Energy and the Environment

Robert M. Lawrence
Professor of Political Science, Colorado State University

GL03739

The noted environmentalist Barry Commoner has warned that regarding civilization's relationship with nature there is no such thing as a free lunch. By that statement he meant that everything taken from nature for human use carries with it some kind of environmental cost. This is certainly true of the contemporary use civilization makes of nature's energy resources, as can be seen when one views a stripmine from which coal is dug for burning in an electric power plant, or when one visits Denver and notices the smog caused in large part by the use of automobiles.

Concerning energy utilization there are, in addition to environmental costs, economic costs in terms of dollars paid out for various fuels and energy production processes, and in some cases costs in terms of national security considerations. In certain conditions these latter two types of costs are more important to some Americans than are the environmental costs. Taken together the three costs — environmental, economic, and national security, plus what is technologically possible — constitute the constraints within which the United States must make its national energy policy decisions in the 1970's and thereafter. (Today national energy policy results from the decisions of a number of governmental entities, plus decisions reached by private producers of energy and various consuming groups which purchase the energy. This somewhat fragmented situation is likely to change as both the Congress and the White House are working to develop a more comprehensive approach to energy utilization.) Generally such decisions will involve various types of compromises, or "trade-offs," involving at least the first two costs, and at times all three costs. In this article the emphasis will be upon the environmental costs of alternative fuel use. However, it will be pointed out that frequently the environmental cost must be considered in conjunction with the other costs.

Complicating the development of compromises regarding the various costs of alternative fuel usage is the fact that many Americans express a desire for a steadily increasing consumption of energy resources with the resultant increased pressure upon the natural environment. Further complicating matters is the fact that the United States is experiencing shortages of some traditional energy resources. This situation will increasingly require the development of new energy sources which will mean new and different impacts upon the environment.

A comprehensive perspective of the current relationships which exist between energy utilization and environmental impacts, as well as the relationships between environmental costs and the other two costs, may be obtained by reviewing the various energy sources now being used by the United States and those which are being proposed for the future.

Coal

The most abundant energy resource remaining in the United States is coal. Currently it accounts for approximately 20 percent of the energy used in America. Estimates of the U.S. coal reserves vary, but there appears to be more than one hundred years' worth of reserves of economically usable coal at current rates of consumption.

From an environmental point of view there are several costs associated with coal utilization. The so-called "hard" coals of the eastern United States, located near the largest population centers which require the most heat and electricity, contain considerable amounts of sulfur. This means that when such coal is burned, for example in a power plant producing electricity, sulfur dioxide, along with the particulate matter (fine gray ash emitted by the smokestack), is released up the stack into the surrounding atmosphere. Unfortunately, sulfur dioxide is a major air contaminant, and to date, efforts to remove it from stack gasses have not proved satisfactory, although much particulate matter can be removed by using expensive cleaning devices. Therefore, "hard" coal burning power plants may not often be located near large cities because of air pollution standards which prohibit their operation.

So-called "soft" coal contains less sulfur; hence it contributes less sulfur dioxide to the environment when burned. However, the "soft" coal is located in portions of the nation with relatively sparce population, causing less demand for electricity, and even "soft" coal burning may exceed the more stringent air pollution standards which are expected. Approximately 85 percent of the "soft" coal is found under western lands owned in various ways

by the Federal Government. The primary states involved are the Dakotas, Wyoming, Colorado, Utah, New Mexico, Montana, and Arizona. In order to use the western coal deposits to produce electricity for large population centers, such as those in the midwest near Chicago and in southern California, extensive efforts have gone into building large coal-fired power plants in the area of the coal deposits, then transporting the electricity along power lines to the consuming centers. The greatest development of this type has been on the Colorado River plateau in northwestern New Mexico, southern Utah, and northern Arizona, with similar development possible for eastern Wyoming. Burning the low sulfur coal in these relatively low population areas is environmentally preferable to burning it in the heavily populated areas. However, there is concern among some persons that there is still some air pollution from the western power plants which enters the atmosphere of what many consider to be particularly scenic areas of the United States. Further, the western coal is typically located near the surface of the land, which encourages stripmining. This procedure involves stripping off the covering soil and vegetation so that giant scoops can scrape up the underlying seams of coal. Scars left from such operations are the subject of efforts to rehabilitate the land with new vegetation; however, this is a difficult undertaking because of the problems involved in starting new growth on the disturbed soil in arid and semiarid areas.

Where coal is used in power plants there develops a demand for water to use in the power plant for cooling purposes. In areas where water is scarce, the resulting thermal pollution is viewed as an additional environmental burden of significant proportions.

The demand for eastern and western coal will increase substantially should any of several methods of converting coal to synthetic pipeline gas or synthetic gasoline be successfully completed. Not only would such developments mean more stripmining, but since the coal gassification and liquification plants would require large amounts of water, further demands upon what is often a scarce resource would result. As natural gas and gasoline become more in demand and shorter in domestic supply, one may expect impressive efforts will be made to achieve coal conversion methods.

Nuclear Energy

Despite glowing predictions by possibly overly ardent champions of nuclear power, to date less than two percent of the electricity produced in the United States comes from nuclear power plants. A number of explanations exist for this situation. The nuclear power plants are expensive in relation to coal-fired plants, and they take several years to construct. Further, although nuclear plants do not pollute in the usual sense, i.e., release sulfur dioxide, particulate, and other objectionable emissions associated with combustion of fossil fuels into the atmosphere, there are significant environmental concerns about their operation. These objections have led to organized political opposition to the location of nuclear plants in specific sites, and to delays in their construction occasioned by environmental objections raised in the courts. The most dangerous environmental impact which could possibly be associated with a nuclear power plant, and one which has never happened during the several decades of nuclear power plant operation in the world, is an explosion which would spread radioactive debris over a wide area (there have been accidents involving small explosions of a conventional type and fires in nuclear plants — but no major explosion of the kind being discussed here). Other environmental impacts consist of thermal pollution of nearby lakes and rivers because of the necessity to use water from such sources to cool the nuclear reactors (with the water thus heated being returned to the environment) and very slight emission of radioactive substances — at levels far below the tolerances set for human exposure by the U.S. Atomic Energy Commission.[1] An environmental impact of nuclear power plants which often is of concern in areas miles from the plants is the necessity to dispose of radioactive wastes produced in the reactors when uranium or plutonium undergoes slow fissioning to produce heat which turns water into steam for driving generators to produce electricity. Such

[1]*Not all scientists are satisfied that the AEC exposure levels have been set sufficiently low to avoid harm to human and other forms of life. The bulk of scientific opinion, however, is of the belief that the levels of exposure permitted by the AEC are in fact safe.*

wastes are highly radioactive and retain their radioactivity for thousands of years. The standard method of storing such material away from human contact is to seal it into containers and bury it. Concerns have been voiced that disposal of large quantitites of radioactive wastes, as more nuclear plants are put into use, will pose serious environmental problems in terms of finding places to bury the material safe from earthquakes and water seepage over the centuries.

In his June, 1971, Energy Message to the Congress, President Nixon described a new type of nuclear reactor as America's best hope for a clean and plentiful supply of energy in the future. His reference was to the Liquid Metal Fast Breeder Reactor, or LMFBR in shortened form, which in 1973 received more Federal research monies than any other effort to develop new energy sources. The name of this remarkable new nuclear power plant is explained thus — *liquid metal* refers to the substance used to circulate about the reactor core to draw off heat which is used to convert water to steam for turning generators to produce electricity; *fast* refers to fast neutrons which are produced by the fission process in the reactor core; *breeder* refers to the fact that the reactor core is surrounded with a "blanket" of uranium which is useless for other purposes, but which when subjected to bombardment by fast neutrons can be partially transmuted into an artificial element (plutonium), which can be used as the fissionable fuel in other reactor cores. Thus it is claimed that a breeder reactor will operate over time to produce electricity while creating more fissionable fuel than that with which it is originally fueled! Breeders could greatly assist in the production of fissionable fuel for additional reactors at a time (the 1980's when they may enter commercial operation) when uranium suitable for reactor fuel will become relatively scarce and expensive. Proponents of the breeder, including President Nixon, claim that the LMFBR will be less creative of thermal pollution than the currently operating reactors, that radioactive emissions will be lower, and hence that breeders will usher in a new era of clean and abundant energy. On the debit side, it should be noted that extensive use of breeder reactors will create substantial amounts of radioactive wastes which must then be disposed of in some fashion, and that in the past nuclear power has often been oversold in relation to what actually developed.

Still another nuclear reactor is under research, and it is billed by advocates as being the "ultimate" source of energy. It is the fusion reactor. If it can in fact be built, such a device would create the same reaction which fuels the sun or thermonuclear weapons — the fusion of light elements such as hydrogen which produces awesome amounts of heat which can be converted into electricity. Difficult technical and engineering hurdles remain to be solved before the fusion reactor can become a commercial reality. However, the AEC continues to work upon fusion year after year and slow progress is reported each year.

Fusion reactors would probably involve some very low level emissions of radioactive substances such as tritium, and might cause some thermal pollution of nearby water sources as water which was heated during cooling of the reactor would be returned into the environment. There would also be some long lasting radioactive wastes which would require disposal. On the positive side of the environmental ledger are the facts that successful fusion reactors would produce immense quantities of electricity which would reduce substantially or eliminate the need to produce electricity in coal-fired or oil-fired power plants, thus reducing or eliminating the need for stripmining and greatly clearing the atmosphere of the pollution products of fossil fuel burning. Further, it appears that large explosions in fusion plants are almost impossible because of the physical properties such plants would possess.

An interesting possibility that has been mentioned in regard to fusion reactors is the "fusion torch." This concept would utilize the tremendous temperatures produced in a fusion reactor to reduce garbage and even metal rubbish, including car bodies, to their basic constituent elements — a kind of recycling which has no counterpart at this time.

Natural Gas

Of all the fuels now being widely used in the United States, natural gas has the least impact upon the environment because little air pollution is caused by its burning. Because of this and the fact that the price of natural gas has

been kept artificially low by government regulation, it is the preferred fuel for heating many homes and buildings. Since it is cheap in relation to other fuels and nearly pollution free, natural gas is being used in huge quantities in the U.S. — supplying 32 percent of the total energy consumed in America. Because of this heavy use and because of dwindling domestic supplies, the United States faces a real possibility that if demand for this premier fuel continues unabated, Americans will not be able to meet the demand from domestic reserves. At this time it is not clear whether efforts to convert coal to synthetic gas, increases in gas prices to stimulate further discoveries of gas fields, or importation from abroad will combine to enable Americans to use such environmentally desirable fuel; however, private producers and the government appear optimistic.

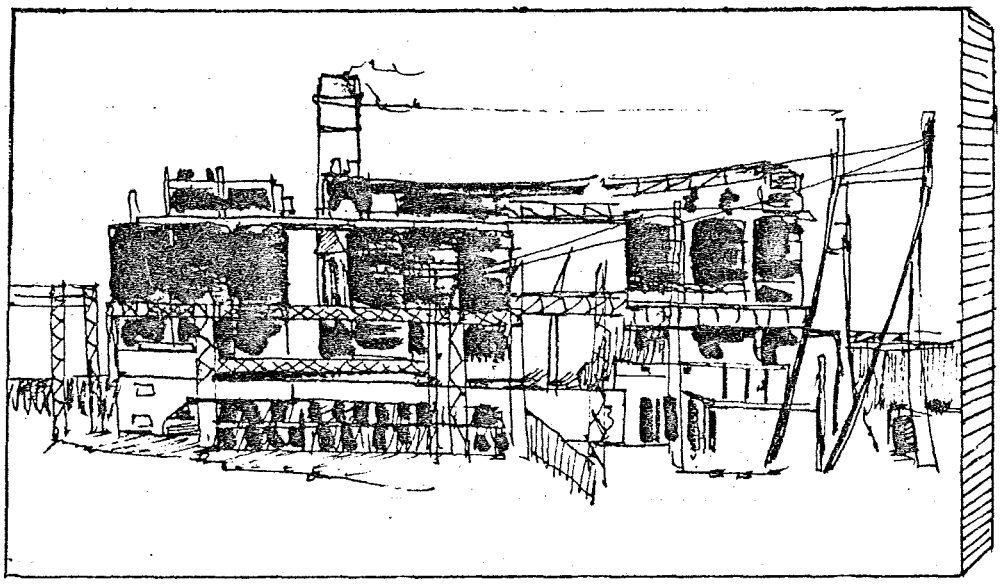
A very controversial means of increasing natural gas supply is to detonate nuclear weapons in underground strata containing natural gas, thus freeing the gas so it can be more readily pumped to the surface. This method, called gas stimulation by nuclear means, has been tried selectively in New Mexico and Colorado. The results have been ambiguous, with various groups claiming it is economic and does not involve radioactive gas, and others claiming the opposite.

Petroleum

Fuel oil for heating, fuel for diesel engines, gasoline for automobiles, and JP4 for jet aircraft engines constitute major energy requirements in the United States. Last year petroleum products accounted for 43 percent of all energy consumed in the country. As is the case with natural gas, the United States is not able to produce all the petroleum from domestic sources which it uses. This has led to increasingly greater reliance upon petroleum imports, most notably from the Middle East, with the possibility that some will come in the future from the Soviet Union. Some estimates are that by 1980 the U.S. may be importing something like 30 percent of its petroleum from abroad — a condition which creates fears in the minds of those responsible for national security as well as officials concerned with the economic health of the nation. The first group does not like to see the U.S. importing such an important necessity from an area of the world which is both politically unstable and possibly subject to controls imposed by the Soviet Union. The economic implications of such heavy imports arise from the possibility that the U.S. could soon be paying some $25 billion for petroleum bought abroad, and this would seriously undercut the efforts by the government to correct an already serious balance of payments problem.

Two types of general environmental problems are associated with the use of petroleum. One involves spills and leaks while the fuel is being transported — for example, the oil spill when a tanker sinks and the leaks and other environmental damage feared by some groups should the Alaska pipeline be built, which would bring oil from the North Shore field either directly to the "lower forty-eight" states or to southern Alaska, where it could be shipped by tanker the rest of the way. The other environmental problem associated with petroleum use is probably the pollution with which most Americans are now all too familiar — air pollution in major cities. This condition found in far more areas than Los Angeles — where the smog jokes started — is caused to a large extent by auto and truck exhaust which reacts chemically with sunlight to produce the yellow-brown smudge befouling many city skylines. As yet there seems to be no really good technical solution for the pollutants produced by internal combustion engines. This circumstance recently led Congress to pass the Clean Air Act, which requires the nation's automakers to increase their efforts to reduce auto emissions within the next few years. Success in this effort is not guaranteed, and another approach was suggested early in 1973 by the director of the Environmental Protection Agency. That was to ration gasoline in the Los Angeles basin as a means of greatly reducing vehicular traffic in that area, which would in turn greatly reduce the smog.

An alternative to importing more petroleum is to develop deposits of oil shale. These strata of rock are found in western Colorado and the nearby states of Utah and Wyoming, and a gasoline-like substance has been extracted from oil shale in a pilot plant. While the method is not yet economically competitive with



gasoline produced within and without the U.S., the rising price of gasoline in the future could make oil shale development attractive. The environmental impacts of oil shale development could be fairly substantial, according to some observers. For example, the process used would require water in a water-short region of the nation. Further, accumulations of spent oil shale, from which the synthetic oil had been removed, would require some type of disposal. This could be done by simply dumping the shale slag into deep uninhabited canyons of the area with what is claimed by petroleum interests to be of little environmental consequence to the nation as a whole. In time the slag might be rehabilitated with vegetation. Obviously, some conservation and environmental groups oppose such a plan. Fortunately, the oil shale may be dug from deep holes rather than stripmined so the problem so often associated with coal does not appear regarding oil shale. The scare created by the Arab oil cutoff during and following the 1973 Arab-Israeli war in October 1973, created pressure to develop oil shale. Part of the emphasis was supplied by President Nixon's goal to make the United States independent in energy production by 1980.

Hydroelectric Power

Electricity, which is produced when water stored behind a dam is used to spin turbines to produce electricity, does not create air pollution nor radioactive wastes. It does require, however, that valleys which are scenic or fertile be covered with water, which constitutes a significant environmental impact on the local area. Hydroelectric power no longer poses much of an environmental consideration because most of the areas suitable for dam building have been utilized and those remaining probably cannot be used because of determined opposition by environmental groups. Currently the amount of energy produced by hydroelectric dams is only slightly more than two percent, and the percentage of total usage will probably shrink as other sources are tapped.

Geothermal

Anyone who has watched in fascination as Old Faithful spewed forth steam and boiling water in Yellowstone National Park has witnessed a source of energy receiving renewed interest. Those who view geothermal power as a real energy alternative visualize pumping water deep into the earth where it would be turned to steam by heat radiating outward from the earth's core. The steam would be piped to the surface, where it would spin turbines and produce electricity, as is being done in a power plant north of San Francisco and in New Zealand and Italy. Aside from the construction necessary to drill the steam wells and build the plant itself, there would be little environmental degradation associated with geothermal energy utilization. While thus attractive from an environmental standpoint, geothermal

energy may not be available at costs to make it competitive with other forms of energy for some time. Further, tapping geothermal energy requires the location of places where the earth's crust is sufficiently thin to permit drilling down to hot zones, and it appears that such places are not always available.

Solar Energy

The source of energy which may come the closest to breaking Barry Commoner's statement about no free lunches is energy from the sun, which in some instances may have no environmental degradation effects at all.

Anyone who has stood for a time in the direct rays of the sun in an Arizona desert in the summer will appreciate the tremendous amount of solar energy which strikes some parts of the earth each day. For some time men and women have dreamed of capturing a portion of this energy for use in producing electricity or in the heating and cooling of homes and buildings. Some success in research has been achieved. For example, there is a home in Denver, Colorado, upon whose roof there are solar energy collecting panels. The sun's heat captured is transferred to bins of rocks which gradually radiate the heat in the evening and on cloudy days to warm the house. About one-third of the home's heat is produced by solar energy. Built by a professor at Colorado State University, the process used in the home is now too expensive for commercial application. However, with rising fuel costs, such solar heating and cooling may become economical within this decade.

Other proposals exist for utilizing the sun's energy. One is to capture it with giant satellites operating above the earth and then to beam the concentrated energy down to receiving stations. Another is to cover portions of the Arizona and California deserts with solar collecting panels which would trap the sun's heat for use in turning water to steam for operating generators in the production of electricity. While the former would seem to pose no environmental problems, the latter would involve construction of solar panels in sizable areas of the desert and might involve utilization of quantities of water in an area where that resouce is quite scarce. Nevertheless, energy in the form of electricity thus produced might be less environmentally degrading than increased burning of coal and oil.

Hydrogen

If truly immense amounts of cheap electricity were to become available, say from the new types of nuclear reactors, collection of solar energy, or geothermal sources, one may consider the massive extraction of hydrogen from seawater by electrolysis. The hydrogen gas could then be used to heat homes and buildings in place of natural gas, and probably to operate internal combustion engines. In either case there would be little air pollution.

Future Predictions

Considerable savings in the consumption of various fuels are expected in the near future from developments which will increase the efficiency of current operating means of energy production. Further, impressive savings may also be expected from efforts to insulate buildings and homes to prevent the loss of heat in the winter and coolness in the summer. Higher prices for all fuels should also cut down wasted energy usage. Together these efforts will lighten the environmental impact of energy production and use.

When the various new energy sources are reviewed, and even considering the savings associated with increased efficiences and insulation, energy use in the near future in the United States must be viewed as continuing to place considerable burden upon the natural environment. This is particularly so if the assumption is made that energy use in the United States will continue to increase in support of a rising standard of living.

Several of the immediate means of producing additional energy — greater burning of coal to produce electricity, conversion of coal to synthetic gas or gasoline, and importation of oil and gasoline — all will contribute to greater environmental degradation. Only importation of natural gas, which has economic and national security implications, carries a reduced environmental impact. Thus for the near future greater energy use will mean generally greater environmental impacts, although the danger to human and other forms of life is debated. Clean energy must await further scientific development.