June 1, 1972

STATE OF WASHINGTON
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Olympia, Washington 98504

GEOTHERMAL ENERGY—QUESTIONS AND ANSWERS

WHAT IS GEOTHERMAL ENERGY?

Geothermal energy is the heat of the earth's interior. This heat deep within the earth is generated by radioactive decay and is conducted through the rocks of the earth's crust to the surface, where the heat slowly escapes. At the places where molten rock is cooling near the earth's surface, the escape of heat may be much greater than normal. Man is attempting to harness this energy and utilize it as a source of power.

WHAT FORMS DOES GEOTHERMAL ENERGY TAKE AND HOW IS IT MANIFESTED AT THE EARTH'S SURFACE?

Over most of the earth's surface the temperature in the earth's crust increases slowly with depth—at an average rate of about 1 degree Fahrenheit per 100 feet. Under these conditions the escape of heat from the surface can be detected only by sensitive instruments, and there are no visible signs of geothermal energy.

In a few areas, such as hot springs or the oceanic ridge systems, where igneous rocks (rocks formed by solidification from a molten or partly molten magma) are cooling and fairly near the earth's surface, the temperature increases rapidly with depth. Within the earth, circulating ground water may absorb the escaping heat and reach temperatures that exceed the boiling point. This can result in surface manifestations such as geysers, hot springs and pools, or vents where hot gases escape into the atmosphere. Here, the surface of the earth is often warm or even hot to the touch.

WHAT GEOLOGIC CONDITIONS ARE NECESSARY FOR THE EXISTENCE OF A GEOTHERMAL FIELD?

There are four geologic requirements for a geothermal field. These are:

1. A source of heat, usually a cooling igneous rock.
2. A reservoir rock with high porosity and permeability (ability to hold and transmit large quantities of fluid).
3. A cap rock that is impermeable to keep the hot geothermal fluids from escaping.
4. A source for recharge of the reservoir. Recharge is usually accomplished by percolation of ground water into the geothermal reservoir.

HOW IS GEOTHERMAL ENERGY TAPPED?

In areas where the escape of heat toward the surface is much greater than normal and hot ground water is present at depth, the energy can be tapped by using drills and drilling methods similar to those used in the oil industry for handling fluids at high pressures and temperatures. The deepest geothermal wells drilled so far are 9,000 to 10,000 feet deep.

HOW IS GEOTHERMAL ENERGY UTILIZED?

Geothermal energy is used for recreation (resorts), space heating, domestic hot water, and industrial process heating. Where it is hot enough to produce steam, it may be used to drive turbines for the generation of electricity.

WHERE IS GEOTHERMAL ENERGY CURRENTLY BEING USED?

Geothermal energy is being used for electric power generation at The Geysers geothermal field in California; at Cerro Prieto, near the Gulf of California in Mexico; in New Zealand; Italy; Japan; and the Soviet Union. Geothermal energy is used for heating in Iceland; Klamath Falls, Oregon; and Boise, Idaho. Resorts in many parts of the world use hot springs for bathing and recreation.

WHAT AREAS OF THE WORLD MIGHT HAVE GEOTHERMAL POTENTIAL?

Since cooling igneous rocks are required as a heat source, most discoveries of geothermal fields will probably be made in areas where volcanic activity has recently occurred. Most of these active or recently active areas are located around the rim of the Pacific Ocean and in a belt passing through the Mediterranean-Himalayan region.

IS GEOTHERMAL POWER ECONOMICAL IN RELATION TO OTHER ENERGY FORMS?

The geothermal electric-generating plants constructed so far have been able to produce power at costs equal to or less than power costs for competing coal-fired, nuclear, or hydroelectric generating plants.

WILL OUR PRESENT OR PLANNED COAL-FIRED, NUCLEAR, OR HYDROELECTRIC GENERATING FACILITIES BE ADEQUATE FOR THE FUTURE?

Recent studies show that the Pacific Northwest is entering a period when supplies of electricity may not be able to meet peak demands. Thus, we may be subjected to "brownouts" such as those that have occurred on the east coast. New generating plants must be built to correct this situation and provide for anticipated increases in demand for energy. Since our hydroelectric sites have been nearly used up, it will be necessary to build coal-fired or nuclear plants. But there is considerable concern regarding the environmental impact of nuclear plants, and the Pacific Northwest does not have economically extractable coal supplies to support additional coal-fired generating plants. Any new method of supplying energy, including geothermal, should be investigated in order to evaluate its potential capacity and environmental impact.

HOW SIGNIFICANT IS THE NORTHWEST'S GEOTHERMAL ENERGY POTENTIAL IN COMPARISON WITH OTHER POWER SOURCES?

There has not been enough study to predict the amount of power that might eventually be produced from geothermal sources in the Pacific Northwest. However, most authorities agree that geothermal power will not be more than a supplementary source of power—able to supply only a few percent of the power needs of the Pacific Northwest.

WHAT ARE THE TYPES OF GEOTHERMAL FIELDS AND THE ENVIRONMENTAL CONSIDERATIONS OF EACH?

There are two types of geothermal fields. A dry steam field, such as The Geysers in California, produces steam, without liquid water, from its wells. The steam can be used to drive turbines as it comes from the ground. The steam contains about 0.5 percent of gases other than steam. These gases include carbon dioxide, methane, hydrogen sulfide, hydrogen, nitrogen, argon, and ammonia. After the steam has passed through the turbines, these gases escape into the atmosphere. The Geysers is in a sparsely populated area and the escape of these gases has been tolerated—there has been no noticeable effect on the local flora and fauna. "Spent" steam evaporates into the air as water vapor, and any condensate is pumped back into the geothermal reservoir.

The other type of geothermal field—the hot water field—produces a mixture of steam and hot water from its wells. The steam may be used to operate turbines, but the hot water presents disposal problems because of its content of heat and dissolved solids, and its large volume. Plants now in operation in Mexico and New Zealand simply allow this waste water to flow into nearby rivers or accumulate in holding ponds.

One alternative might be to desalt the waste water and use it for irrigation or drinking, and the mineral salts recovered may be sold. However, this alternative has not yet proven economical.

The production of electricity from dry steam fields is possible by using present technology and with only minor environmental disruption. Hot water geothermal fields present serious environmental problems that must be solved before such fields can be developed in this country.

IS SPECIAL EQUIPMENT REQUIRED IN GEOTHERMAL POWER PLANTS?

The design of geothermal turbines and piping is different from other power plants because the steam is at lower pressure and temperature. Since the steam is mildly to severly corrosive because of the presence of gases other than steam, special corrosion-resistant metals and materials must be used in the manufacture of geothermal equipment. These differences from conventional power plants can, in most cases, be easily handled using present levels of technology.

CAN A GEOTHERMAL POWER PLANT BE BUILT WHEREVER IT IS NEEDED?

No, geothermal fields occur at relatively few places, and these places are generally not in the highly populated areas where most of the electrical power is needed. Generating facilities must be constructed near the geothermal field because steam cannot be transported more than 1 or 2 miles without losing much of its energy.

Because the geothermal plant must be located near the geothermal field, any environmental impact from the facilities needed for power generation—wells, pipelines, generators, and turbines—is confined to one site. However, the electric power generated from the geothermal plant must often be transmitted considerable distances to reach the area of power use. Other types of power generating plants, such as coal-fired and nuclear, require mines and fuel processing plants that may be located in many different areas. Therefore, their environmental impact may cover a larger area.

WHAT IS THE "PLOWSHARE" GEOTHERMAL PROGRAM?

The "Plowshare" geothermal program is designed to use underground nuclear explosions to create heat and fracture naturally hot rock. Water then may be circulated through this rock and the resulting steam used to drive turbines and create electric power. The concept has not been fully tested, and its economic and environmental feasibility is still not proven.

WHAT EXPLORATION TECHNIQUES ARE USED TO LOCATE A GEOTHERMAL FIELD?

Surface geologic mapping is an important tool that may be used to find areas with suitable geologic structure. Chemical analysis of hot spring waters and measurements of temperature gradients in drilled holes can supply much information about how hot and how large a geothermal field may be.

Other sophisticated geophysical devices are able to add considerable detail about the underground shape and size of a geothermal field.

IS EXPLORATION FOR GEOTHERMAL ENERGY BEING CARRIED ON IN WASHINGTON?

Yes. The Division of Mines and Geology of the Department of Natural Resources sponsors and supports geologic mapping and geophysical research that is aimed at investigating Washington's geothermal potential. In addition, the Division of Mines and Geology staff members are engaged in thermal gradient studies and evaluation of data bearing on geothermal energy.

WHAT IS THE POTENTIAL FOR FINDING USUABLE GEOTHERMAL ENERGY IN WASHINGTON?

Washington has fairly extensive areas where young volcanic rocks occur, especially in Klickitat, Yakima, and Skamania Counties. The most obvious examples of young volcanic activity are the five large volcanoes, Mount Baker, Glacier Peak, Mount Rainier, Mount Adams, and Mount St. Helens. Washington also has several areas where hot springs occur.

The abundant evidence of young volcanic activity in Washington makes the prospect for discovering geothermal energy appear bright enough so that a thorough exploration effort is justified. At this time, however, no one can predict the extent of Washington's geothermal resources.