

EXTERNALITIES AND ENVIRONMENT

This section includes the latest conclusions on how human energy use is effecting our environment. The consensus is growing that we are affecting our global climate computer modeling programs become more accurate. Recently, the insurance industry has stepped into the debate, calling for reducing greenhouse gas emissions. This section discusses the potential and estimated effects of current energy practices as they translate into related events in our society and environment.

Pricing Pollution in a Competitive Market
Climate Change
Pollution and Health
Energy, Economic and National Security
Hazardous Waste
Land Use

PRICING POLLUTION IN A COMPETITIVE MARKET

Excerpts From a Wind Power Monthly Article, May 1996:

External Costs are costs attributable to an activity that are not borne by the party involved in that activity. Many studies on externalities have been conducted over the last decade. One 1995 study, the European Union's six-volume "ExternE: Externalities of Energy" is probably one of the most systematic and detailed studies ever carried out. A complimentary U.S. Energy Information Administration report that same year, "Electricity Generation and Environmental Externalities: Case Studies", focused on the utility planning issues. (3)

External costs can be broken into three categories; Hidden costs borne by governments, including subsidies and R & D programs. The costs of global warming attributable to CO₂ emissions, including flooding and changes in agricultural patterns. 40-80% of the external costs. Costs of the damage caused to health and the environment by emissions other than CO₂, including acid rain damage and hospitalization or productivity losses. 10-20% of the external costs.

A German study, "The Social Costs of Energy Consumption", by Olav Hohmeyer found that the German Government spent nearly six times more money per kilowatt-hour on research and development of nuclear power than on wind power. (3) Several mechanisms are being considered for introducing externalities into the market.

Government regulation.

This historical approach has lead to inefficient and monopolistic industries, inflexible and highly resistant to necessary change. In addition, the monopolies have not lead to uniformly low costs. For these and other reasons, the current vogue is to deregulate. In completely free markets, however, short-term interests prevail and external costs are ignored. Government regulation can require a mix or minimum use of those energy sources with fewer external costs.

Tax pollution.

To ensure that markets take long-term economics into consideration, governments can impose taxes — such as a Carbon Tax — to the amount of pollution a company generates. Denmark has imposed such a tax, and the European Union is considering the idea and

would use proceeds from such a tax to support other environmental measures like energy savings. Several states in the U.S. have also proposed a Carbon Tax. Give clean technologies "environmental credits." This is the basis of the one-and-half cent "production tax credit" currently available to wind power in the United States. Washington State now offers a sales-tax-free environment for manufacturing of renewable energy technologies. This method has the merit of simplicity and has only a marginal effect on energy costs, but it is not a true integration of external costs into market prices. The taxpayer pays, not the electricity consumer.

Integrated Resource Planning (IRP).

This model seems to best combine the elements of a competitive market with long-term economic (environmental) responsibility. An IRP mandate from the government would require the selection of new generating capacity to include all factors, not just short term economic ones, in the decision process. Environmental impacts, sighting, and customer preference would all be required to be considered but no actual costs would be mandated. Efficiency and renewables would be encouraged, discussions are public, and consumers can vote with their pocketbooks.

Resources:

- (1) Milborrow, David, "Pricing Pollution in a Competitive Market", Wind Power Monthly, p.34.

CLIMATE CHANGE:

The Warming of Our Planet

Carbon dioxide is the primary greenhouse gas. The accumulation of this gas in addition to several others including CFCs are thought to be warming our planet. These gasses are being released by burning fossil fuels faster than natural systems are absorbing them leading to their atmospheric accumulation. (1) The sources of CO₂ are as follows: Industry 4%; Deforestation 8%; Agriculture 12%; CFCs 18%, Energy Production 58%.

Fossil fuel burning releases about 6 billion tons of carbon into the air each year. Since only half of this is being absorbed by natural systems (plants) this adds 3 billion tons annually to the 170 billion tons that have accumulated since the Industrial Revolution. (1) By 1995, the concentration of CO₂ in the atmosphere had reached 360 parts per million (PPM) - higher than at any time in the past 150,000 years. This is far above the 280 PPM that existed when fossil fuel burning began. (1) All greenhouse gasses combined trap as much heat as would be released from more than 300,000 nuclear power plants. (1) Increases in greenhouse gasses coincide with an increase in global average temperatures of 0.6 degrees Celsius over the past century, leading many scientists to conclude that the two trends are linked. (1) The United States is still the largest contributor of carbon to our atmosphere but developing countries are raising contributors. (1)

Indications of climate change include: (1)

The ten warmest years in the past century have all occurred since 1980. The warming of Antarctica in recent decades was demonstrated in spring 1995 when a chunk of the Antarctic glacier as big as Rhode Island collapsed into the South Atlantic. Northern Europe has experienced a string of warm winters and severe winter storms, and alpine glaciers there have retreated revealing rock previously buried for thousands of years.

Northern interior areas of India have experienced life-threatening heat waves in recent summers. A new orbiting radar gun has detected an annual rise in sea level of 3 millimeters during the past three years. Scientists at the University of Helsinki are observing pine trees taking root in northern Finland in tundra areas at a rate of about 10 meters per year. Oceanographers at the Hopkins Institute in Monterey, California, which has been tracking undersea life for 60 years, say that marine snails and other mollusks normally found in warm waters are now expanding their ranges north, while cold-water species retreat. In many regions, tropical corals, which are sensitive to water temperature, are dying. A 130,000 square-kilometer region of the Pacific Ocean has lost 80 percent of its zooplankton as water temperatures have risen.

Recent advances in climate modeling computer programs are eliminating arguments about their effectiveness. The effect of sulfate aerosols, a form of pollution that partly offsets the impact of greenhouse gasses, and closer analysis of regional and temporal climate shifts have now been incorporated into the model. The models have been able to replicate past climate patterns and project future trends far more accurately. (1) Klaus Hasselmann, director of the Max Planck Institute for Meteorology in Hamburg, Germany, says that there is a 95-percent chance that the rise in temperature over the past century is caused by greenhouse gases. (1) A United Nations Panel of scientists called the Intergovernmental Panel on Climate Change (IPCC) concluded in the summer of 1995 "a pattern of climatic response to human activities is identifiable in the climatological record." (1)

What Temperature Change Means For Us

The relatively modest increases in projected global average temperature are not the chief concern of scientists, but the possible disruption of atmospheric and oceanic systems that regulate weather, is. The IPCC report cited above states that "the incidence of floods, droughts, fires and heat outbreaks is expected to increase in some regions" as temperatures rise. (1)

What may happen if global average temperatures continue to rise quickly: (1)

Rainfall patterns may shift, changing the food security in various regions. Steven Hamburg, a forest ecologist at Brown University says one third of the earth's forests could be forced to move as a result of the doubling of CO₂ concentrations projected by 2100. Environmental stresses on forest would likely cause many trees to be infested with insects or disease and susceptible to wildfires. Wood product industries, tourism and forest species may be threatened.

The frequency and severity of severe storms, hurricanes, tornadoes, thunderstorms and hailstorms, may increase as a warmer atmosphere and seas exchange energy faster and add momentum to the vertical exchange process that leads to such storms.

Stronger storms may extend the U.S. hurricane season by two months and allow some storms to move north as far as New York. According to the Intergovernmental Panel on Climate Change (IPCC), most of the beaches on the East Coast of the United States will disappear during the next 25 years as sea levels rise. Rising sea levels due to melting ice caps may also threaten coastal cities, estuaries and aquifers, which people depend on for food. In the case of some islands, the entire country may be at stake.

Insurance companies enter the debate

A mounting body of evidence showing increasing frequency and severity of storms has attracted the attention of a potentially powerful ally for reducing greenhouse gases - the insurance industry. See also, "What's Being Done About Climate Change" below. In May 1991, a cyclone hit Bangladesh killing an estimated 140,000 people and damaging or destroying more than a million homes. Financial losses of \$3 billion came to more than 10 percent of Bangladesh's gross national product (GNP). (1)

In August 1994, Typhoon Fred killed 700 people and caused \$1.6 billion in damage in China. (1)

Hurricane Andrew came ashore in August, 1992 in South Florida destroying 85,000 homes, leaving 300,000 homeless and causing \$30 billion in losses - equivalent to the combined losses of the three most costly previous U.S. storms. This storm alone has changed how some insurance companies assess the purchase of their catastrophe protection. (1);

Since 1990, the worldwide insurance industry has paid out \$48 billion for weather-related losses, compared with losses of \$14 billion for the entire decade of the eighties. (1)

The insurance industry has pressed for many important policy changes to help reduce society's risk like tougher safety standards for automobiles and building codes that reduced the number of fires. (1)

The President of the Reinsurance Association of America, Franklin Nutter, sums up his industry's dilemma; "The insurance business is first in line to be affected by climate change...it could bankrupt the industry." (1)

A representative of Lloyd's of London insurance stated at the Berlin Conference of the Parties to the Framework Convention on Climate Change in March 1995 "it is thus probable that the insurance industry is going to have to take some initiatives by itself or along with the banking industry." (1)

What's Being Done About Climate Change?

The challenge of reducing carbon emissions is not technical or economic but political. Strong opposition from industries deeply vested in the fossil fuel economy has slowed progress in some nations while countries that lack large oil and coal industries have the strongest climate plans. (1)

Results of the Berlin Climate Convention

Environmental leaders from more than 120 countries gathered in Berlin in March 1995 for the first Conference of the Parties to the Framework Convention on Climate Change. Assessments presented at the meeting demonstrated that the world is not yet meeting the climate convention goal adopted three years earlier at the Earth Summit in Rio de Janeiro: holding industrial country emissions of greenhouse gases to the 1990 level in the year 2000. New information from scientists, environmental groups, and insurance companies, led to the current work to develop a protocol to the climate convention aimed for the first time at reducing carbon emissions. (1)

Germany has a goal of 30% reduction in carbon emissions from the 1990 level by 2005. They plan to meet this goal through a combination of energy efficiency and laws such as their "electricity infeed law" that grants generators of renewable electricity the right

to sell power to utilities at a generous price of 17 pfennigs (12 cents) per kWh. As a result of this law, Germany installed more wind turbines in 1994 than any other country. (1)

Despite a hefty gasoline tax of \$3.00 per gallon, German climate policy is still plagued by contradiction. A coal penny surcharge of 8.5% on the nation's power bills supports the otherwise uncompetitive coal industry. This surcharge may be phased out by 2000. (1)

Germany is expected to meet the goal of holding 1990 carbon emission levels the same in 2000 but not the more ambitious goal of a 30% reduction by 2005. (1)

The U.S. climate policy includes fifty measures (two thirds of them voluntary) mostly aimed at energy efficiency, encouraging renewables and planting trees. (1)

A significant increase in gasoline tax was left out of the U.S. climate policy as was any standard for automobile fuel economy. (1) The 1994 U.S. Congress approved only half the funds called for by the climate policy and the 1995 Congress made even more cuts. (1) Recent trends suggest that U.S. carbon emissions will exceed 1990 levels by as much as 10% in 2000. (1)

Japan has a climate program similar to the U.S. including a number of voluntary energy efficiency efforts. (1) In Japan, electric utilities intend to increase coal burning, automobile fuel economy is declining, and renewable energy technologies receive only modest support from the government. (1)

Carbon emissions have leveled off in Japan due mostly to their sluggish economy. They may meet the year 2000 goal for emissions (same level as 1990) if manufacturers continue to be forced offshore by the strong yen. Relocating emissions to their neighbors may be a poor example to set when they host the third Conference of the Parties to the Framework Convention on Climate Change in Kyoto in 1997. (1) Denmark, the Netherlands, and Switzerland have launched an Energy 2000 plan aimed at reducing carbon emissions to 20% below 1988 levels by 2005. These countries are roles of natural gas, renewable energy and energy efficiency and already increasing the have a heavy gasoline tax. Public transportation recently received a subsidy increase in the Netherlands to \$5.7 billion. There, 10% of the surface transportation budget goes to bicycle facilities. (1)

Thirty-six nations represented by The Alliance of Small Island States (AOSIS) that are particularly threatened by rising seas, tabled a proposal in Berlin that would commit industrial countries to reduce their emissions by 20%. The proposal gained endorsement from the Group of 77 (G77) led by nations such as Brazil, China, Egypt, India, Malaysia and the Philippines. European officials including the conference chair and German environmental minister Angela Merkel welcomed the proposal, dubbed the Green Paper. Kuwait, Saudi Arabia, the United States, Australia and others expressed outrage in response to the Green Paper. (1)

Following a Different Energy Path

There is controversy over how practical or expensive it will be to follow a different energy path. The controversy is framed on one side by economists and fossil fuel lobbyists who suggest that holding carbon emissions steady could cost hundreds of billions of dollars and cut economic output by 1.5% to 2.5%. On the other side are other economists, scientists, engineers, environmentalists, and energy entrepreneurs who argue that, once market barriers are removed, new energy technologies are commercialized, and environmental costs recognized, a low-carbon economy would be more economical. (1)

A practical low-carbon energy economy could be achieved in the next few decades with high levels of energy efficiency throughout the economy, a decentralized system of power generators whose waste heat would be used by homes and industry, and increased reliance on methane gas to replace oil and coal. (1)

An excellent collection of industrial energy efficiency projects is available from Environmental Media Services, 1606 20th Street NW, Suite 200, Washington, DC 20009. Tel. (202) 483-0664, Fax. (202) 265-6160. Ask for "Boosting Prosperity; Reducing the Threat of Global Climate Change Through Sustainable Energy Investments." January 1996. 2 Efficiency of consumer appliances continues to rise contributing directly to lower carbon emissions. (2)

Whirlpool's "Golden Carrot" super-efficient refrigerator saves \$135 per year in electricity, while cutting carbon emissions by two-thirds.

A typical commercial building could meet its energy need while reducing carbon emissions associated with meeting those needs by 80%-90% using off-the-shelf technology. (1)

Eliminating the billions of dollars of subsidies to fossil fuel use (see - GOVERNMENT AND REGULATORY IMPACTS) and giving customers a say in the marketplace can be effective reforms for slowing carbon emissions. California, the Netherlands, and the United Kingdom are good examples of where such measures have lowered emissions and energy bills. (1) Mark Mansley of the Delphi Group, a London-based financial firm, concluded in a 1994 study "climate change presents major long term risks to the carbon fuel industry...that are not adequately discounted by the financial markets." (1)

If banks and insurance companies were to dump some of their extensive holdings in oil and coal, or actively invest some of their funds in new, highly energy efficient and renewable energy technologies, they could spur the development of a less carbon-intensive energy system. (1)

Resources:

1. Worldwatch Institute, State of the World 1995, p.21-39.
2. Ogden, Douglas H., "Boosting Prosperity: Reducing the Threat of Global Climate Change Through Sustainable Energy Investments." January 1996.
3. Milborrow, David, "Pricing Pollution in a Competitive Market", Wind Power Monthly, May 1996, p. 34.

POLLUTION AND HEALTH

Fossil Fuel

Amory Lovins of the Rocky Mountain Institute says pollution is just resources out of place. We can tell how well we are utilizing our resources by looking at the pollution. Carbon monoxide (CO), nitrogen oxides (NO₂ and NO) are formed from the incomplete combustion of fossil fuel. Power plants and cars and trucks are the primary source of these gasses in our air. They lead to the formation of ground level ozone, which is toxic in the lower atmosphere, and smog, which can irritate the lungs, cause bronchitis and pneumonia, and decrease resistance to respiratory infections. (5)

Two-thirds of the U.S. emissions of sulfur dioxide (SO₂) are from coal-burning power plants. This gas is the primary contributor to acid rain, which literally kills lakes and rivers,

damages buildings and reduces crop production. (5) Coal mining and oil drilling and transportation result in thousands of examples of drastic ecological effects. We may best remember the Exxon Valdez spill of 1989 but similar accidents and normal mining practices happening every day are continuing to foul our environment. U.S. carbon emissions have reached an all time high: 1,394 million metric tons in 1994, accounting for 25 percent of the global total. (4)

In 1996, the World Resources Institute estimated that more than one billion people live in urban areas with unhealthy levels of air pollution. (6)

In the United States alone, air pollution kills over 50,000 persons a year - a death toll higher than that of traffic accidents, breast cancer, or AIDS. (6) In 1995, 33 million Americans lived in cities that failed to meet federal smog regulations. (6)

The six major air pollutants regulated by the EPA are Particulate Matter, Sulfur Dioxide, Ozone, Oxides of Nitrogen, Lead, and Carbon Monoxide. All are the result of the burning of fossil fuels.

The most dangerous air pollutant regulated by the EPA is Particulate Matter. Multiple studies show that as particulate pollution rises, so do sickness and death. (6)

Asthmatics are highly vulnerable to Sulfur Dioxide, which can trigger asthma attacks even when people are resting. (6)

At levels encountered in most American cities, ozone oxidizes pulmonary tissue, burning holes through the lung's cell walls. As ozone levels rise, so do hospital admissions and emergency department visits. (6) In November 1996, the EPA proposed new, stronger standards for ozone and particulate matter, based on evidence of harm to human health. (6) In China, India, Thailand and other industrialized nations, air pollution is literally palpable. (6)

In the city of Teplice, in the Czech Republic, children wear filter masks to school to protect their lungs from the soot and sulfur pouring out of nearby coal plants. (2) In Katowice, Poland, one of the most polluted areas in the world, only half of all babies are declared fit at birth. One morning in November 1986, 150 babies in Katowice were found dead in their beds. They did not survive the extremely high air pollution during the previous night. (2)

A specialist in allergies in Norway, Arve B. Frostad, says "In Norway we have had a doubling in the number of allergy-sufferers over the last five years. One in five Norwegians is now troubled by it. At the same time, the allergy season is getting longer." Health impairments lead to reduced productivity, and increased consumption of drugs, which lead to higher social costs. (2)

A Swedish research center that investigated the air in Stockholm, Gothenburg, Malmo, and other major cities in 1990 stated, "At least 40% of Bangkok's police have been hospitalized with respiratory problems as a result of the huge amount of motor traffic." (2)

The Renewables Way

Renewables are clean, healthy alternatives to our outdated energy paradigm.

Photovoltaic power generation has zero emissions. The cleanest fossil fuel plants available today will produce over its lifetime, more than 20,000 tons of carbon dioxide and more than 25 tons of nitrous oxides for each MW of power. (1)

Even when the emissions are counted for the energy used to manufacture solar cells, PV generation will produce 1/100th the carbon dioxide of a conventional coal fired power plant (not counting construction of the plant). (1)

By 2015 Low-E windows are projected to prevent, through avoided electricity production only (not other heating), 64 million metric tons of carbon dioxide and 142,000 tons of sulfur dioxide as emissions. (4)

On May 13, 1997, the American Lung Association released a report that helps refute the often repeated claim that stricter air control standards are not worth the costs that would be incurred to achieve them. Instead, the report states that, "cleaning up smog and soot beyond currently acceptable levels would bring major health and economic benefits and could boost the economy." The benefits include avoiding the cost of premature deaths, emergency room visits, time missed from school and work. The author, Jane Hall of California State University at Fullerton asserts, "Lower health care costs and increased worker productivity translate into a better quality of life and also into savings and investment..."

The report concludes that modest reductions in soot and smog would prevent billions of dollars in health damages and premature deaths annually. According to John Garrison, Managing Director, "The human health benefits of cleaner air enhance economic activity and outweigh costs that industry may incur as a result of installing reasonable control measures."

In addition to preventing health damages, the report also concludes enforcement of all parts of the Clean Air Act between 1970 and 1990 resulted in estimated health benefits of \$23 trillion over the 20 year period.

Resources:

1. ASES fact sheet "Photovoltaics and the Environment."
2. Worldwatch Institute, State of the World 1995, p.168.
3. Romm, and Curtis, "Mideast Oil Forever?" The Atlantic Monthly, April 1996, p.57-74.
4. Ogden, Douglas H. "Boosting Prosperity: Reducing the Threat of Global Climate Change Through Sustainable Energy Investments". January 1996.
5. Cole, Nancy and Skerrett, P.J., "Renewables are Ready" Chelsea Green Publishing Company, 1995, p. 210.
6. Moore, Curtis A. "Dying Needlessly: Sickness and Death Due to Energy-Related Air Pollution" February 1997, Renewable Energy Policy Project Issue Brief.

Renewable Energy Policy Project: <http://solstice.crest.org/renewables/repp/>

ENERGY, ECONOMIC AND NATIONAL SECURITY:

Oil and War

A 1981 quote from OPEC-Yamani, Saudi Arabia: (4) "If we force [by raising prices] western countries to invest heavily in finding alternative sources of energy, they will. This will take them no more than seven to ten years and will result in their reduced dependence

on oil as a source of energy to a point, which will jeopardize Saudi Arabia's interest. Saudi Arabia will then be unable to find markets to sell enough oil to meet its financial requirements."

The powerful U.S. fossil fuel industry supports the status quo in the energy markets as they stand to lose a lot of money from changes in it. Large oil and gas companies wield considerable clout in Congress and in state legislatures. They raise the fear of job losses and tax revenue losses whenever renewables are discussed. (6)

Allen Greenspan, Chairman of the U.S. Federal Reserve stated before Congress in July 1995 that a rising trade deficit in oil "tends to create questions about security of our oil resources." (1)

Robert Dole, as Senate Majority Leader said in March 1995, "the security of the world's oil and gas supplies will remain a vital national interest of the United States and many of the most important geopolitical decisions -- ones on which a nation's sovereignty can depend -- will deal with the location and routes for oil and gas pipelines." (1)

Since 1970, sharp increases in the price of oil have always been followed by economic recessions in the United States. (1) If trends continue, in 2006, the United States will be importing roughly a third of our oil from the Persian Gulf. As the dominant share of the world oil market shifts to this area, our economic health shifts to powers in the Persian Gulf. (1) Persian Gulf Nations' oil revenues are likely to almost triple by 2010 to \$250 billion per year. This represents a \$1.5 trillion increase in wealth for Persian Gulf producers over the next decade and a half. That money could buy a tremendous amount of weaponry or influence in a chronically unstable region. (1) The final tab for the Gulf War of 1990 is estimated at \$1 billion a day. That's almost \$50 billion for 45 days of war and roughly equal to the Norwegian national budget. (2)

The Gulf War rebuilding costs are \$50 billion on top of the cost to destroy the area. (2) According to a Greenpeace report, at least 200,000 people lost their lives in the Gulf War. (2)

Long Term Thinking

Federal cuts for renewables in the 1980's were immediately followed by German and Japanese companies buying several major American PV companies. As in the silicon chip industry, these foreign competitors saved tens of millions of dollars on basic research by plucking the best companies. Lack of steady support for renewables may cost the United States its technological leadership advantage as the world market finally takes off. Look to the International and Federal sections under the GOVERNMENT AND REGULATORY IMPACTS heading to see the difference in commitment. (1)

Akio Morita, the founder of Sony has said, "Japan is thinking ten years ahead, while the Americans are preoccupied with the profits they can make in ten minutes. In that way they can never compete with us." (3)

The U. S. wind industry has reached a production plateau while other countries rage ahead. Short term thinking by a utility industry facing new deregulated competition is limiting investment in wind. Once again, The U.S. market position is at risk with little support at home. Look to the PURPA section under the GOVERNMENT AND REGULATORY IMPACTS heading to understand the utility's concerns. (5)

Resources:

1. Romm and Curtis, "Mideast Oil Forever?" The Atlantic Monthly, April 1996, p.57-74.
2. Rostvik, Harald N., The Sunshine Revolution, Sun-Lab Publishers, August 1992, p. 25
3. Ibid. p. 154.
4. Ibid. p. 14.
5. The Solar Letter, Feb. 16, 1996 p. 54.
6. Cole, Nancy and Skerrett, P.J., "Renewables are Ready" Chelsea Green Publishing Company, 1995, p.4.

HAZARDOUS WASTE

The Old Way

When the Exxon Valdez oil tanker spilled its load in Alaska in 1989, Exxon admitted liability and agreed to pay one billion dollars in compensation. This is part of the total price of our energy policies. (2) Oil spills did not start or stop with the Valdez. A partial list includes: (3)

A tanker spilled 21 million gallons off the Shetland Islands in 1992. A foul weather spill off a Spanish fishing port was set ablaze in 1992. February 1996, 20 million gallons spill into the Celtic Sea off the coast of Wales. March 1996, a Galveston, Texas spill sends out a two-mile ribbon of oil. More than 90% of the oil entering U.S. ports is carried in single-hulled tankers, such as the Exxon Valdez.

As often as they occur, tanker accidents account for only 6% of the oil dumped into the marine environment. Municipal and industrial runoff accounts for twice as much oil in the oceans as do tanker spills, according to a Greenpeace report. (3) The Swedes estimate that storage costs for radioactive waste from nuclear power stations in their country will likely add up to \$7 billion. (2) Radioactivity leaked from the Chernobyl accident in Russia was equal to the content of 2000 Hiroshima bombs. Costs from this accident in the Soviet Union alone are estimated at \$150 billion. Probably several million people are suffering from radiation damage leading to impaired immune systems. (2) Nuclear power is among the most expensive forms of electricity available today without considering the cost of decommissioning the plants or any risk from radioactive waste or accidents.

The Renewables Way

The process of manufacturing solar cells is very similar to that of manufacturing computer chips. Both processes use hazardous materials, but experience has yielded very cost-effective recycling of materials used in the process and excellent safety procedures making this a relatively environmentally benign manufacturing process. The cells produce no emissions when producing electricity over their 20-30 year life. (1)

Lubricants in wind turbines need to be replaced at regular intervals. No emissions are produced from the production of electricity over the 30-year life of a wind turbine.

Using renewables does not produce runoff or toxic emissions, and does not increase global warming.

Resources:

1. ASES fact sheet "Photovoltaics and the Environment."

2. Rostvik, Harald N., The Sunshine Revolution, Sun-Lab Publishers, August 1992, p. 23
3. Chivers, Chris, "Currents, Troubled Waters", E Magazine, May/June 1996, p. 14.

LAND USE

The Old Way vs. The Renewables Way

Solar energy systems need less space to produce a megawatt of electricity than does coal-fired power when the land devoted to mining is factored in. (1)

Coal uses 3,642 square meters per 1000 megawatt-hours over 30 years. Solar Thermal uses 3,561 square meters per 1000 megawatt-hours over 30 years. Photovoltaics uses 3,237 square meters per 1000 megawatt-hours over 30 years.

Wind uses 1,355 square meters per 1000 megawatt-hours over 30 years. According to the Worldwatch Institute, it would require only one third of the land at nearby Edwards air-force base to meet the electricity demand of the whole of Los Angeles with solar power. (2)

A solar concentrating system like the Luz plant in California would need 33% less land to produce the same amount of electricity as a coal-fired power station in California's sunny climate, when mining area is included. (2)

Most hydropower projects require at least 20 times as much land per kilowatt-hour as solar power does. (2)

10% of the Arizona desert lands are sufficient to meet the whole of USA's electricity needs using present-day solar cell technology. (2)

Solar cells deployed over 8% of the area used by the U.S. military would provide 25% of today's U.S. electric needs according to a 1992 statement by the Electric Power Research Institute. (2)

Resources:

1. ASES fact sheet "Photovoltaics and the Environment."
2. Rostvik, Harald N., The Sunshine Revolution, Sun-Lab Publishers, August 1992, p. 80