SOLAR ELECTRICITY

A PRIMER FOR KIDS

Using sunlight to make electricity

by
Eric Golanty

Images courtesy of the
National Renewable Energy Laboratory
except where otherwise noted.

Project Web site: http://www.ergo84.com/solar.htm

SOLAR ELECTRICITY: A PRIMER FOR KIDS

Using sunlight to make electricity

People started using electricity to power their homes, schools, stores, movies, factories, and just about everything else about 120 years ago. During that period of time, nearly all the world's electricity was made from burning fossil fuels: coal, oil, and natural gas. (They are called "fossil fuels" because they were created over millions of years from forests buried deep in the ground , not from fossils).

Getting electricity from burning fossil fuels has benefitted people tremendously. But, we now know that doing so has caused pollution and Earth's climate to change. So, it's time to find and use nonpolluting ways to generate electricity, including sunlight.

I made this booklet to accompany a presentation I gave on solar electricity to a third grade class. I hope others find it useful.

~Eric Golanty, Ph.D.

Contents

Page 1 What is Electricity?
Page 2 How Electricity Gets to a Building
Page 3 What Does Solar Mean?
Page 4 Using Sunlight to Make Electricity
Page 5 How a Solar Cell Works
Page 6 Solar Modules and Solar Panels
Page 7 Where are Solar Panels Put?
Page 8 Using the Sun's Heat to Make Electricity
Page 9 The Steam_Turbine Generator
Page 10 Solar Thermal Power Plant
Page 11 Why is Solar Electricity Important? Less Pollution
Page 12 Why is Solar Electricity Important? Less Global Warming!
Page 13 Web Resources: Electricity; Energy Transmission
Page 14 Web Resources: Sunlight; Photovoltaics
Page 15 Web Resources: Solar Cells; Solar Modules and Solar Panels
Page 16 Web Resources: Solar Thermal Energy; Electricity Generation
Page 17 Web Resources: Magnets and Electricity; Solar Thermal Power Plants
Page 18 Web Resources: Air Pollution; Global Warming

What is Electricity?

Electricity is a kind of energy that makes lights, refrigerators, factory machines, televisions, satellites in space, and some cars work.

` The energy in electricity comes from tiny particles called electrons. You can't see an electron. It's too small. It would take 10 million electrons lying side-by-side in a straight line to cover the tip of a sharpened pencil.

How Electricity Gets to Buildings

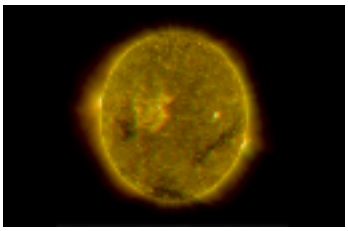
Electricity gets into buildings through special wires that start at a large power plant where electricity is made.

The electricity moves through wires from the power plant to your house, school, or other buildings.

Wires inside a building's walls connect to wall plugs and ceiling lights.

What Does Solar Mean?

Solar* is a Latin language word that means *from the sun.



3D image of the sun courtesy of NASA

Sunlight is made up of teeny, tiny energy packets called *photons*. Sunlight travels very fast: 186,000 miles per second.

The sun is 93 million miles from Earth. It takes a photon 8.33 minutes to get from the sun to Earth. Here's the calculation:

- **We know that the distance between the sun and the earth is 93,000,000 miles.**
- **We know that photons (packets of light) travel at 186,000 miles per second.**
- **Moving at 186,000 miles per second, to go 93,000,000 miles, we divide 93,000,000 miles by 186,000 miles/sec = 500 seconds**
- **To calculate the time in minutes we divide 500 seconds by 60 seconds in a minute = 8.333 minutes.**

Photons colliding with things makes them visible and sometimes warmer. The sun provides light and heat.

Using the Sunlight to Make Electricity

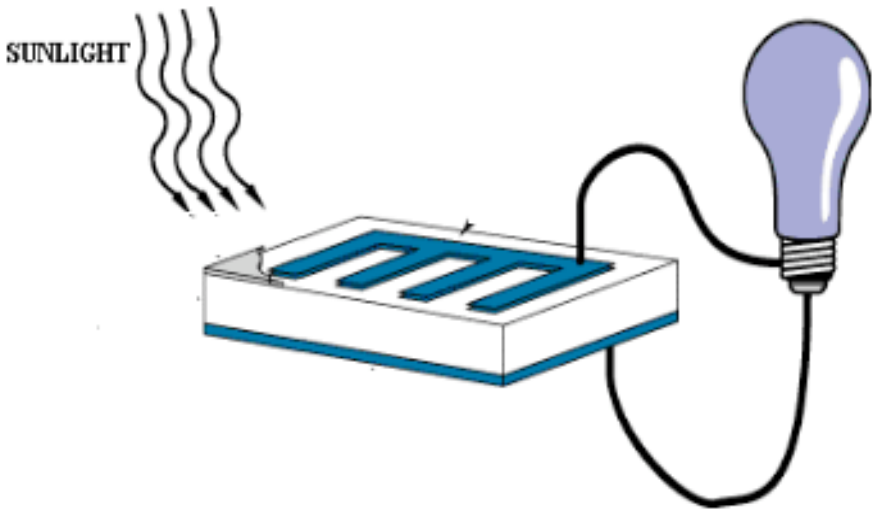
Photovoltaic
***photo* means light**
***voltaic* means electricity**

To get electricity from the sun's light, you need a special box called a *solar cell*.

A Solar Cell

How A Solar Cell Works

A solar cell has crystals inside. When light shines on a solar cell, the crystals get energized, which makes electricity. The electricity in the crystals goes into a wire that carries it to a light or anything else powered with electricity, or to a battery for storage.



Solar Modules and Solar Panels

Connecting solar cells together makes a *solar module.*

Connecting solar modules together makes a *solar panel.*

Where Solar Panels Can Be Put

On houses and other buildings

On the ground ("solar farms")

Over parking lots

Solar Thermal Electricity

Solar Thermal

solar **means from the sun**
thermal **means heat**

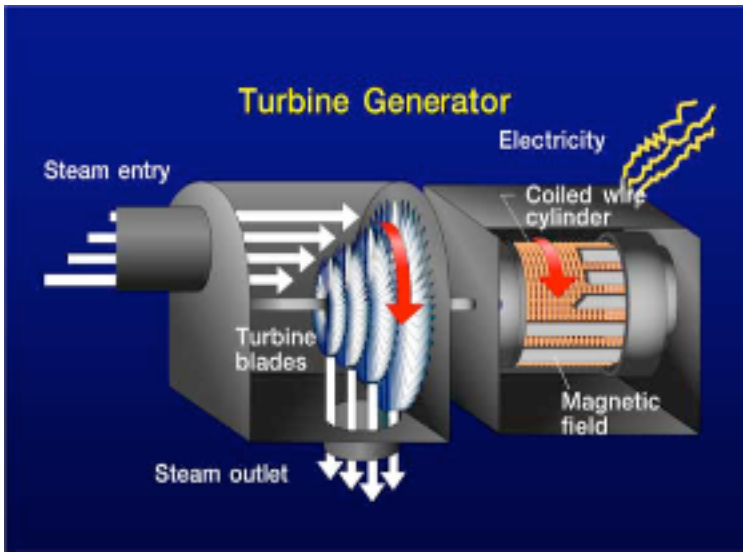
Sunlight shining on something can warm it, like the ground getting hot on a sunny day.

One way to make steam with sunlight is to arrange many mirrors to aim sunlight at a water tower. The sunlight heats the water in the tower and turns it to steam. The steam drives a generator (see page 9) to make electricity.

Solar thermal electricity is made where there is lots of sun, like in a desert, and where there is space for the mirrors.

The Steam Turbine-Generator

Making electricity from steam requires a machine called a turbine-generator. The turbine part has blades that turn when steam whooshes against them, like a windmill in the wind.



The generator part consists of a coil of copper wire surrounded by a large magnet. The coil of copper wire is connected to the turbine blades, so when the blades turn the coil turns and makes electricity. The coil of copper wire is connected to different wires that carry the electricity to where it can be used or stored.

Solar Thermal Electricity Power Plant

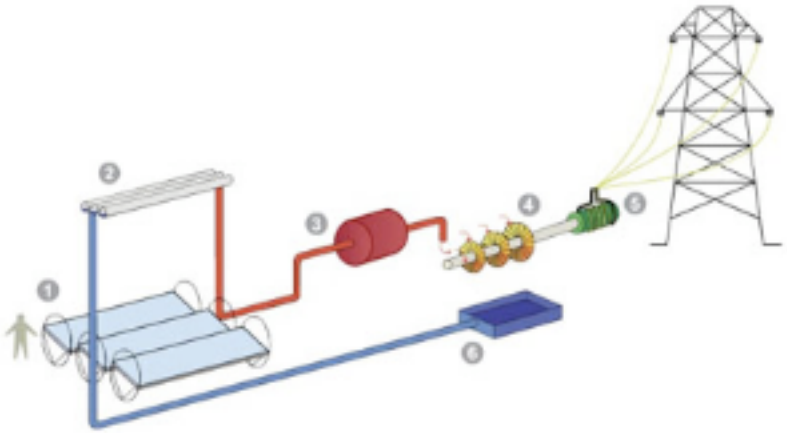


Diagram courtesy of Ausra

1. Mirrors that rotate track the sun to capture the most sunlight
2. Water pipes that carry water to be heated into steam by sunlight
3. Steam pipe and steam tank
4. Blades of a steam turbine-generator
5. Turning magnet and copper coils to make electricity, which goes to the transmission lines to houses, schools, and other things that use electricity.
6. Source of cold water

Why Solar Electricity is Important

Less pollution!

Right now, most electricity comes from large power plants that burn coal, oil, and natural gas to make steam to drive generators. Burning coal, oil, and natural gas causes pollution. Solar electricity does not pollute.

Why Solar Electricity is Important

No global warming!

Burning coal, oil, and natural gas to make electricity releases millions of tons of carbon dioxide gas into the air. This gas traps heat, causing Earth's temperature to increase. Solar electricity produces no carbon dioxide and no global warming. Solar electricity is good for us and the planet.

Image courtesy of NASA

Web Resources

Links @ http://www.ergo84.solarhm.htm

Electricity

Benjamin Franklin and Electricity...the story of Ben F.'s experiments with flying kites and lightning (http://sln.fi.edu/franklin/scientst/electric.html).

Thomas Edison Biography...the story of the man who invented the light bulb (http://www.nps.gov/archive/edis/edisonia/tae_bio.html).

The Science of Electricity...the U.S. Energy Information Administration explains electrons, atoms, magnets, electricity, electric circuits, and electricity generation (http://www.eia.doe.gov/kids/energyfacts/sources/electricity.html).

The History of Electricity in America...brom 600 B.C. E. to the present, from the Tennessee Valley Authority (http://www.tvakids.com/electricity/history.htm).

Electricity Timeline... from the U.S. Energy Information Administration (http://www.eia.doe.gov/kids/history/timelines/electricity.html).

Electricity Transmission

How Electricity Gets to You...from the Tennessee Valley Authority http://www.tvakids.com/electricity/transmission.htm.

Energy Transmission System...from the State of California's Energy Story (http://www.energyquest.ca.gov/story/chapter07.html).

Electric Power Transmission...Wikipedia explains (http://en.wikipedia.org/wiki/Electric_power_transmission).

How Power Grids Work...how electricity gets to you from the power plant (videos included) (http://www.howstuffworks.com/power.htm).

Nikola Tesla's Biography...the man who invented alternating current, which allows electricity to be transmitted over power lines (http://www.teslasociety.com/biography.htm).

Web Resources

Links @ http://www.ergo84.solarhm.htm

Sunlight

Light...Physics4Kids explains light (http://www.physics4kids.com/files/light_intro.html).

Sunlight and Solar Energy...from Science Kids at Home (http://www.sciencekidsathome.com/science_topics/sunlight_a.html#more).

The Basics of Light...advanced discussion from the Physics and Astronomy Department at Johns Hopkins University http://fuse.pha.jhu.edu/~wpb/spectroscopy/basics.html).

Solar Heat...getting heat from sunlight, from Re-energy.ca (http://www.re-energy.ca/t-i_solarheat.shtml).

Photovoltaics

Photovoltaics...explained by the U.S. Department of Energy (http://www1.eere.energy.gov/solar/photovoltaics.html).

How Photovoltaics Work...video from SolarSchools.com (http://www.solarschools.com/videos/howpvworks.asx).

How Solar Cells Work (http://www.howstuffworks.com/solar-cell.htm).

The Photoelectric Effect...the physics of how solar cells work, from the U.S. Department of Energy (http://www1.eere.energy.gov/solar/photoelectric_effect.html).

Solar Electricity Basics...from the Florida Solar Energy Center at the University of Central Florida (http://www.fsec.ucf.edu/en/consumer/solar_electricity/basics/index.htm).

Photovoltaics...described by the National Renewable Energy Laboratory (http://www.nrel.gov/learning/re_photovoltaics.html).

How Do Voltaics Work?...Science@NASA offers a thorough explanation (http://science.nasa.gov/headlines/y2002/solarcells.htm).

Web Resources

Links @ http://www.ergo84.solarhm.htm

Solar Cells

Types of Solar Cells...described by The U.S. Department of Energy (http://www.energysavers.gov/your_home/electricity/index.cfm/mytopic=10791).

Solar Cell Materials...The U.S. Department of Energy explains what solar cells are made of http://www1.eere.energy.gov/solar/solar_cell_materials.html).

Solar Cell Structures...The U.S. Department of Energy explains the four basic designs for solar cells (http://www1.eere.energy.gov/solar/solar_cell_structures.html).

Thin Film Solar Cells...from How Stuff Works (http://science.howstuffworks.com/thin-film-solar-cell1.htm).

The World's Most Efficient Solar Cell (http://apps1.eere.energy.gov/news/news_detail.cfm/news_id=11936).

Using Regular Windows as Solar Cells...from the Massachusetts Institute of Technology (http://web.mit.edu/newsoffice/2008/solarcells-0710.html).

Solar Modules and Solar Panels

How Solar Moduels are Made...Discovery Channel video on YouTube (http://www.youtube.com/watch?v=qYeynLy6pj8).

Certified Solar Modules...by the Florida Solar Energy Center in accordance with a standardized review process (http://www.fsec.ucf.edu/en/industry/testing/PVmodules/pv_flashtest_list.htm).

Solar Cell Structures...The U.S. Department of Energy explains the four basic designs for solar cells (http://www1.eere.energy.gov/solar/solar_cell_structures.html).

Thin Film Solar Cells...from How Stuff Works (http://science.howstuffworks.com/thin-film-solar-cell1.htm).

The World's Most Efficient Solar Cell (http://apps1.eere.energy.gov/news/news_detail.cfm/news_id=11936.

Using Regular Windows as Solar Cells...from the Massachusetts Institute of Technology (http://web.mit.edu/newsoffice/2008/solarcells-0710.html).

Web Resources

Links @ http://www.ergo84.solarhm.htm

Solar Thermal Energy

Solar Thermal Energy Development...a video (http://www.youtube.com/watch?v=OZ7uTu6PRD4).

The World's 13 Biggest Solar Thermal Energy Projects (http://ecoworldly.com/2008/04/12/mega-solar-the-worlds-13-biggest-solar-thermal-energy-projects/).

Solar Thermal Energy Initiative...explains solar thermal energy and updates developments (http://www.solarthermalenergy.com/).

Global Solar Thermal Energy Council...international solar thermal news and developments (http://www.solarthermalworld.org/).

Solar Thermal Energy Plants (http://www.worldofsolarthermal.com/vbnews.php?do=viewarticle&artid=14&title=solar-thermal-plants).

Electricity Generation

Electricity Generation...a description from The Energy Forum (http://www.electricityforum.com/electricity-generation.html).

How An Electric Generator Works...descrption and animation from Wisconsin Valley Improvement Company (http://new.wvic.com/index.php?option=com_content&task=view&id=9&Itemid=46).

Generators...from HowStuffWorks (http://science.howstuffworks.com/electricity2.htm).

Steam Turbine Generator Animation (http://www.cf.missouri.edu/energy/em_fun/animations/turbine.html).

Web Resources

Links @ http://www.ergo84.solarhm.htm

Magnets and Electricity

Pioneers of Electricity and Magnetism...biographies from the Magnet Lab at Florida State University (http://www.magnet.fsu.edu/education/tutorials/pioneers/).

Faraday's Law of Magnetic Induction...Physics4Kids explains how electricity can be produced with a magnet (http://www.physics4kids.com/files/elec_faraday.html).

Michael Faraday, His Life and Work...an online exhibition of the life of the scientist whose discoveries led to understanding electricity and magnetism (http://www.theiet.org/about/libarc/archives/exhibition/faraday/index.cfm).

Solar Thermal Power Plants

CSP- How It Works...solar thermal power, also called *concentrating solar power*, or CSP, is explained by SolarPACES (http://www.solarpaces.org/CSP_Technology/csp_technology.htm).

The Rise of Solar Thermal Power...a report from the American Society of Landscape Architects (http://dirt.asla.org/2009/06/08/the-rise-of-solar-thermal-power/).

Solar Thermal Technology...a description of solar thermal projects around the world, from Economist.com (http://www.economist.com/sciencetechnology/tq/displayStory.cfm?story_id=13725855)

Turning Glare Into Watts...*New York Times* article about solar thermal power (http://www.nytimes.com/2008/03/06/business/06solar.html).

Wikipedia's list of Solar Thermal Power Plants in the world (http://en.wikipedia.org/wiki/List_of_solar_thermal_power_stations).

Web Resources

Links @ http://www.ergo84.solarhm.htm

Air Pollution

How Does Electricity Generation Affect the Environment?...The Environmental Protection Agency answers the question for each of these power-producing technologies: Natural Gas, Coal, Oil, Nuclear Energy, Municipal Solid Waste, Hydroelectricity, Non-Hydroelectric Renewable Energy (http://epa.gov/cleanenergy/energy-and-you/affect/index.html).

How Clean Is the Energy I Use?...use the Environmental Protection Agency's *Power Profiler* to find out (http://epa.gov/cleanenergy/energy-and-you/how-clean.html).

AIRNOW...find out your location's current and future air quality, from the Environmental Protection Agency (http://www.airnow.gov/).

Pollution Sources: Electricity Generation...described by Environment Canada (http://www.ec.gc.ca/cleanair-airpur/Electricity_Generation-WSDC4D330A-1_En.htm).

Air Pollution and Health....from the American Academy of Family Physicians (http://familydoctor.org/online/famdocen/home/common/asthma/triggers/085.html).

Global Warming

Climate Change Kids Site...The Environmental Protection Agency's explains global warming and climate change (http://www.epa.gov/climatechange/kids/).

Global Warming - Kids Page...basic information from the Pew Center on Global Climate Change (http://www.pewclimate.org/global-warming-basics/kidspage.cfm).

Global Warming and Climate Change...Florida Power and Light's semi-animated program on global warming (http://www.fplforkids.com/energyenviro.aspx).