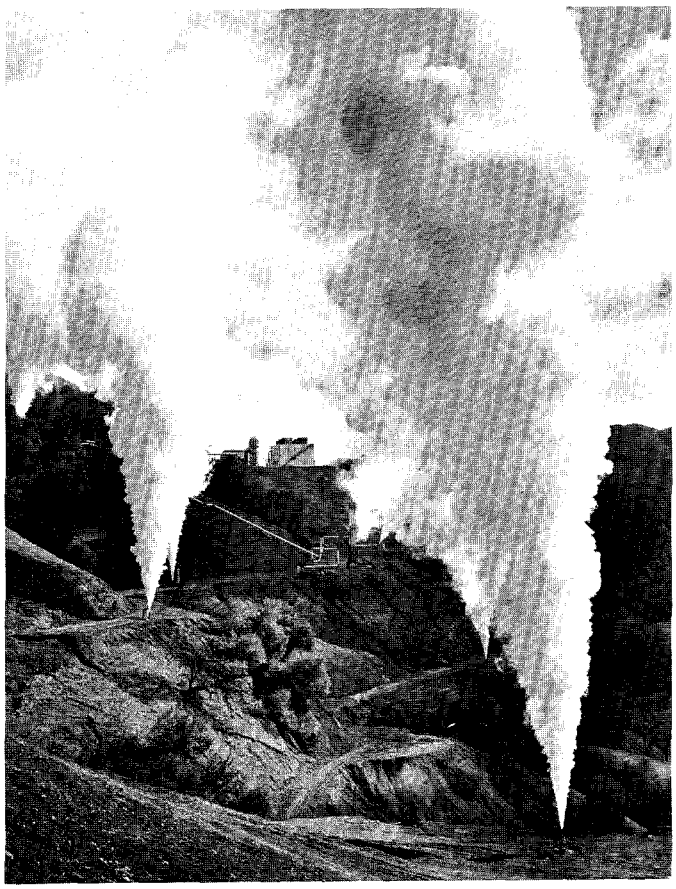
Geothermal Resources—Potentials and Problems



The only geothermal power plant in the United States at present is the 11-year-old Pacific Gas and Electric Company facility, "The Geysers," located 85 miles north of San Francisco. The plant's four turbogenerators turn out 82,000 kilowatts, and two more generators are now being added. Plans call for expansion to produce up to 1 million kilowatts from the steam.

The margin between the supply of electrical power in the United States and the demand for it is rapidly narrowing. Major breakdowns, rationing, and other cutbacks have become commonplace in many parts of the country during the summer.

Over the long term, relief may come from the development of relatively "clean" sources of energy, such as fusion power. Accomplishing this would make limitless supplies of energy available. For the short term, however, there is little prospect of respite. Public resistance to nuclear-powered plants has slowed or stopped their construction, and tougher standards imposed on fossil-fueled plants has reduced their output. The result is that the ability of the utility companies to meet increasing energy demands is severely restricted.

As a temporary solution, utility companies have been urged to turn to an energy source that some believe is pollution-free, comparatively inexpensive, and plentiful enough to contribute as much as 4 to 5 percent of the total power generated in the U.S.—geothermal energy.

Geothermal energy is the scientific name for large underground reservoirs of steam and scalding water. Found at depths of from a few hundred to 30,000 feet beneath the surface, the water is heated by the molten matter that oozes up from the earth's core between the huge plates that make up the crust. Geothermal fields are found where two plates are trying to pull apart from each other. California, which some geologists believe may hold between 5 and 10 percent of the world's geothermal reserves, is one such spot.

However, Martin Goldsmith (PhD '55) visiting associate in environmental engineering, on leave from Aerospace Corporation to work with the Environmental Quality Laboratory, reports that such geothermal fields are not as pollution-free, inexpensive, or extensive as those who favor their development have claimed. In an EQL report, "Geothermal Resources in California, Potentials and Problems," Goldsmith points out that there is enough geothermal potential—at least in California—to enable us to squeeze through the predicted power crisis for the next few decades. But it will take technical solutions—often expensive—to solve the inherent environmental problems.

Goldsmith investigated two geothermal reservoirs, one near San Francisco and the other in the Imperial Valley.

The northern California site—The Geysers—is currently being exploited for power by Union Oil Company and Pacific Gas and Electric Company. It is now producing 193 megawatts of electrical energy. By 1979 it should be generating 1,000 megawatts, about the equivalent of a single modern nuclear power plant. The area of the steam reservoir under The Geysers is known to be greater than 10 square miles, and it may be as large as 20 square miles, which leads to some speculation that the field's capacity could be increased to 4,000 megawatts.

The Imperial Valley field is estimated to contain between one billion and five billion acre-feet of superheated water—which might produce 20,000 to 30,000 megawatts of electrical power. The field has been under exploration since about 1957, but so far it has not been developed commercially. Goldsmith attributes this delay both to the reluctance of companies to invest money and to foot-dragging by the federal government. At this time, one year after the federal geothermal leasing law was signed, no federal leases have been granted. Exploration companies, utilities, and local government agencies have pointed to this as a problem of procrastination because over half of the potentially productive wells appear to lie under federal lands.

If geothermal power is indeed to supply any portion of California's electricity in the near future, development of these fields must proceed as soon as possible because of the technical and environmental problems that must be overcome.

One of the most serious environmental problems involves the nature of the wastewater produced by a geothermal plant. In the Imperial Valley, the wells encounter very hot water at depth; this scalding water flashes into a mixture of steam and water as it flows up the well pipe. The salts and minerals in it amount to as much as 25 to 30 percent by weight in some areas. (By comparison, ocean water contains 3.3 percent salts.) These highly mineralized wastes cannot be discharged into surface waters. Even discharge into the ocean could lead to serious contamination if the plant waste differed substantially from ocean water—unless the two were very well mixed.

The most promising method of disposal appears to be injecting the wastewater into the ground. If large quantities of fluids are removed from an underground reservoir, the land surface may sink—sometimes with disastrous consequences. One method for coping with this problem in oil fields is to inject water into the reservoir. Similarly, disposal of geothermal wastes by injecting them into or near the reservoirs may be necessary to prevent subsidence.

Noxious gases are often a by-product of geothermal wells. At The Geysers, the odor of hydrogen sulfide is pervasive. It exists in the steam with other gases such as carbon dioxide, methane, hydrogen, and ammonia. In a 1,000-megawatt installation in some geothermal areas, 100,000 pounds of hydrogen sulfide might be released each day. This is about the same as the amount of sulfur released by a fossil fuel power plant of the same size, burning low-sulfur oil. The problem in eliminating these gases is not one of technical feasibility but of practicality and cost.

Another significant local environmental effect is heat rejection. If ten 1,000-megawatt geothermal plants were installed in the Imperial Valley, the total heat rejected from them, added to the 1,000-square-mile area, would be 5 percent of the total summer solar heat. What the effect of this added heat on the local weather would be is unknown.

Since drilling for geothermal steam involves high-pressure fluids, well blowouts are a major environmental problem. Standard oil-field methods have been used to bring such blowouts under control, but days were required to cap the wells, which meanwhile geysered steam and salt water. Such a release of salt water in an agricultural area, where many geothermal sites would be located, would cause irreparable damage. Means for effecting prompt blowout control must be employed.

While it is clear that geothermal development can have environmental impacts, Goldsmith urges that great caution be observed in passing protective legislation. If land subsidence seems likely to occur, irrigated portions of the Imperial Valley would have to be protected. But blanket prohibition of subsidence is not sensible, for it would not be a problem in many areas. Likewise, the escape of noxious odors must be carefully controlled, but residential standards need not be applied to industrial areas. The solutions are technical, as well as legal, and for this reason Goldsmith cautions against allowing a confusing mishmash of federal, state, and local regulations to evolve that would needlessly inhibit the development of this much needed energy source.