunlight into electricity. Sunlight strikes the semiconductor material and releases electrons from their atomic bonds, producing an electric current.

Traditionally, PV cells are made using various forms of silicon (Si), but recently some companies have commercialized thin film technologies composed of other semiconductors. Thin film technologies show promise of lower cost, and the potential for great efficiency, but are currently less efficient than crystalline silicon solar cells.

General Photovoltaic Technology Links

NREL PV Overview: http://www.nrel.gov/learning/re_photovoltaics.html
Solar Energy Industry Association PV Fact Sheet:
http://www.seia.org/galleries/pdf/SEIA_PV_Factsheet.pdf

1. Crystalline/Multi-crystalline Silicon (c-Si, poly-Si) Technology

C-Si cells were traditionally manufactured by slicing high- grade silicon into thin wafers. (100 to 300 micrometers thick) Mono-crystalline silicon solar cells offer higher efficiencies but are more expensive to manufacture. Poly-crystalline silicon cells have generally lower efficiencies but are cheaper and easier to manufacture.

Silicon Links

Department of Energy, Energy Efficiency & Renewable Energy, Silicon Technology Overview:
http://www1.eere.energy.gov/solar/silicon.html

2. Thin Film Technology

These cells are manufactured by applying very thin layers of semiconductor material (one to 10 micrometers thick) to inexpensive materials such as glass, plastic or metal. Thin-film semiconductors absorb light more easily than c-Si, so they require less semiconductor material but tend to be less efficient at energy conversion. They are also much simpler and less costly to manufacture.

Thin Film Links

Department of Energy, Energy Efficiency & Renewable Energy, Thin Film Technology Overview:
http://www1.eere.energy.gov/solar/tf_polycrystalline.html