

Environmental Benefits of Photovoltaic Systems

Photovoltaic (PV) systems help the environment by producing clean, renewable energy that replaces energy produced by power plants that burn coal, oil, and natural gas. These power plants emit many harmful pollutants and greenhouse gases including carbon dioxide, sulphur dioxide, oxides of nitrogen, and soot.

Global warming, the irreversible heating of the planet's atmosphere, is considered to be a serious environmental concern at this time. Global warming is caused by the greenhouse effect – a process whereby solar radiation is trapped at the lower levels of the earth's atmosphere and is prevented from being re-radiated into space. The largest cause of the greenhouse effect in our atmosphere is carbon dioxide gases. Carbon dioxide concentrations have been shown through geologic dating techniques to be on the increase ever since the Industrial Revolution, due to the burning of fossil fuels.

PV systems and other renewable energy systems help to reduce global warming by generating clean energy that replaces energy created through the burning of fossil fuels. A typical medium-sized 3 KW residential PV system in California will prevent 3 tons of carbon dioxide from being released into the atmosphere every year, or 75 tons over its 25 year useful life ("Pollution per KWH for US Regions", Benjamin M. Root, *Home Power Magazine*, Feb/March 2003). In terms of carbon dioxide reduction, this is equivalent to planting about 1,000 trees. It will also reduce sulphur dioxide and oxides of nitrogen in the atmosphere by 850 pounds over its useful life.

Over time, as more and more PV systems are installed, the need for new power plants will be reduced, even if overall energy consumption goes up. Greater than 90% of new power plants are natural gas-fired (*Bringing the Grid into the 21st Century*, Peter Asmus), causing additional harmful pollutants.

The amount of solar energy available on earth for PV power is 10,000 times greater than the total world energy use (www.archive.greenpeace.org).

Studies have been made to monitor the average temperature of the earth over long periods of time, and to predict the effects of a gradual increase in that temperature. While the increase in average global temperature over the last 100 years is only approx. one degree Fahrenheit, this is considered to be significant. And in December 2002, the United States Commerce Department issued a news release stating that the warming trend is accelerating rapidly, and since 1976 the Earth has been warming at the rate of about 3 degrees Fahrenheit per century (*San Jose Mercury News*, Jan 7, 2003).

Scientists believe this can have major effects on life on Earth. For example, in the Jan 2, 2003 issue of *Nature*, the results of a major study undertaken at Stanford University of animal migratory patterns were described. The study found that in 80 percent of bird migratory patterns analyzed, the creatures had significantly changed their migration patterns as a result of global warming. The period of time studied ranged from a decade to a century. In another study, Alaskan white spruce trees were found to be less robust due to higher ambient temperatures. In a study conducted by the University of Texas at Austin, a species of toad in Costa Rica was found to have become extinct due to global warming. And finally, in 2004 the scientific journal *Nature* published the findings of 19 eminent biological scientists, concluding that climate change will "commit to extinction" 18% to 35% of all land-based animal and plant species.

The Arctic ice sheet is thinning at a rate of 8 to 24 inches a year. To date, the Arctic ice sheet thickness has declined by over 40% (*Real Goods Newsletter*, June 2004). This is believed to be a result of global warming. The melting, and the associated change in salinity of large-scale currents in northern seas, has the potential to modify global weather patterns. "If those currents are disrupted, climate could change quickly, within a decade or so," said Jonathan Overpeck, Director of the University of Arizona Institute for the Study of Planet Earth (*San Jose Mercury News*, Dec 8, 2002). One concrete example of this change has been forecast in a study published in March 2004 by Lisa

C. Sloan, professor of earth sciences at UC Santa Cruz. Her research uses satellite measurements of the Arctic ice thickness to predict future global weather patterns. Professor Sloan and her team found that the thinning Arctic ice pack will cause warming in the polar region, shifting the jet stream farther north, and reducing rain and snowfall by nearly a third to the entire West coast of North America. The Sierra Nevada snow pack is the source of water for two-thirds of all Californians, and is crucial for irrigation in the millions of acres of agriculture in the Central Valley.

The Arctic Climate Impact Assessment team has made extensive measurements of glaciers and snow pack levels in Alaska to model global warming. They have found that average year-round temperatures have risen 5 degrees Fahrenheit since the 1960s, and average winter temperatures have soared 8 degrees during that period. Glaciers across Alaska are retreating and thinning. For example, the Columbia Glacier has retreated 7 miles just since the 1960s. And Alaska's forests are suffering under the rising temperatures. Spruce trees, which make up 80% of Alaska's wild forests, are dying at twice the historical rate due to the spruce-bark beetle, which is reproducing more rapidly with warmer temperatures. "It's the largest episode of insect-caused tree mortality ever recorded in North America," said Glenn Juday, a professor of forest ecology at the University of Alaska-Fairbanks (*San Jose Mercury News*, Aug 19, 2003).

The Antarctic ice sheet has been studied extensively by measuring chemical isotope concentrations in rocks collected from the slopes of the West Antarctic Ice Sheet. Rapid melting of this region of the ice pack could cause a rise in the level of the world's oceans, leading to flooding and a greater susceptibility to storm surges. In a study which appeared in the Jan 3, 2003 issue of *Science*, John O. Stone of the Geology Department at the University of Washington noted that "The real problem is that there are places in the world" where a 4 inch rise over the next few decades "would be a quite serious concern because of storm surges and tides."

Most experts agree that the world has between 30 and 50 years of petroleum reserves left. We need to start introducing renewable energy technologies into our national grid and our transportation system now, so that we are not so dependent on oil and natural gas for our energy. This is especially true of imported oil and natural gas, for reasons of national security, balance of trade, and national economic health. The US currently imports 3.8 trillion kilowatt hours of electricity annually, and 70% of that is derived from the burning of fossil fuels (*Energy Information Administration*, US Department of Energy).

The Bush administration is proposing to drill for oil and natural gas in the Arctic National Wildlife Refuge (ANWR). This 19 million acre tract in northern Alaska is home to polar bears, grizzlies, wolves, musk oxen, and a 125,000-strong herd of caribou. The USGS estimates that it contains between 3B and 16B barrels of recoverable oil, which is 3 to 15 years of production at today's Alaskan production rate of about 3M barrels a day. Wouldn't it be better to put that money into photovoltaics?

Photovoltaic systems are a form of distributed generation, meaning that the energy is produced at the same location at which it is consumed. One long-term benefit of this is reduced need for electrical transmission lines, and the electrical losses associated with them.

In summary, many people are concerned about the effects of global warming, our dependence on fossil fuels for our way of life, and the increase in pollutants in our environment. One indication of this is the popularity of hybrid cars, which have far fewer emissions per mile than conventional cars. Sales of hybrid cars grew by 43% in 2002, and major automakers have recently announced plans to enter the hybrid vehicle market. General Motors says it expects to sell as many as 1 million hybrid cars in the next 5 years (*San Jose Mercury News*, Jan 4, 2003). Ford Think Technologies has announced the development of a fuel cell powered hydrogen car.

Photovoltaic systems will become more popular and widespread over the next five to ten years as well, as people look for ways to economize and help the planet's environment at the same time.