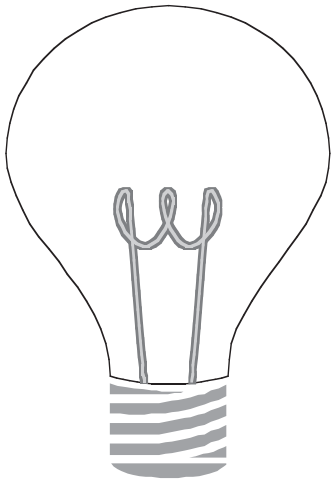
Solar Power on Earth

Current Electric Energy Production



• Present demand for electric power is rising. Current estimates suggest that demand for electricity could increase by 90% over the next two decades, well beyond the capacity of existing power plants. The U.S. consumes 27% of total world electricity production.

• Market price paid for electric power per kilowatt hour is about 7¢. Production is from: fossil fuels, 62%; solar, under 2%; and other renewables (primarily hydroelectric) are under 20%. Electricity produced by solar energy costs over 10¢ per kilowatt hour but is cost competive for remote locations, mobile devices (e.g. portable highway signs) and low power consumer electronics.

Sunlight into Electricity

Using photovoltaic cells to convert sunlight into electricity requires no fuel and creates no greenhouse gasses or radioactivity. Photovoltaic cells are made of layers of semiconductors (the same materials as used for computer chips). Manufacturing solar cells does produce some pollution, though. There are several types of photovoltaic cells.

• **Amorphous / Thin film.** Thin film cells are thin layers of semiconductor material deposited on a transparent nonconducting material such as glass. Such cells are inexpensive to produce but deliver only tiny amounts of electric current. They are mainly used for calculators and other consumer goods with low power requirements.

• **Single-crystal silicon.** These are the traditional solar cells and are expensive to produce. They can still be competitive where an array of cells must be small such as on a satellite or a portable power supply.

• **Polycrystalline silicon.** These are a newer type of cell which promise to be less expensive. Though less efficient than single-crystal silicon, they may become the "workhorse" cell for many applications.

• **Gallium Arsenide.** Such cells are the most efficient type of solar cell (up to 27.3%), but they are very expensive to produce. These cells are desirable where an array of cells must be small such as on a satellite but where power requirements are greater than single-crystal silicon cells can produce and where resistance to radiation is desirable.

Other Solar Energy Production and Utilization

• **Dynamic.** These are systems where reflectors use heat to cause mechanical motion. There is a large dynamic system at Barstow, California comprised of many mirroring focusing sunlight upon a liquid sodium heat engine.

• **Passive heating, skylites.** Both old and new solar technology is also used to heat and light homes.

• **Agriculture/Aquaculture.** Sunlight is used to grow plants for food, energy and O_2/CO_2 control.

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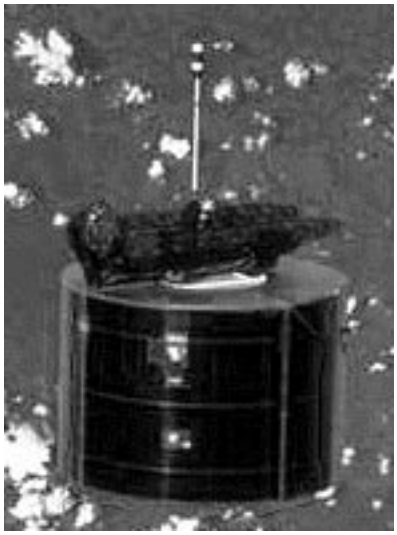
Solar Power from Space

Solar power is commonly used in space to power both satellites and space stations such as Mir (and formerly Skylab). Large orbiting solar power satellites (SPS) have been proposed to collect sunlight and beam its energy to the Earth to provide electricity for people on Earth. With growing concern over a possible "greenhouse" effect produced by burning fossil fules on Earth, there has been renewed interest in SPS as a source of "clean" electric power.



Existing Space Power Systems

• Satellite power systems. Most satellites are powered by photovoltaic (PV) "solar" cells which directly convert light into electricity. Power levels range from a few watts to a few kilowatts.

• Skylab. The first U.S. space-station, Skylab was powered at a level of about 20 kilowatts by one large and four small panels of PV cells.

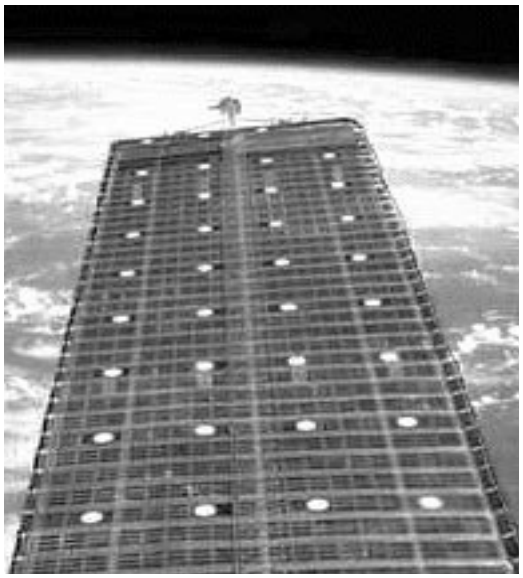
• ISS system. When completed, the International Space Station will have a 105 kilowatt power system comprised of 28 PV arrays.

Demonstrations and Prototypes

• Wireless Power Transmission.

SPS systems require a way to move power from space to the Earth. Unlike the case of the local coal-burning electric plant, you can't have a wire running from space to your house! In 1993 ISYMETS (Japan) transmitted a 832 watt microwave beam between two spacecraft.

• Dynamic Reflector System Similar to terrestrial solar dynamic systems in which a solar collector heats a mechanical engine which generates electricity. NASA performed a successful ground test of a system.



Proposed Large Systems

All of these systems collect solar energy in space and transmit it via a microwave energy beam to an Earth-based rectenna which converts the beam's energy to electricity for use on Earth. Some SPS systems may eventually be built from materials from asteroids and the Moon.

• Reference System. (1979) Large arrays of PV cells in low-Earth orbit (LEO) for 5 to 10 Giga Watts (GW) of power.

• Solar Discs. A large disc covered with thin film PV material in geosynchronous Earth orbit (GEO) for 1 to 10 GW.

• Sun Tower. Reflectors with an advanced PV focus along a tether in sunsynchronous orbit (1000 km) for 0.25 GW.

• Empowerment. 12 dynamic reflectors (see Dynamic Reflector System above) on a truss for 0.0003 GW (300 kW).

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