U.S. Department of Energy
Energy Efficiency and Renewable Energy

The History of Solar

Solar technology isn't new. Its history spans from the 7th Century B.C. to today. We started out concentrating the sun's heat with glass and mirrors to light fires. Today, we have everything from solar-powered buildings to solar-powered vehicles.

Here you can learn more about the milestones in the historical development of solar technology, century by century, and year by year. You can also glimpse the future.

Byron Stafford, NREL / PIX10730

Byron Stafford, NREL / PIX05370

This timeline lists the milestones in the historical development of solar technology from the 7th Century B.C. to the 1200s A.D.

7th Century B.C. — 1200s A.D.

Courtesy of New Vision Technologies, Inc./ Images ©2000 NVTech.com

7th Century B.C.

Magnifying glass used to concentrate sun's rays to make fire and to burn ants.

3rd Century B.C.

Greeks and Romans use burning mirrors to light torches for religious purposes.

2nd Century B.C.

As early as 212 BC, the Greek scientist, Archimedes, used the reflective properties of bronze shields to focus sunlight and to set fire to wooden ships from the Roman Empire which were besieging Syracuse. (Although no proof of such a feat exists, the Greek navy recreated the experiment in 1973 and successfully set fire to a wooden boat at a distance of 50 meters.)

20 A.D.

Chinese document use of burning mirrors to light torches for religious purposes.

1st to 4th Century A.D.

The famous Roman bathhouses in the first to fourth centuries A.D. had large south facing windows to let in the sun's warmth. For an example, see information on the http://www.hum.huji.ac.il/archaeology/zippori/RomanSeph.htm Zippori in the Roman Period from the Hebrew University of Jerusalem.

Courtesy of Susan Sczepanski , NREL

6th Century A.D.

Sunrooms on houses and public buildings were so common that the Justinian Code initiated "sun rights" to ensure individual access to the sun.

1200s A.D.

Ancestors of Pueblo people called Anasazi in North America live in south-facing cliff dwellings that capture the winter sun.

The Anasazi cliff dwellings demonstrate passive solar design. (John Thornton, NREL / PIX 03544)

This timeline lists the milestones in the historical development of solar technology from 1767 to 1891.

1767-1891

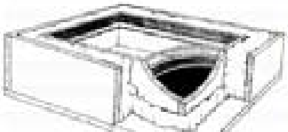


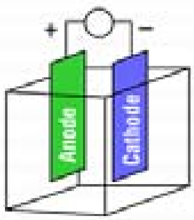
Illustration courtesy of Kevin Porter, Solar Cookers, International

1767

Swiss scientist Horace de Saussure was credited with building the world's first solar collector, later used by Sir John Herschel to cook food during his South Africa expedition in the 1830s. See the Solar Cooking Archive for more information on http://solarcooking.org/saussure.htm Sassure and His Hot Boxes of the 1700s.

1816

On September 27, 1816, Robert Stirling applied for a patent for his economiser at the Chancery in Edinburgh, Scotland. By trade, Robert Stirling was actually a minister in the Church of Scotland and he continued to give services until he was eighty-six years old! But, in his spare time, he built heat engines in his home workshop. Lord Kelvin used one of the working models during some of his university classes. This engine was later used in the dish/Stirling system, a solar thermal electric technology that concentrates the sun's thermal energy in order to produce power.



1839

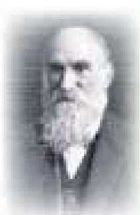
French scientist Edmond Becquerel discovers the photovoltaic effect while experimenting with an electrolytic cell made up of two metal electrodes placed in an electricity-conducting solution—electricity-generation increased when exposed to light.

1860s

French mathematician August Mouchet proposed an idea for solar-powered steam engines. In the following two decades, he and his assistant, Abel Pifre, constructed the first solar powered engines and used them for a variety of applications. These engines became the predecessors of modern parabolic dish collectors.

1873

Willoughby Smith discovered the photoconductivity of selenium.



William Crylls Adams, Courtesy of John Perlin 2002 From Space to Earth: The Story of Solar Electricity

1876

1876 William Grylls Adams and Richard Evans Day discover that selenium produces electricity when exposed to light. Although selenium solar cells failed to convert enough sunlight to power electrical equipment, they proved that a solid material could change light into electricity without heat or moving parts.

Samuel P. Langley, Courtesy of NASA

Bolometer, Courtesy of NASA

1880

Samuel P. Langley, invents the bolometer, which is used to measure light from the faintest stars and the sun's heat rays. It consists of a fine wire connected to an electric circuit. When radiation falls on the wire, it becomes very slightly warmer. This increases the electrical resistance of the wire.

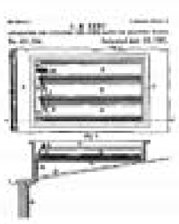
Heinrich Hertz, Courtesy of NASA/ Goddard Space Flight Center

1883

Charles Fritts, an American inventor, described the first solar cells made from selenium wafers.

1887

Heinrich Hertz discovered that ultraviolet light altered the lowest voltage capable of causing a spark to jump between two metal electrodes.



Solar Water Heater Courtesy of John Perlin/ Butti Solar Archives

1891

Baltimore inventor Clarence Kemp patented the first commercial solar water heater. For more information on the water heater, see the http://www.californiasolarcenter.org/history_solarthermal.html California Solar Center.

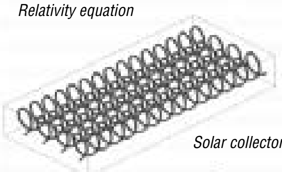
This timeline lists the milestones in the historical development of solar technology in the 1900s.

Early 1900s

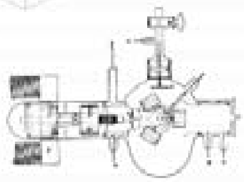
Albert Einstein, courtesy of the Lotte Jacobi Archives, University of Hampshire

$$a = \frac{F}{M}\left(1 - \frac{v^2}{c^2}\right)^{3/2}$$

Theory of Relativity equation

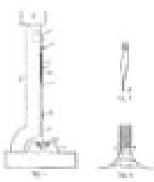


Solar collector



©1916 by The American Physical Society

Jan Czochralski, courtesy of Debra Kaiser, AACG newsletter



Single-crystal silicon

Mid 1950s

Bell Labs scientists, Daryl Chaplin, Calvin Fuller, and Gerald Pearson, courtesy of John Perlin

Bell Labs silicon solar cell

1904

Wilhelm Hallwachs discovered that a combination of copper and cuprous oxide is photosensitive.

1905

Albert Einstein published his paper on the photoelectric effect (along with a paper on his theory of relativity).

1908

1908 William J. Bailley of the Carnegie Steel Company invents a solar collector with copper coils and an insulated box—roughly, it's present design.

1914

The existence of a barrier layer in photovoltaic devices was noted.

1916

Robert Millikan provided experimental proof of the photoelectric effect.

1918

Polish scientist Jan Czochralski developed a way to grow single-crystal silicon. For more information on Czochralski, see the article http://rekt.pol.lublin.pl/users/ptwk/art2.htm Professor Jan Czolchralski (1885-1953) and His Contribution to the Art and Science of Crystal Growth.

1921

Albert Einstein wins the Nobel Prize for his theories (1904 research and technical paper) explaining the photoelectric effect.

1932

Audobert and Stora discover the photovoltaic effect in cadmium sulfide (CdS).

1947

1947 Passive solar buildings in the United States were in such demand, as a result of scarce energy during the prolonged W.W.II, that Libbey-Owens-Ford Glass Company published a book entitled Your Solar House, which profiled forty-nine of the nation's greatest solar architects. http://www.californiasolarcenter.org/history_solarthermal.html.

1953

Dr. Dan Trivich, Wayne State University, makes the first theoretical calculations of the efficiencies of various materials of different band gap widths based on the spectrum of the sun.

1954

1954 Photovoltaic technology is born in the United States when Daryl Chapin, Calvin Fuller, and Gerald Pearson develop the silicon photovoltaic (PV) cell at Bell Labs—the first solar cell capable of converting enough of the sun's energy into power to run everyday electrical equipment. Bell Telephone Laboratories produced a silicon solar cell with 4% efficiency and later achieved 11% efficiency. See the http://www.californiasolarcenter.org/history_pv.html for more information.

1955

Western Electric began to sell commercial licenses for silicon photovoltaic (PV) technologies. Early successful products included PV-powered dollar bill changers and devices that decoded computer punch cards and tape.

Mid 1950s (cont.)

William Cherry, courtesy of Mark Fitzgerald

Mid-1950s
Architect Frank Bridgers designed the world's first commercial office building using solar water heating and passive design. This solar system has been continuously operating since that time and the Bridgers-Paxton Building, is now in the National Historic Register as the world's first solar heated office building.

1956
William Cherry, U.S. Signal Corps Laboratories, approaches RCA Labs' Paul Rappaport and Joseph Loferski about developing photovoltaic cells for proposed orbiting Earth satellites.

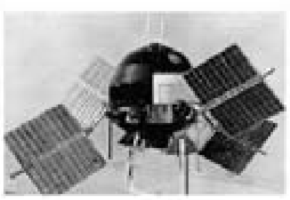
1957
Hoffman Electronics achieved 8% efficient photovoltaic cells.

1958
T. Mandelkorn, U.S. Signal Corps Laboratories, fabricates n-on-p silicon photovoltaic cells (critically important for space cells; more resistant to radiation).

1958
Hoffman Electronics achieves 9% efficient photovoltaic cells.

1958
The Vanguard I space satellite used a small (less than one watt) array to power its radios. Later that year, Explorer III, Vanguard II, and Sputnik-3 were launched with PV-powered systems on board. Despite faltering attempts to commercialize the silicon solar cell in the 1950s and 60s, it was used successfully in powering satellites. It became the accepted energy source for space applications and remains so today. For more information, see the Smithsonian National Air and Space Museum's information on http://www.nasm.si.edu/nasm/dsh/artifacts/SS-vanguard.htm "Vanguard 1".

1959
Hoffman Electronics achieves 10% efficient, commercially available photovoltaic cells. Hoffman also learns to use a grid contact, reducing the series resistance significantly.



Courtesy of http://www.suite101.com

1959
On August 7, the Explorer VI satellite is launched with a photovoltaic array of 9600 cells (1 cm x 2 cm each). Then, on October 13, the Explorer VII satellite is launched.

1960s

1960
Hoffman Electronics achieves 14% efficient photovoltaic cells.

1960
Silicon Sensors, Inc., of Dodgeville, Wisconsin, is founded. It starts producing selenium and silicon photovoltaic cells.

1962
Bell Telephone Laboratories launches the first telecommunications satellite, the Telstar (initial power 14 watts).

1963
Sharp Corporation succeeds in producing practical silicon photovoltaic modules.

1963
Japan installs a 242-watt, photovoltaic array on a lighthouse, the world's largest array at that time.

1960s (cont.)

1964

NASA launches the first Nimbus spacecraft—a satellite powered by a 470-watt photovoltaic array. See NASA's http://nssdc.gsfc.nasa.gov/earth/nimbus.html "Nimbus Program" for more information.

1965

Peter Glaser conceives the idea of the satellite solar power station. For more information, see DOE's reference brief, http://www.eere.energy.gov/consumerinfo/refbriefs/l123.html "Solar Power Satellites".

1966

NASA launches the first Orbiting Astronomical Observatory, powered by a 1-kilowatt photovoltaic array, to provide astronomical data in the ultraviolet and X-ray wavelengths filtered out by the earth's atmosphere.

1969

The Odeillo solar furnace, located in Odeillo, France was constructed. This featured an 8-story parabolic mirror.

Allan Lawandowski / PIX06409

1970s

1970s

Dr. Elliot Berman, with help from Exxon Corporation, designs a significantly less costly solar cell, bringing price down from $100 a watt to $20 a watt. Solar cells begin to power navigation warning lights and horns on many offshore gas and oil rigs, lighthouses, railroad crossings and domestic solar applications began to be viewed as sensible applications in remote locations where grid-connected utilities could not exist affordably.

1972

The French install a cadmium sulfide (CdS) photovoltaic system to operate an educational television at a village school in Niger.

1972

The Institute of Energy Conversion is established at the University of Delaware to perform research and development on thin-film photovoltaic (PV) and solar thermal systems, becoming the world's first laboratory dedicated to PV research and development.

1973

The University of Delaware builds "Solar One," one of the world's first photovoltaic (PV) powered residences. The system is a PV/thermal hybrid. The roof-integrated arrays fed surplus power through a special meter to the utility during the day and purchased power from the utility at night. In addition to electricity, the arrays acted as flat-plate thermal collectors, with fans blowing the warm air from over the array to phase-change heat-storage bins.

1976

The NASA Lewis Research Center starts installing 83 photovoltaic power systems on every continent except Australia. These systems provide such diverse applications as vaccine refrigeration, room lighting, medical clinic lighting, telecommunications, water pumping, grain milling, and classroom television. The Center completed the project in 1995, working on it from 1976-1985 and then again from 1992-1995.

1976

David Carlson and Christopher Wronski, RCA Laboratories, fabricate first amorphous silicon photovoltaic cells.

Warren Gretz, NREL / PIX04501

1970s (cont.)

1977

The U.S. Department of Energy launches the Solar Energy Research Institute http://www.nrel.gov/ "National Renewable Energy Laboratory", a federal facility dedicated to harnessing power from the sun.

1977

Total photovoltaic manufacturing production exceeds 500 kilowatts.

1978

1978 NASA's Lewis Research Center dedicates a 3.5-kilowatt photovoltaic (PV) system it installed on the Papago Indian Reservation located in southern Arizona—the world's first village PV system. The system is used to provide for water pumping and residential electricity in 15 homes until 1983, when grid power reached the village. The PV system was then dedicated to pumping water from a community well.

1980s

Courtesy of http://www.otherpower.com

1980

ARCO Solar becomes the first company to produce more than 1 megawatt of photovoltaic modules in one year.

1980

At the University of Delaware, the first thin-film solar cell exceeds 10% efficiency using copper sulfide/cadmium sulfide.

1981

Paul MacCready builds the first solar-powered aircraft—the Solar Challenger—and flies it from France to England across the English Channel. The aircraft had over 16,000 solar cells mounted on its wings, which produced 3,000 watts of power. The Smithsonian Institute National Air and Space Museum has a photo of the http://www.nasm.edu/nasm/aero/aircraft/maccread.htm "Solar Challenger" in flight.

Courtesy of ©1988 National Air and Space Museum, Smithsonian Institution

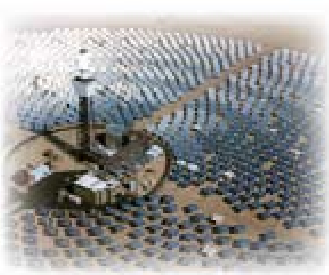
1982

The first, photovoltaic megawatt-scale power station goes on-line in Hisperia, California. It has a 1-megawatt capacity system, developed by ARCO Solar, with modules on 108 dual-axis trackers.

Courtesy of http://www.speedace.info/

1982

Australian Hans Tholstrup drives the first solar-powered car—the Quiet Achiever—almost 2,800 miles between Sydney and Perth in 20 days—10 days faster than the first gasoline-powered car to do so. Tholstrup is the founder of the http://www.wsc.org.au/2003/home.solar "World Solar Challenge" in Australia, considered the world championship of solar car racing.



Sandia National Laboratories / PIX00036

1982

The U.S. Department of Energy, along with an industry consortium, begins operating Solar One, a 10-megawatt central-receiver demonstration project. The project established the feasibility of power-tower systems, a solar-thermal electric or concentrating solar power technology. In 1988, the final year of operation, the system could be dispatched 96% of the time. For more information, see www.eere.energy.gov/erec/factsheets/csp.html "Concentrating Solar Power: Energy From Mirrors" and http://www.energylan.sandia.gov/sunlab/Snapshot/STFUTURE.htm "Solar Two Demonstrates Clean Power for the Future".

– Photo caption: Solar One, a 10-megawatt central receiver power tower is located in Daggett, CA. (Sandia National Laboratories / PIX00036)

1982
Volkswagen of Germany begins testing photovoltaic arrays mounted on the roofs of Dasher station wagons, generating 160 watts for the ignition system.

1982
The Florida Solar Energy Center's http://www.fsec.ucf.edu/About/quals/index.htm#recentcon "Southeast Residential Experiment Station" begins supporting the U.S. Department of Energy's photovoltaics program in the application of systems engineering.

1982
Worldwide photovoltaic production exceeds 9.3 megawatts.

1983
ARCO Solar dedicates a 6-megawatt photovoltaic substation in central California. The 120-acre, unmanned facility supplies the Pacific Gas & Electric Company's utility grid with enough power for 2,000-2,500 homes.

1983
Solar Design Associates completes a stand-alone, 4-kilowatt powered home in the Hudson River Valley.

1983
Worldwide photovoltaic production exceeds 21.3 megawatts, with sales of more than $250 million.

1984
The Sacramento Municipal Utility District commissions its first 1-megawatt photovoltaic electricity generating facility.

1985
The University of South Wales breaks the 20% efficiency barrier for silicon solar cells under 1-sun conditions.

1986
1986 The world's largest solar thermal facility, located in Kramer Junction, California, was commissioned. The solar field contained rows of mirrors that concentrated the sun's energy onto a system of pipes circulating a heat transfer fluid. The heat transfer fluid was used to produce steam, which powered a conventional turbine to generate electricity.

– Photo Caption: This solar power plant located in Kramer Junction, California, is the largest of nine such plants built in the 1980's. During operation, oil in the receiver tubes collects the concentrated solar energy as heat and is pumped to a power block located at the power plant for generating electricity. (Warren Gretz, NREL / PIX01224)

Warren Gretz, NREL / PIX01224

1986
ARCO Solar releases the G-4000—the world's first commercial thin-film power module.

1988
Dr. Alvin Marks receives patents for two solar power technologies he developed: Lepcon and Lumeloid. Lepcon consists of glass panels covered with a vast array of millions of aluminum or copper strips, each less than a micron or thousandth of a millimeter wide. As sunlight hits the metal strips, the energy in the light is transferred to electrons in the metal, which escape at one end in the form of electricity. Lumeloid uses a similar approach but substitutes cheaper, film-like sheets of plastic for the glass panels and covers the plastic with conductive polymers, long chains of molecular plastic units.

1990s

Warren Gretz, NREL / PIX03541

1991
President George Bush redesignates the U.S. Department of Energy's Solar Energy Research Institute as the National Renewable Energy Laboratory.

1992
1992 University of South Florida develops a 15.9% efficient thin-film photovoltaic cell made of cadmium telluride, breaking the 15% barrier for the first time for this technology.

– Photo caption: Thin-film modules, such as this one made with amorphous silicon, can be deposited on a variety of low-cost substrates, including glass and flexible plastic sheets. (Warren Gretz, NREL / PIX03541)

Sandia National Labs / PIX01728

1992
A 7.5-kilowatt prototype dish system using an advanced stretched-membrane concentrator becomes operational.

Terry O'Rourke / PIX00253

1993
1993 Pacific Gas & Electric completes installation of the first grid-supported photovoltaic system in Kerman, California. The 500-kilowatt system was the first "distributed power" effort.

– Photo caption: Pacific Gas and Electric Company (PG&E) installed a 500-kilowatt photovoltaic system at its Kerman substation to reinforce a weak feeder. PG&E found that distributed systems like this have measurable benefits such as increased system reliability and peak-shaving capabilities. (Terry O'Rourke / PIX00253)

Dave Parsons / PIX06995

1994
The National Renewable Energy Laboratory (formerly the Solar Energy Research Institute) completes construction of its http://www.nrel.gov/buildings/highperformance/serf.html "Solar Energy Research Facility", which was recognized as the most energy-efficient of all U.S. government buildings worldwide. It features not only solar electric system, but also a passive solar design.

1994
First solar dish generator using a free-piston Stirling engine is tied to a utility grid.

Warren Gretz, NREL / PIX03302

1994
The National Renewable Energy Laboratory develops a solar cell—made from gallium indium phosphide and gallium arsenide—that becomes the first one to exceed 30% conversion efficiency.

1996
The world's most advanced solar-powered airplane, the Icare, flew over Germany. The wings and tail surfaces of the Icare are covered by 3,000 super-efficient solar cells, with a total area of 21 m2. See http://www.ifb.uni-stuttgart.de/icare/pictures/ica-fl2.jpg "Solar Aircraft of the University of Stuttgart" for more information about Icare.

Sandia National Laboratories / PIX01701

1996
The U.S. Department of Energy, along with an industry consortium, begins operating Solar Two—an upgrade of its Solar One concentrating solar power tower project. Operated until 1999, Solar Two demonstrated how solar energy can be stored efficiently and economically so that power can be produced even when the sun isn't shining. It also fostered commercial interest in power towers. See http://www.energylan.sandia.gov/sunlab/Snapshot/STFUTURE.htm "Solar Two Demonstrates Clean Power for the Future" for more information.

– Photo Caption: The Solar Two project will improve the 10-megawatt Solar One central receiver plant in Daggett, CA. A field of mirrored heliostats focuses sunlight on a 300-foot (91 meter) tower, which will be filled with molten nitrate salt. The salt flows like water and can be heated to 1050 degrees F. The salt is pumped through a steam generator to produce the steam to power a conventional, high-efficiency steam turbine to produce electricity. (566 degrees C). (Sandia National Laboratories / PIX01701)

1990s

United Solar Systems Corporation / PIX03636

Kiss + Cathcon - Architects / PIX06456

SPECTROLAB

A BOEING COMPANY

Warren Gretz, NREL / PIX00183

1998

The remote-controlled, solar-powered aircraft, "Pathfinder" sets an altitude record, 80,000 feet, on its 39th consecutive flight on August 6, in Monrovia, California. This altitude is higher than any prop-driven aircraft thus far.

1998

Subhendu Guha, a noted scientist for his pioneering work in amorphous silicon, led the invention of flexible solar shingles, a roofing material and state-of-the-art technology for converting sunlight to electricity.

– Photo caption: The PV shingles mount directly on to the roof and take the place of asphalt shingles. The system is connected to the utility grid through an inverter and produces electricity on customer's side of the meter. United Solar Systems Corporation / PIX03636)

1999

1999 Construction was completed on 4 Times Square, the tallest skyscraper built in the 1990s in New York City. It incorporates more energy-efficient building techniques than any other commercial skyscraper and also includes building-integrated photovoltaic (BIPV) panels on the 37th through 43rd floors on the south- and west-facing facades that produce a portion of the buildings power.

– Photo Caption: 4 Times Squares most advanced feature is the photovoltaic skin, a system that uses thin-film PV panels to replace traditional glass cladding material. The PV curtain wall extends from the 35th to the 48th floor on the south and east walls of the building, making it a highly visible part of the midtown New York skyline. The developer, the Durst Organization, has implemented a wide variety of healthy building and energy efficiency strategies. Kiss + Cathcart Architects designed the building's PV system in collaboration with Fox and Fowle, the base building architects. Energy Photovoltaics of Princeton, NJ, developed the custom PV modules. (Kiss + Cathcon - Architects / PIX06456)

1999

Spectrolab, Inc. and the National Renewable Energy Laboratory develop a photovoltaic solar cell that converts 32.3 percent of the sunlight that hits it into electricity. The high conversion efficiency was achieved by combining three layers of photovoltaic materials into a single solar cell. The cell performed most efficiently when it received sunlight concentrated to 50 times normal. To use such cells in practical applications, the cell is mounted in a device that uses lenses or mirrors to concentrate sunlight onto the cell. Such "concentrator" systems are mounted on tracking systems that keep them pointed toward the sun.

1999

The National Renewable Energy Laboratory achieves a new efficiency record for thin-film photovoltaic solar cells. The measurement of 18.8 percent efficiency for the prototype solar cell topped the previous record by more than 1 percent.

1999

Cumulative worldwide installed photovoltaic capacity reaches 1000 megawatts.

This timeline lists the milestones in the historical development of solar technology in the 2000s.

Courtesy of NASA

Sandia National Labs, PIX10809

Courtesy of NASA, Dryden Flight Research Center Photo Collection

2000

First Solar begins production in Perrysburg, Ohio, at the world's largest photovoltaic manufacturing plant with an estimated capacity of producing enough solar panels each year to generate 100 megawatts of power.

2000

At the International Space Station, astronauts begin installing solar panels on what will be the largest solar power array deployed in space. Each "wing" of the array consists of 32,800 solar cells.

2000

Sandia National Laboratories develops a new inverter for solar electric systems that will increase the safety of the systems during a power outage. Inverters convert the direct current (DC) electrical output from solar systems into alternating current (AC), which is the standard current for household wiring and for the power lines that supply electricity to homes.

2000

Two new thin-film solar modules, developed by BP Solarex, break previous performance records. The company's 0.5-square-meter module achieves 10.8 % conversion efficiency—the highest in the world for thin-film modules of its kind. And its 0.9-square-meter module achieved 10.6% conversion efficiency and a power output of 91.5 watts — the highest power output for any thin-film module in the world.

2000

A family in Morrison, Colorado, installs a 12-kilowatt solar electric system on its home—the largest residential installation in the United States to be registered with the U.S. Department of Energy's http://www.millionsolarroofs.com/ "Million Solar Roofs" program. The system provides most of the electricity for the 6,000-square-foot home and family of eight.

2001

Home Depot begins selling residential solar power systems in three of its stores in San Diego, California. A year later it expands sales to include 61 stores nationwide.

2001

NASA's solar-powered aircraft—Helios sets a new world record for non-rocket-powered aircraft: 96,863 feet, more than 18 miles high.

– Photo caption: The Helios Prototype flying wing is shown near the Hawaiian Islands during its first test flight on solar power. (Photo Courtesy of NASA, Dryden Flight Research Center Photo Collection)

2001

The National Space Development Agency of Japan, or NASDA, announces plans to develop a satellite-based solar power system that would beam energy back to Earth. A satellite carrying large solar panels would use a laser to transmit the power to an airship at an altitude of about 12 miles, which would then transmit the power to Earth.

2001

TerraSun LLC develops a unique method of using holographic films to concentrate sunlight onto a solar cell. Concentrating solar cells typically use Fresnel lenses or mirrors to concentrate sunlight. TerraSun claims that the use of holographic optics allows more selective use of the sunlight, allowing light not needed for power production to pass through the transparent modules. This capability allows the modules to be integrated into buildings as skylights.

2000s

PowerLight Corporation / PIX06431

2001

PowerLight Corporation places online in Hawaii the world's largest hybrid system that combines the power from both wind and solar energy. The grid-connected system is unusual in that its solar energy capacity—175 kilowatts—is actually larger than its wind energy capacity of 50 kilowatts. Such hybrid power systems combine the strengths of both energy systems to maximize the available power.


Warren Gretz, NREL / PIX11979

2001

British Petroleum (BP) and BP Solar announce the opening of a service station in Indianapolis that features a solar-electric canopy. The Indianapolis station is the first U.S. "BP Connect" store, a model that BP intends to use for all new or significantly revamped BP service stations. The canopy is built using translucent photovoltaic modules made of thin films of silicon deposited onto glass.

– Photo Caption: The PowerView Semi-Transparent Photovoltaic Module, developed by NREL and BP Solar, is a novel system that serves as a roof or window while creating power for a building. BP has to date incorporated the system in more that 150 of its service stations and the panels are envisioned to become a functional replacement for conventional glass in walls, canopies, atriums, entrances and facades in commercial and residential architecture. (Warren Gretz, NREL / PIX11979)


Courtesy of NASA Dryden Flight Research Center Photo Collection

2002

NASA successfully conducts two tests of a solar-powered, remote-controlled aircraft called Pathfinder Plus. In the first test in July, researchers demonstrated the aircraft's use as a high-altitude platform for tele-communications technologies. Then, in September, a test demonstrated its use as an aerial imaging system for coffee growers.

– Photo Caption: The Pathfinder Plus is a lightweight, solar-powered, remotely piloted flying wing aircraft that is demonstrating the technology of applying solar power for long-duration, high-altitude flight. This solar-powered aircraft could stay airborne for weeks or months on scientific sampling and imaging missions. Solar arrays covering most of the upper wing surface provide power for the aircraft's electric motors, avionics, communications and other electronic systems. It also has a backup battery system that can provide power for between two and five hours to allow limited-duration flight after dark. (Photo Courtesy of NASA, Dryden Flight Research Center Photo Collection)

2002

Union Pacific Railroad installs 350 blue-signal rail yard lanterns, which incorporate energy saving light-emitting diode (LED) technology with solar cells, at its North Platt, Nebraska, rail yard—the largest rail yard in the United States.

2002

ATS Automation Tooling Systems Inc. in Canada starts to commercialize an innovative method of producing solar cells, called Spheral Solar technology. The technology—based on tiny silicon beads bonded between two sheets of aluminum foil—promises lower costs due to its greatly reduced use of silicon relative to conventional multicrystalline silicon solar cells. The technology is not new. It was championed by Texas Instruments (TI) in the early 1990s. But despite U.S. Department of Energy (DOE) funding, TI dropped the initiative. See the DOE http://www.nrel.gov/pvmat/ti.html "Photovoltaic Manufacturing Technology" Web site.

Courtesy of www.atsautomation.com

2002

The largest solar power facility in the Northwest—the 38.7-kilowatt White Bluffs Solar Station—goes online in Richland, Washington.

2000s

Courtesy of PowerLight Corporation / PIX12398

2001

Powerlight Corporation installs the largest rooftop solar power system in the United States—a 1.18 megawatt system—at the Santa Rita Jail in Dublin, California.

– Photo Caption: In Spring 2002, Alameda County, CA successfully completed the fourth largest solar electric system in the world atop the Santa Rita Jail in Dublin, California. This solar installation, the United States' largest rooftop system, was commissioned to help Alameda County reduce and stabilize future energy costs. This smart energy project reduces the jail's use of utility-generated electricity by 30% through solar power generation and energy conservation. Clean energy is generated by a 1.18 Megawatt system consisting of three acres of solar electric or photovoltaic (PV) panels. (Courtesy of PowerLight Corporation / PIX12398)

Solar History: The Future

Here's a look at the expected future direction of solar technology.

Chris Gunn Photography / PIX12165

All buildings will be built to combine energy-efficient design and construction practices and renewable energy technologies for a net-zero energy building. In effect, the building will conserve enough and produce its own energy supply to create a new generation of cost-effective buildings that have zero net annual need for non-renewable energy.

– Photo Caption: This home was built by students from the University of Colorado (CU) for the first Solar Decathlon, a competition sponsored by the U.S. Department of Energy (DOE). Student teams are challenged to integrate aesthetics and modern conveniences with maximum energy production and optimal efficiency. Each collegiate team will build a uniquely designed 500-ft2 -- 800-ft2 house. Decathletes will transported their houses to the National Mall in Washington D.C. for the competition in the fall of 2002. The CU team took first prize in the competition overall. (Chris Gunn Photography / PIX12165)

Photovoltaics research and development will continue intense interest in new materials, cell designs, and novel approaches to solar material and product development. It is a future where the clothes you wear and your mode of transportation can produce power that is clean and safe.

Kramer Junction Company / PIX11070

Technology roadmaps for the future outline the research and development path to full competitiveness of concentrating solar power (CSP) with conventional power generation technologies within a decade. The potential of solar power in the Southwest United States is comparable in scale to the hydropower resource of the Northwest. A desert area 10 miles by 15 miles could provide 20,000 megawatts of power, while the electricity needs of the entire United States could theoretically be met by a photovoltaic array within an area 100 miles on a side. Concentrating solar power, or solar thermal electricity, could harness the sun's heat energy to provide large-scale, domestically secure, and environmentally friendly electricity.

– Photo Caption: This is the world's largest solar power facility, located near Kramer Junction, CA. The facility consists of five Solar Electric Generating Stations (SEGS), with a combined capacity of 150 megawatts. At capacity, that is enough power for 150,000 homes. The facility covers more than 1000 acres, with over 1 million square meters of collector surface. (Kramer Junction Company / PIX11070)

The price of photovoltaic power will be competitive with traditional sources of electricity within 10 years.

Richard Parish / PIX10732

Solar electricity will be used to electrolyze water, producing hydrogen for fuel cells for transportation and buildings.

– Photo Caption: SunLine, a California transit agency, is being evaluated as they add state-of-the-art hydrogen fuel cell buses to their fleets and set up infrastructure facilities for fueling and maintenance. The hydrogen is produced at the site using solar-powered electrolysis and natural gas reforming. Because fuel cell buses aren't yet commercially available, these demonstration projects are used to better understand the technology and plan for the future. (Richard Parish / PIX10732)