Why Not the Sun? Advantages of and Problems with Solar Energy

by Ethan Goffman

I'd put my money on the sun and solar energy. What a source of power! I hope we don't have to wait until oil and coal run out before we tackle that.

– Thomas Alva Edison, 1931

The oil embargo of the 1970s prompted a national surge of interest in solar energy. A solar water heater was installed in the White House, and photovoltaic panels first came into play, notably in California. While previously solar power as a direct source of electricity had been limited to esoteric functions, such as in spacecraft, companies began to form with the idea of using solar as a regular source of power for ordinary homes.

President Carter inspecting a solar heating panel installed on the roof of the White House.
Photo: Jimmy Carter Library.
http://www.aip.org/history/newsletter/fall2003/carter-photo.htm

Theoretically, solar might seem an ideal energy source, as it is free and virtually limitless. According to Greenpeace, "The solar radiation reaching the earth's surface in one year provides more than 10,000 times the world's yearly energy needs" (4). Furthermore, "harnessing just one-quarter of the solar energy that falls on the world's paved areas could meet all current global energy needs comfortably" (Flavin). Yet the technological barriers to harvesting this energy are great regarding collection, distribution, and storage.

Through the end of the 20th century, solar remained a power source for the eccentric few, accounting for well under 1% of energy generation. As the energy crisis waned, it quickly became apparent that solar was not competitive with conventional energy sources, such as coal. One commentator well captures the frustration: "For years, supporters of solar power have heralded every new technical breakthrough as a revolution in the making. Yet time and again it has failed to materialise, largely because the technology was too expensive and inefficient. It simply cost too much, and solar panels settled in as a small niche market" (Daviss).

This Bethesda, MD home has photovoltaic panels in front and solar collectors in the rear for heating the family's water.
Photos by author.

In the 1990s, as climate change moved in the public consciousness from an esoteric theory to a scientific fact, interest in solar returned, notably in Europe and to a lesser extent in the United States. In the 21st century, growing worries about an energy shortage on a planet voracious for power have added to the demands for solar energy. As Greenpeace points out, "the market has grown by more than 40% a year for almost a decade and the industry is investing large sums to increase production facilities" (3).

The above summary is a bit simplistic, as, technically, humans have used solar power throughout history, notably as a source of light and, in the long run, as a source of pretty much everything, including our very planet. Situating and constructing buildings to best use the light that nature gives us every day is called passive solar. Buildings have long been positioned to take advantage of light and heat, for instance by having large south facing windows to allow plenty of sunlight. For further discussion, see the Discovery Guide Green Buildings: Conserving the Human Habitat (section 4) (http://www.csa.com/discoveryguides/green/review4.php).

This Discovery Guide is not about passive solar, but about more "active" uses of solar as a direct means of replacing energy currently generated mainly by fossil fuels, such as coal, oil, and natural gas.

These more "active" solar energy uses can in turn be divided into two main groups. The first is Solar Thermal, which traditionally has been used to heat water and is increasingly being used, in a more centralized fashion, in large energy plants. The second is solar cells, which can in turn be divided into bulk or wafer based, usually employing silicon, and thin film, which employs a variety of metals and is easily manufactured and installed, but currently requires more square footage to do the work of wafer based cells.

This points to a crucial factor: the efficiency, or percentage of solar energy that can be captured and converted into electricity. In the past this has been too low to allow the technology to replace a substantial portion of fossil fuels; "the efficiency with which a cell can convert light into electricity has been the technology's Achilles' heel" (Daviss). Almost as important are energy storage and delivery, how to get the energy when and where it is needed.

Solar Cells

Bulk

The first photovoltaic cells were created in 1954 at Bell Labs, and the solar energy companies that sprang up in the 1970s, primarily in California, used this technology, employing silicon wafers. The percentage of the sun's energy that could actually be captured for use as energy was relatively small, only 4% at first and later 11% (Lund et al.), a number that has continued to grow with technological advances.

Photovoltaic array. 2007 Solar Decathlon, Washington, DC. Photo by author.

Bulk photovoltaic cells are composed of silicon, "like computer chips, and for the same reason. They rely on that element's properties as a semiconductor, in which negatively charged electrons and positively charged 'holes' move around and carry a current as they do so" (Economist, Another silicon valley).

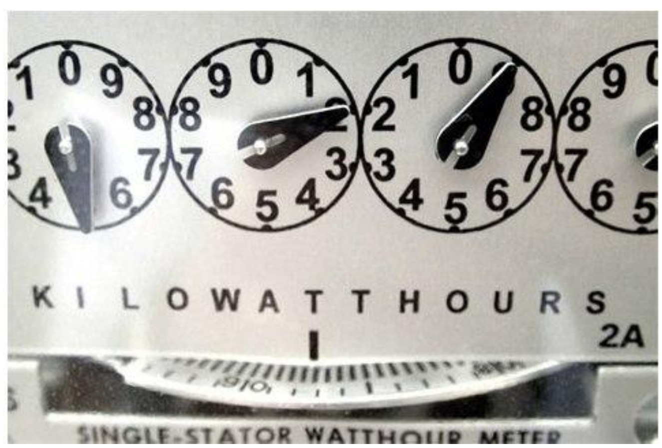
How Stuff Work explains the basic technology behind these cells: "when light strikes the cell, a certain portion of it is absorbed within the semiconductor material. This means that the energy of the absorbed light is transferred to the semiconductor. The energy knocks electrons loose, allowing them to flow freely" (Aldous). The energy comes out in the form of Direct Current (DC), which must then be converted to Alternating Current (AC) for practical uses.

Silicon wafer solar cells come in two main types: polycrystalline and monocrystalline. Monocrystalline solar cells are made from a single crystal and are slightly more efficient than polycrystalline, which are made from many crystals. Less expensive, polycrystalline cells are currently the most common. (Youngester)

Monocrystalline solar panel
http://skycomsmt.com/images/SOLAR%20PRODUCTION/1172494779.jpg

In isolated locations, solar cells offer an excellent source of power. "Solar power has so far always [been] a better option in rural areas where grid power is not possible," says Jayantha Nagendran of the World Bank. (Samath) Stand-alone solar is useful in a variety of situations. In Iraq, for instance, solar powered street lamps are helping to make up for a dysfunctional grid. (Zavis) However isolated solar cells provide energy only for immediate use or for battery storage, which currently is impractical on a large scale.

Buildings connected to the electrical grid may use conventional energy when needed, while employing solar cells when the sun is out and the energy is available. In many locations, solar energy may actually be fed back into the electrical grid, causing the meter to run backwards, a phenomenon known as net metering. Yet, "For many years the utilities did not allow the feeding in of solar electricity into their grid and . . . in most countries the utilities fight this idea forcefully once it comes up" (Greenpeace 48). In many locations, then, returning energy to the grid is not yet possible.



Net metering lets your meter run backwards
http://solar.calfinder.com/blog/solar-information/what-is-net-metering/

On top of net metering, solar advocates would like policies tied to the changing value of energy depending on time of day. This is known as demand pricing, and "requires a meter that can track hourly as well as total usage, differentiating between peak and off-peak consumption" (Derbyshire). Because solar is strongest during day-time, peak hours, it is more valuable than a flat rate would indicate; yet, in many countries, those who invest in solar panels are not rewarded for this value. Travis Bradford advocates variable pricing, which "would charge consumers for electricity based on a variety of factors, including the amount of power the customer uses, the time of day they use it, and customer density" (149).

Two major factors have hamstrung the use of photovoltaic cells for generating energy: cost and intermittency. Except in special situations, such as off-grid uses, solar is simply not competitive with fossil fuels. Explains *Time* magazine, "stiff up-front cost has always been the biggest barrier to residential use of solar power. An average set of rooftop panels costs $20,000 to $30,000 and takes 10 to 15 years to produce enough electricity to pay for itself" (Walsh). On a larger scale, this amounts to solar being "at least two to three times as expensive as the typical electricity generated in America for retail customers" (Economist, Bright).

This PV array has one onlooker gazing upward in awe. 2007 Solar Decathlon, Washington, DC.
Photo by author.

Still this is changing due to experimentation, in combination with practical application. According to the *Economist*, "decades of research have improved the efficiency of silicon-based solar cells from 6% to an average of 15% today, whereas improvements in manufacturing have reduced the price of modules from about $200 per watt in the 1950s to $2.70 in 2004. Within three to eight years, many in the industry expect the price of solar power to be cost-competitive with electricity from the grid" (Economist, Bright).

Although growth has been steady, a worldwide silicon shortage has frustrated expectations for an even faster rate by raising cost: "after decades of steady decline, prices increased from a low of $2.70 per watt in 2004 to about $4 per watt in the spring of 2006" (Economist, Bright). Nevertheless, other factors have kept the situation in check: "Thanks to economies of scale, rising conversion efficiencies, and more-efficient use of polysilicon in conventional cells, average PV module prices declined in 2007, even as polysilicon prices rose" (Sawin).

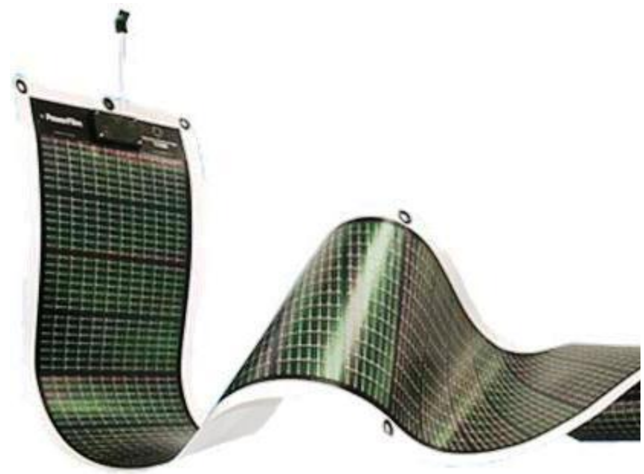
Still the shortage of refined polysilicon, due to a lack of facilities, has kept prices high. This seems puzzling, as silicon is one of the most abundant materials, found, for instance, in sand. As Greenpeace explains, "23% of the earth's crust consists of silicon. However, the process of producing the pure silicon needed for crystalline solar cells is complex. The period from planning a new silicon factory to its first output is approximately two years. The dynamic development of the PV market led to a shortage of silicon" (13). Competition from computer chip makers, which also use silicon, has added to the excess of demand over supply. Still, various projections claim that the worldwide shortage should end in 2009, as production ramps up. For instance, “The European Photovoltaic Industry Association projects 80,000 tons of annual production by 2010, up from just over 37,000 tons in 2007” (Sawin).

Improved technology, increased silicon production, and the increasing cost of energy are acting to make photovoltaic cells more competitive. At some point, solar should start to out-compete fossil fuels.

As solar power becomes more efficient, it is becoming more competitive. The company Sun-Power is notable here, “converting 22 percent of the sun's rays to electricity, compared with industry norms of about 10 to 15 percent” (Wolgemuth). Still the cost for SunPower cells is high; just what mix of cost and efficiency will dominate the industry remains to be seen.

Thin Film

An alternative to polysilicon solar cells is thin film, which uses metallic compounds to capture the sun’s energy. Cheaper and easier to install than wafer based PV cells, “thin- film cells use as little as 1 per cent of the volume of materials that ordinary PV cells demand” (Daviss). Installation is also flexible, since thin film “can be integrated into roof shingles, siding, and the windows of buildings” (Sawin).



Thin film solar panels
http://technicalstudies.youngester.com/2008/06/future-of-solar-cells.html

Many in the industry, then, see thin film technology as the future of solar: “Today, thin-film PV modules that use materials such as amorphous silicon (a-Si); cadmium telluride (CdTe); or copper indium gallium selenide (CIGS) are attracting much attention and are growing at an impressive rate” (Energy Information Administration 10). However, thin film as of yet captures a smaller percentage of the sun’s energy than do wafer based cells. Overall, “thin-film solar cells are inefficient but cheap. Where there's room to put up a lot of them, they're cost effective, but to compete elsewhere, they'll have to get more efficient” (Takahashi). Still thin film efficiency is rapidly increasing. According to one report, “thin-film technology has now reached a critical mass and is poised to start taking ‘significant market share’ from incumbent technology. Thin-film silicon technologies from turn-key vendors will be ramping up in large scale during the second half of 2008” (Solid State). Numerous experiments with the best combination of thin film materials make it likely that efficiency will increase significantly in coming years. In one test thin film technology reached 19.9% (NREL, Thin) although how quickly and easily this material can be manufactured for mass consumption remains to be seen.

Disadvantages of Solar Cells

A major disadvantage of both wafer-based and thin film solar energy is intermittency. The sun does not shine at night, and is diminished by overcast skies and storms. Energy from solar cells therefore cannot be counted on at all times.

This means that decentralized energy from solar cells cannot supply what the energy industry calls baseline power, which supplies a constant energy need. Currently coal plants are the major supplier of base-load electricity, while nuclear is also excellent at this task (although expensive to bring on-line).

For peak demand times, as well as sudden surges (such as during a heat wave when air conditioners work overtime) power must be added. The energy needed for this part-time demand is called "*intermediate-load electricity,* as opposed to the *base-load electricity* that is needed twenty-four hours a day" (Bradford 13). Natural gas is currently the favorite method for supplying intermediate-load electricity, although renewable sources, such as solar and wind, are well suited to the task.

Intermittency is actually less of a problem for solar cells than for wind power. This is because solar tends to be most available during times of peak demand, particularly working hours: Intermediate load power, "which represents some 30 percent of all the electricity supply" must be provided primarily during daylight hours. (Bradford 130) This is fortuitous for solar energy, since, "in the middle of the afternoon when the sun is at its peak and solar panels are producing at their optimum, demand and pricing for electricity also peaks" (Canberra Times). In addition, solar and wind can complement each other, since times of low sunshine are often excellent for wind power, notably in winter.

Still, the use of solar cells and wind power will be limited until more efficient storage methods can be developed to conserve energy when it's generated and use it when it's most needed. Bradford explains that "there are potential technical limits to widespread adoption of intermittent sources of electricity beyond 15 percent of total grid capacity without the added inclusion of energy storage solutions" (132) (other recent studies put the number at 20% for wind power). Currently, batteries are the method of choice for storing solar energy, although these need to be replaced regularly. Solid oxide fuel cells employing hydrogen technology show great promise, but need to be further developed (see http://www.csa.com/discoveryguides/fuecel/overview.php). For hydrogen storage to fulfill its promise it needs to derive its power from nonpolluting sources, such as electrolysis powered by solar energy. (Bradford 87-88) (see http://www.csa.com/discoveryguides/hydrogen/overview.php).

Solar Thermal

Although photovoltaic panels have become the prototypical image of solar power, solar thermal is actually older. Leonardo Da Vinci had solar energy designs in his notebooks, while "in the 1870s and 1880s, at the height of the Industrial Revolution, French and U.S. scientists developed an array of solar cookers, steam engines, and electricity generators, all based on a simple concept, a parabolic-shaped solar collector that is coated with a mirrored surface to reflect light coming from different angles onto a single point or line" (Flavin USA Today). That design is the basis of many of today's large-scale solar plants, which rely on parabolic troughs.

US President George W. Bush (R) walks past a parabolic dish during a tour of the Department of Energy's National Solar Thermal Test Facility at Sandia National Laboratories in Albuquerque, NM. AFP or Agence France-Presse, 2005

Solar thermal, unlike solar cells, employs glass or other material to concentrate light and convert it to a source of electricity. In general, solar cells are used as a decentralized source of power, often on individual houses. Solar thermal, by contrast, is being developed in large, centralized power plants: "The technology which is generally proposed for harvesting solar energy at large scales in the Sunbelt is Concentrated Solar Power (CSP). This method concentrates the sun's rays to heat water, producing steam which drives turbines to generate electricity in an otherwise conventional way" (Al Bawaba).

Parabolic troughs are currently the standard form of solar thermal used in large power plants. They consist of "long parabolic-shaped rows of mirrors focus sunlight on fluid-filled metal tubes encased in glass. The heat collected drives steam generators similar to those that run coal-fired power plants to make electricity" (Woodside). Explains CSP entrepreneur Randy Gee, "there is a great deal of interest from the investment community because parabolic trough is a proven commodity" (Power Engineering). Research continues apace, not only in parabolic troughs but in other ways of providing solar thermal.

CSP has the huge advantage of storing energy, via molten salt (NREL, Trough), greatly alleviating the intermittency problem and allowing it to be used as a baseline energy source. Explains Gee, "CSP is positioned to be the largest means of generating renewable electricity in the 10-15 year timeframe. . . . CSP systems can provide despatchable [sic] electricity, meaning they can deliver the electricity to the utility or customers wherever it is needed by virtue of the fact that CSP is a thermal technology and can therefore can [sic] incorporate thermal storage. This is what separates it from wind and photovoltaics" (Power Engineering).

Spanish solar-power-plant developer Abengoa Solar plans to build and begin operating this 280-megawatt solar thermal power plant in Gila Bend, AZ, by 2011.
http://www.technologyreview.com/Biztech/20356/page2/

Solar thermal plants are particularly apt in sunny climates such as the American Southwest. According to one source, "at least 250,000 square miles of land in the Southwest alone are suitable for constructing solar power plants . . . . Converting only 2.5 percent of that radiation into electricity would match the nation's total energy consumption in 2006" (Zweibel). The Nevada Solar One solar thermal plant, which came online in 2007, is a notable example. Its "64 megawatts (MW) capacity makes it the largest solar plant to be built in the world in the last 16 years" (Energy Information Administration 6). Still, in the American Southwest plans for solar thermal are slowing due to a 22 month moratorium on solar collector applications from the federal Bureau of Land Management to study environmental impact. (Economist, Freezing) This conflicting environmental claim illustrates one of the many obstacles and diversions in renewable energy's path becoming a dominant power source.

Critics claim that solar takes too much land to be viable as a large-scale energy source (Hiserodt). Clearly, moving to solar as a major energy producer would mean an enormous reallocation of land and resource use. Yet, according to one source, "installations already in place indicate that the land required for each gigawatt-hour of solar energy produced in the Southwest is less than that needed for a coal-powered plant when factoring in land for coal mining" (Zweibel). Estimates are tricky, because they need to account for all the land and installations needed for any given power source, as well as environmental problems and the cost of transportation and storage.

One problem with concentrated solar in the southwest is distance from where energy is produced to where it is most needed. One expert explains that "major obstacles such as long-life storage and long distance transportation remain to be overcome before solar power becomes a major contributor to the world energy grid" (Al Bawaba). Major infrastructure investment would be needed. According to one advocate, “a new high-voltage, direct-current (HVDC) power transmission backbone would have to be built” using Direct Current. (Zweibel) Certainly the initial price would be high, although once energy did begin flowing it would be close to free.

If the obstacles can be overcome, according to one report, “concentrating solar power, which always works on a utility scale, could provide seven times of all of America's power needs. This expands on a prediction green advocates have made for years, arguing that, potentially, all of the country's power needs could be met in a 100-square-mile plot of land in a sunny region like Nevada” (Woodside).

One decentralized form of solar thermal that has been around a long time is solar water heaters. Currently, these are a better investment for individual houses than are solar cells; they pay for themselves in about 15 years (City of Columbia) as opposed to 20 or more for photovoltaic cells. Factoring in any government incentives, the payback time could be far less.

Mr. Mingde Zhou, who manages a hostel, shows solar panels that supply power and hot water on the roof of his building in Shanghai 01 March 2006. MARK RALSTON/AFP/Getty Images

Direct solar power for automobiles seems extremely unlikely. However, if the current development of plug-in electric automobiles continues apace, solar energy on the grid may end up powering these vehicles.

<u>The Economics of Solar Power</u>

Without government subsidy, solar is not yet a competitive form of energy. Numerous sources agree that currently, “in direct competition with electricity generated from fossil fuels, solar cells almost always lose” (Derbyshire). Subsidies are needed. “For the expansion of solar energy to be successful,” Greenpeace explains, “there must be a clear commitment from governments” (3). Still, such subsidies are expected to be only temporary; solar advocates believe that as technology and economies of scale improve, solar will far outstrip fossil fuels in economic competitiveness.

Solar advocates also point out that fossil fuels have long received government subsidies, that “the oil and natural gas industries received substantial government aid during their early histories and continue to receive tax breaks for exploration, favorable terms for drilling leases on government land, and so forth” (Derbyshire). Bradford estimates that “global government support is currently skewed toward the nuclear and fossil-fuel infrastructure, with about ten times as much money going to these conventional power sources as to all renewables combined” (172).

Because solar provides advantages that the economic laws of supply and demand, in a vacuum, do not account for, many governments choose to subsidize solar as a clean and renewable energy source. Conventional fossil fuels generate costs that the users do not pay for–what economists term externalities–that are shared by the wider community and may occur at a future time. Pollution is the most obvious of these, in the form of harming local air quality, and through generating greenhouse gasses. In addition, fossil fuels are a limited resource that will eventually run out; future generations may therefore "pay" for our use of coal, oil, and natural gas today. The fact that we must deal with often unstable and unfriendly governments to attain fossil fuels is another reason to seek renewable options. Exclaims one solar advocate, "although the investment is high, it is important to remember that the energy source, sunlight, is free. There are no annual fuel or pollution-control costs like those for coal, oil or nuclear power" (Zweibel).

California solar companies say they plan to hire new workers in the next year.
http://www.ibabuzz.com/education/2008/04/14/do-green-collar-jobs-promise-a-better-future-for-bay-area-youth/

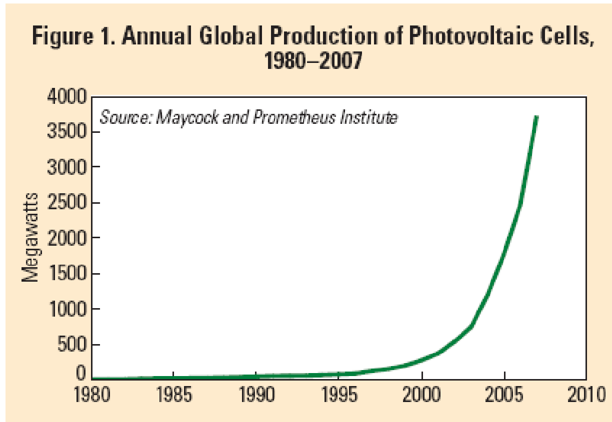
Job creation is another argument often put forward for solar power. Indeed "green jobs" have been suggested as a major potential stimulus for the United States' faltering economy. Explains Bradford, "installation jobs cannot be exported: they must remain in the locations where systems will be used. . . . These relatively highly paid, skilled jobs will help sustain an educated and prosperous middle class in any industrialized economy" (164). Green jobs are a major platform of the incoming Obama administration and are popular at the local level; "States are clamoring for renewable energy projects such as wind farms and solar power plants because of the potential jobs they create, in addition to reducing global warming and increasing the country's energy independence" (Yung).

To offset externalities, and increasingly to create green jobs, many governments subsidize solar and other renewable energy. These subsidies occur in several forms. Feed-in tariffs have been the most successful, notably in German. Feed-in tariffs require utilities or consumers to pay extra for solar energy on the grid; the money then goes to individuals who have installed solar. This system incentivizes not only solar installation, but installation of the most efficient solar possible. (Greenpeace 49) Cash rebates and tax deductions are other incentives used for solar energy: "The most direct [incentives] are tax credits and rebates paid to owners of renewable energy facilities. . . . The production tax credit (PTC) is a per kilowatt-hour tax credit for energy generated by qualified energy resources" (Derbyshire). These methods are bottom-up, and "are usually supplemented by renewable portfolio standards (RPS) . . .a top-down incentive, requiring utilities to obtain some fraction of their energy from renewable sources" (Derbyshire). Often used in the U.S. at a state level, RPS programs are attempts "to set target percentages of renewables in their power-generation mix to be deployed by certain dates" (Bradford 182). RPS programs are an example of targets, which mandate certain measures by setting a cap or definite number. Perhaps the most famous targets were set by the Kyoto Treaty to limit carbon emissions.

The goal of all these targets and subsidies is to make solar energy viable to stand on its own. To do so, greater efficiency is needed in converting sunlight into electricity. That day may be arriving; "inexpensive cells with an efficiency of 20 per cent have become a commercial reality, while in the lab efficiencies are leaping forward still further" (Daviss).

The Growth of Solar Energy

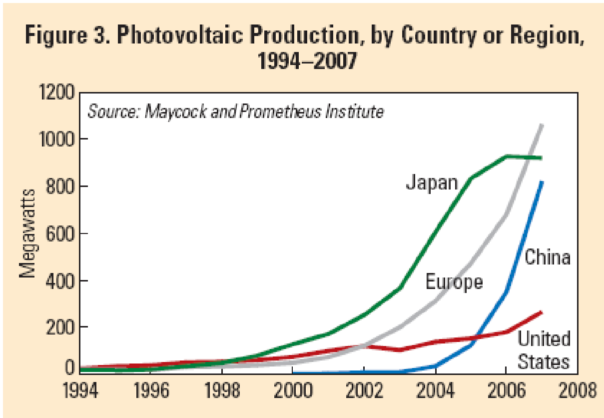
The promise of solar power is seductive in being clean, virtually free once the technology is in place, and seemingly limitless. "The initial investment for solar power may be high but after a few years you have virtually recovered the investment and thereafter pay nothing for the resource" said Pradip Jayewardene, founder of the Solar Industries Association. (Samath)



Source: Sawin, Janet. 2008. Another Sunny Year for Solar Power. Worldwatch Institute.

Location and circumstance play a huge role in deciding just how viable this promise is. "Three factors—real unsubsidized PV system cost, insolation, and cost of grid electricity—determine the likelihood of market growth and maturation in different locations in the industrial world," explains Bradford. (144) In theory, one should be able to balance factors to determine just when solar is cost-competitive in a particular area. A dark country with lots of access to cheap fossil fuel, such as Russia, for instance, would seem a poor candidate for solar, while a bright country with few natural resources would be an excellent candidate. As solar technology improves and fossil fuels become scarcer, solar power becomes viable in an increasing range of locations. In practice, the social values of a country also play an enormous role in when and how aggressively it adopts solar.

Of course cost competitiveness is crucial for solar to continue to grow, and it is improving rapidly. According to Cambridge Energy Research Associates "a kWh [kilowatt hour] of photovoltaic electricity cost 50 cents in 1995. That had fallen to 20 cents in 2005 and is still dropping" (Economist, Another silicon valley).



Source: Sawin, Janet. 2008. Another Sunny Year for Solar Power. Worldwatch Institute.

With better competitiveness and increased environmental concern, solar power is spreading, so that "over the past five years, annual global production of PV cells has increased nearly sevenfold" (Sawin). However leadership in the solar energy has been shifting: "In previous years the manufacture of solar cells and modules was concentrated in three key areas – Europe, Japan and the United States." (Greenpeace 18). The U.S., which had pioneered solar energy, fell behind Japan in the 1990s, when that island nation, lacking local energy resources, pushed solar energy hard and became the global leader. This was largely because "the Japanese residential market has some of the highest prices of grid electricity in the world—an average of twenty-one cents per kWh" (136). Where other energy is expensive solar energy is competitive. Recently, Europe, also facing high energy prices and greatly concerned about global warming, has become the solar energy leader: "Europe—led by Germany—passed Japan to lead the world in PV manufacture, producing an estimated 1,063 megawatts of solar cells in 2007, up 56 percent over 2006" (Sawin). Meanwhile, U.S. share has lost ground, comparatively speaking; "In the United States, cell production rose 48 percent to 266 megawatts. Although this represents a dramatic increase in production from the once world-leading U.S. solar industry, the nation's shares of global production and installations continued to fall in 2007" (Sawin).

Germany now has the largest amount of solar energy in the world. The country has heavily subsidized solar energy, in the form of a feed-in tariff, so that "the average annual growth rate between 2000 and 2005 was well over 40%" (Greenpeace 38). Indeed, with Gemany's subsidy, "so many firms rushed to install solar panels in such profusion that the world ran short of the type of silicon used to make them. The price of silicon—and thus of solar panels—rose" (Economist, More Light). Ironically, Germany is an often overcast country and does not get as much out of each solar panel as sunnier locations would. Germany's subsidies are therefore an example of the law of unintended consequences, and of the care that should be taken in developing solar energy.

Buerstadt, Germany: The roof of a warehouse, equipped with solar panels, May 13, 2005. The 50,000 square meter system with a capacity of 4.5 megawatts per year represents the largest roof based solar system worldwide. Photo by Ralph Orlowski/2005 Getty Images, Inc.

In the U.S., solar activists complain of complacency: "What we have lacked–and it really is unfortunate because these technologies were developed here–is a national energy policy that places a priority on establishing clean, sustainable, renewable energy as a mainstay of our energy portfolio" (Woodside). California, however, remains notable for its emphases on renewable energy: "Solar power generated in the state has grown from about 3 megawatts in 2000 to 177 megawatts this year, a remarkable 5,900% increase" (Jeff St. John). Yet continued exponential growth is necessary for solar to become more than a small player. Even with the recent surge, California still has "only enough to meet about one-third of 1% of the state's peak electricity needs" (Jeff St. John).

California is doing better than most places, where solar remains a puny part of the total energy picture. Even though, "solar energy today is recognized as clean and viable . . . it represents just 0.1 percent of the total electricity market" (Wolgemuth). Yet solar is worth following closely for its trend of exponential growth, which is likely to continue or increase. Solar advocates foresee a surge in solar power similar to, but larger than, that currently happening with wind power. Bradford argues that, "the transition to solar energy and electricity will happen much faster than most people imagine, faster even than most experts commonly predict" (14). Given the current energy picture, and renewed calls for green energy, jobs, and infrastructure, this may very well prove true. Yet the exact mix of technical, economic, and political factors needed to spur this kind of growth remains uncertain. We will have to wait to see if solar remains an exotic sideshow in the energy portfolio or heralds a bright new future for the planet.

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