

SOLAR ELECTRICITY

A PRIMER FOR KIDS

Using sunlight to make electricity



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

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

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People started using electricity to power their homes, schools, stores, movies, factories, and much more about 120 years ago. For nearly all that time, the world's electricity has been made from burning coal, oil, and natural gas. These are called "fossil fuels" because, like dinosaur fossils, they are buried in the ground and were created millions of years ago. Unlike dinosaur fossils, however, fossil fuels are derived from ancient forests and not from long-dead animals.

Getting electricity from burning fossil fuels has benefitted people tremendously. We now know, however, that doing so has caused pollution and Earth's climate to change. So, it is time to find and use nonpolluting ways to generate electricity. One of these ways is to use sunlight.

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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 to buildings through special wires. The wires start in a large building, called a power plant, where electricity is made.



Other wires, called transmission lines, carry the electricity from power plants to homes, schools, or other buildings.



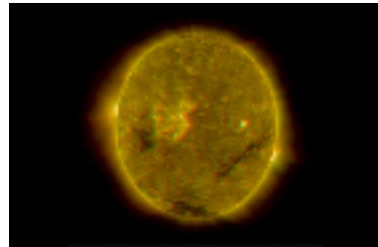
Other wires bring electricity into buildings, and wires inside walls connect to wall plugs and ceiling lights.



What Does Solar Mean?

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

Sunlight is made up of very small energy packets



3D image of the sun courtesy of NASA

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.
- We divide 93,000,000 miles by 186,000 miles/sec = 500 seconds
- 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 Sunlight to Make Electricity

Photovoltaic is a word that describes making electricity from sunlight. *Photo* means light and *voltaic* means electricity.

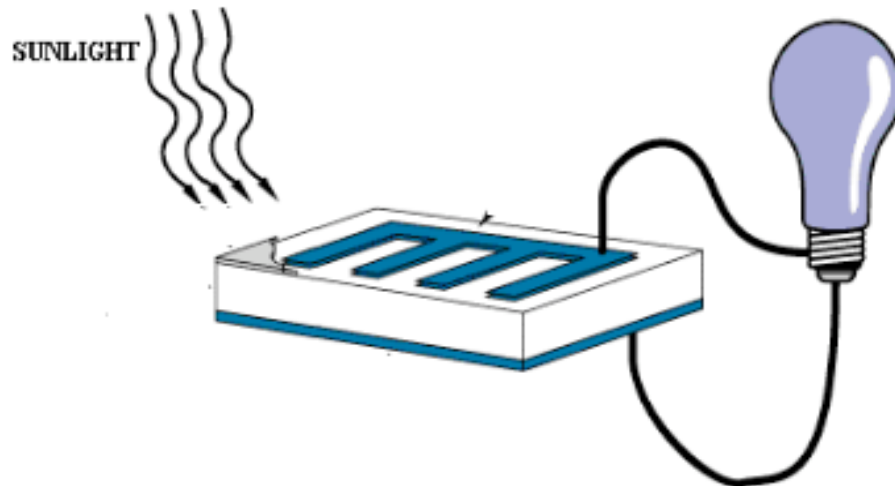
One way to get electricity from the sunlight is to use a special box called a *solar cell*.



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 creates larger amounts of solar electricity.

Connecting
a few solar cells
together makes a
solar module.



Connecting
many solar cells
together makes a
solar panel.



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Where Can Solar Panels Be Put?

On houses and other buildings



**On the ground
("solar farms")**

**Over
parking
lots**



On space satellites



Solar Thermal Electricity

Solar thermal describes using the sun's heat to make electricity. *Solar* means from the sun and *thermal* means heat.

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

One way to use the sun's heat to make electricity is to arrange many mirrors to aim sunlight at a water tower. The sunlight heats water in the tower and turns it to steam. The steam goes into a machine called a turbine-generator that makes electricity (see the next page).



Solar thermal electricity is usually made where there is a lot of sunlight, like in a desert, and where there is space to array many mirrors.

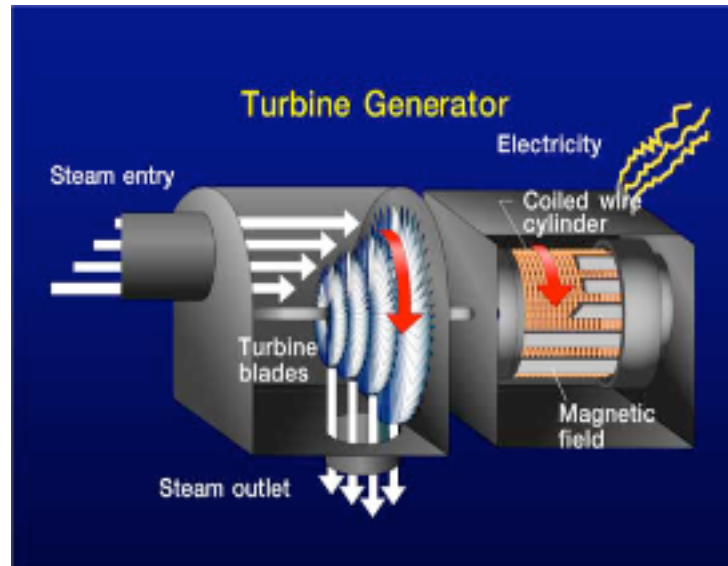
Using Steam to Make Electricity I

Using steam to make electricity requires a machine called a turbine-generator. The turbine part spins when steam whooshes against blades inside it, like a windmill turning in the wind.



Using Steam to Make Electricity II

The generator part of a turbine-generator 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 steam makes the blades turn, the coil of wire also turns. The turning of the coil of copper inside the magnet makes electricity. The coil of copper wire is connected to wires that carry the electricity to where it can be used, transported across wires to buildings, or stored.

Solar Thermal Electric Power Plant

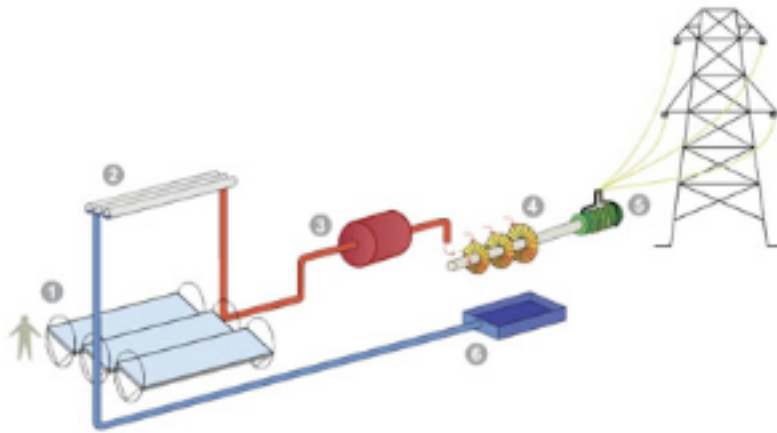


Diagram courtesy of Ausra

Diagram #1: Rotating mirrors move to capture the most sunlight as the sun moves across the sky.

Diagram #2: Pipes carry cold water (see Diagram # 6) to be heated into steam by sunlight.

Diagram #3: The steam goes through a pipe to a storage tank.

Diagram #4: The steam from the storage tank turns a turbine-generator

Diagram #5: The turning of the turbine-generator makes electricity. The electricity goes through wires to houses, schools, and other things that use electricity, or it is stored for later use.

Diagram #6: Source of cold water

Why Is Solar Electricity Important? Less pollution!

Right now, most electricity is made in giant power plants that burn coal, oil, and natural gas to make steam. The steam powers turbine-generators to make electricity. Burning coal, oil, and natural gas causes pollution. Solar electricity does not pollute.



Why Is Solar Electricity 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. This is called *global warming*. Solar electricity produces no carbon dioxide and no global warming. Solar electricity is good for us and the planet.



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Web Resources

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

Electricity

Benjamin Franklin and Electricity...the story of Ben F.'s experiments with 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...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>).

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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.aspx>).

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>).

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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 Modules 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
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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...description 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).

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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).

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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>).