Solar Cells: Applications

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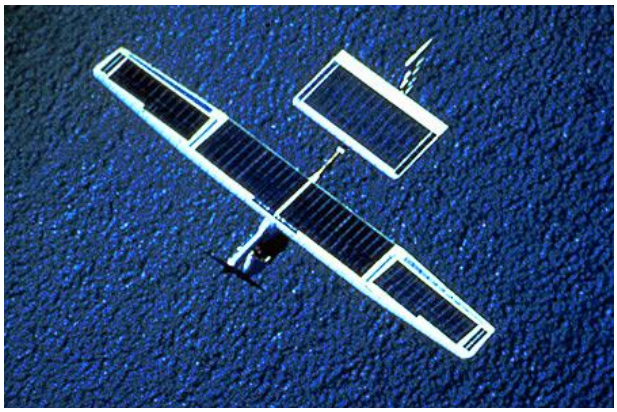
Solar cells found use in the sky and on the road

The 1970's saw a large growth in applications of solar energy but the 80's brought about another change with solar energy -vehicles. Believe it or not, it wasn't an automobile that was the first solar powered vehicle, but an airplane! In 1981 Paul MacCready built the Solar Challenger **(Figure a)**, the first solar powered aircraft. This aircraft was flown from France to England across the English Channel a distance of 163 miles. The plane soared at 11,000 ft at a top speed of only 40 miles per hour and stayed in the air a total of 5 hours and 23 minutes. The wings contained more than 16,000 solar cells which powered a pair of motors. This airplane was an advancement of MacCready's prototype plane, the Gossamer Penguin **(Figure b)**. This prototype only had 3,920 solar cells and its public demonstration with NASA only flew for about 2 miles.



Caption: An aerial view of the Solar Challenger.
Source: https://www.nasa.gov/centers/armstrong/news/FactSheets/FS-054-DFRC.html

Caption: The Gossamer Penguin.
Source: https://www.nasa.gov/centers/armstrong/news/FactSheets/FS-054-DFRC.html

It was the very next year that the solar cells found their way onto a vehicle. Hans Tholstrup drove the first solar powered car in Australia for 2800 miles! Tholstrup drove his car, "The Quiet Achiever" **(Figure c)** or as some called it 'The Bathtub on Wheels", from Sydney to Perth in 20 days. Though this was only an average of 140 miles per day, it was actually 10 days faster then what it took the first gasoline automobile to drive this distance. Tholstrup is also credited with the creation of the first international solar race in 1987 called the "Solar Challenge" which still runs today. Also in this year, Volkswagon started experimenting with solar panels on one of their vehicles -the Dasher station wagon. Solar arrays on the vehicle provided 160 Watts to help with the ignition system and reduce fuel usage

Caption (c): The *Quiet Achiever* on the road.
Source: https://en.wikipedia.org/wiki/The_Quiet_Achiever

Is this the world's biggest solar cooker?

This solar furnace **(Figure)** is eight stories tall and contains 10,000 mirrors which form one very large concave mirror. It is not the type of furnace like the one you may have in your home to help keep you warm, at least not in that same way. This concave mirror focuses the sunlight onto an area that is only the size of about a cooking pot. This "cooking pot" gets upwards to a temperature of about 5400^{o} Fahrenheit. This can be used to boil away water into steam which is used in a process called electromagnetic induction (described later).

Caption: Solar furnace in France.
Source: https://en.wikipedia.org/wiki/Odeillo_solar_furnace

Solar power plants generate on large scales

The 1980's brought not only solar powered vehicles, but different types of solar power plants. For example, in Barstow California, Solar One was built in 1982 **(Figure a)**. This was a 10 megawatt power tower system designed to show the feasibility of solar power generation on a large scale. The plant works in a similar fashion to the solar furnace described earlier. Solar One operated until 1986 and was then redesigned and renamed Solar Two. Solar One used 1,818 mirrors to concentrate the sun's rays into a focal point which was a central tower. A high temperature transfer fluid was used to bring the thermal energy to the boiler on the ground which was used to create steam which then turned the turbines which created electricity. Most of our modern day power plants use this same technology.

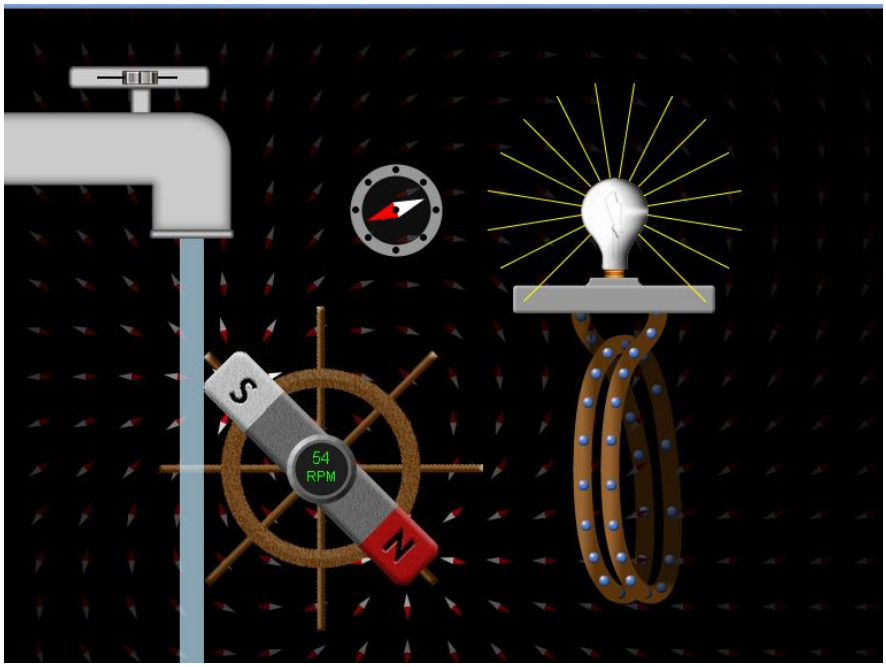
Caption: An aerial view of Solar One.
Source: http://americanhistory.si.edu/powering/images/bigsolr1.jpg

The largest facility built during the 1980s was built in 1986 and remains the world's largest facility to date. This solar thermal facility was built in Kramer Junction California (which is part of a larger group of facilities) and is still in use today **(Figure b)**. Currently, there are 936,384 mirrors which if lined up would be 229 miles long. The facility covers a total of 1600 acres. This system is different by similar to Solar One. Each mirror is a parabolic mirror that focuses the sun's rays onto a tube filled with synthetic oil that can be heated up to 400^{o} C (750^{o} F). This oil transfers its thermal energy to water, which causes it to boil and evaporate, thus spinning the turbines which creates electricity. NextEra, the group running this plant claims that they provide power to 232,500 homes every year. This much electricity, in turn reduces 3800 tons of pollution that would have been created each year had these homes been powered by other fossil fuels such as oil.

Caption (b): A ground-level view of a solar collector at Kramer Junction.
Source: https://en.wikipedia.org/wiki/Solar_Energy_Generating_Systems

Electromagnetic induction – how we get electricity

To better understand how these plants work, we need to take a step back and understand an important principle in Physics: electromagnetic induction. An interesting phenomenon is that if you have an electrical current, this will create a magnetic field. If you hook up a wire to a battery and then place a compass above and below that wire, you will see that the compass will switch directions. The reverse is also true. If you have a magnetic field in a coil of wires, and you change that field in any way, that changing field will create a current. This is how a turbine (sometimes referred to as an electrical generator) works. To further help with this, look at **(Figure)**:



Caption: Electromagnetic induction.
Source: https://phet.colorado.edu/en/simulations/category/physics/work-energy-and-power

The first step is that you need to have something turn the magnet. This can be steam created from boiling water at solar power plants, falling water from a dam, or a windmill. The spinning magnet changes the direction of the magnetic field. Surrounding the magnet you have coils of copper wire where the current gets created. The magnetic field is changing inside the coils, which is why the current gets created. This current can then light up the light bulb.