CHAPTER I. INTRODUCTION

This report describes progress during Fiscal Year 1979 (FY 79) and near-term plans of the Federal government for promoting the use of geothermal energy. In 1979 the United States produced about 62 quadrillion Btu (quads) of energy. Of these about 21 quads were from petroleum; 20 were from natural gas; 15 were from coal; 3 were from hydroelectric; 3 were nuclear; and about 0.1 was "other," which included geothermal, biomass, and solar energy. Geothermal energy contributed 62 trillion Btu, yet this form of energy has a great potential to assist in the future energy needs of the United States.

In order to keep energy imports at a manageable level, we must again resume an annual increase of domestic energy production of about 1.25-1.5 quads per year. By the year 2000 the nation must be producing about 90-92 quads of energy to maintain present per capita consumption. No one fuel source appears to have the potential to produce that much energy. Geothermal, solar, coal, nuclear, agricultural waste, and gasohol must all augment an aggressive conservation program. The geothermal energy of the nation, if vigorously produced, could supply as much as 0.1 quad each year to this 1.25-1.5 quad.

While geothermal energy will not solve the United States' energy problem by itself, it will make a major contribution to relieving energy supply shortfalls in some regions. Geothermal energy is one of the cleanest, safest, and sometimes most economically attractive energy sources available, and presents the further advantage of being available now for the higher quality resources. Research programs are making possible its more widespread use.

The IGCC goals for energy production in the year 2000 are electricity production equivalent to 2.2 quads of fossil fuel input (1,056,000 barrels of oil per day equivalent), direct heat use equivalent to 1 quad of fossil fuel input (472,000 barrels of oil per day equivalent), and methane production of 3 quads. Meeting these goals will make significant contributions to national energy needs. The National Energy Plan (NEP-II, May 1979, Medium World Oil Price Case) projects for the year 2000 energy consumption of 119 quads, and end use of 85 quads. When the hydrothermal goals are compared to the NEP-II projected growth in demand between 1985 and 2000, the geothermal contribution will be 4 percent of the increased electricity supply and about 10 percent of the increased supply for direct heat.

By the year 2000, more than 25 percent of California's electricity could come from geothermal sources. Twenty percent of the nation's natural gas use could come from methane from geopressured aquifers.

This report contains a number of important findings:

- Geothermal development by the private sector is increasing
- A very aggressive Federal program is needed to ensure that the specified goals are met

DISCLAIMER

- Successful coordination of Federal, state, and private sector planning and activities has improved
- Recent technology advances have reduced the cost and risk associated with geothermal development
- Geothermal energy is economically competitive today at many sites, and on the verge of being so at other sites
- Environmental, legal, and socioeconomic constraints may impose impediments on development at specific technically attractive sites

The commercial development of geothermal energy is relatively new. Consequently convincing the appropriate decisionmakers and end-users that geothermal resources should be used in their projects will not be easy, for commitment to this energy resource still involves financial risks.

A. SCOPE OF GEOTHERMAL ENERGY

Geothermal energy sources are concentrations of thermal energy stored in subsurface rocks and fluids that are heated by underlying molten rock or radiogenic plutons. Some of these resources can be tapped by drilling, and the hot fluids brought to the surface for generation of electric power or for direct uses of heat from the thermal fluids.

- Hydrothermal sources include water and steam trapped in fractured or porous rocks. A hydrothermal system is classified as either hot-water or vapor-dominated (steam), according to the principal physical state of the fluid. Hydrothermal resources are used both for electric production and for direct thermal applications.
- Geopressured resources consist of water at moderately high temperatures at pressures higher than normal hydrostatic pressure. This water contains dissolved methane. Geopressured sources in sedimentary formations along the Texas and Louisiana Gulf Coast are believed to be quite large. Geopressured formations also exist in sedimentary basins elsewhere in the U.S. Commercial-scale utilization of these resources may begin in the late 1980's.
- Hot dry rock resources consist of relatively unfractured and unusually hot rocks at accessible depths that contain little or no water. To extract usable power from hot dry rock, the rock must be fractured and a confined fluid circulation system created. A heat transfer fluid is then introduced, circulated, and withdrawn. Commercial-scale utilization of hot dry rock resources may begin in the 1990's.

Geothermal energy has been used in this country on a very limited scale since the end of the 19th century. Fluids from a geothermal system in

Boise, Idaho, began heating homes there in 1894. The city, with DOE help, is currently expanding development of that system. It now heats about 145 homes, and will eventually be used for a community-wide system, beginning with a major downtown redevelopment project. In 1960, use of geothermal resources for generation of electric power began at The Geysers field in California and use has increased steadily. Present development provides steam for 663,000 kilowatts of electric capacity. Nonelectric uses consume about 1.5 trillion Btu per year for space heating and industrial and agricultural processes in more than a dozen states.

During the past year utility companies announced that they intend to build electric power generating plants totaling more than 1,000 MWe from high-temperature hot water resources. These plants, plus announced additional plants extending high-temperature dry steam-generating capacity at The Geysers to 1,900 MWe, should produce installed generating capacity of about 3,000 MWe by 1985. The most efficient and timely development of geothermal resources will depend on the coordinated efforts of Federal, state, and local governments, industry, consumer and environmental groups, and private citizens.

B. THE INTERAGENCY GEOTHERMAL COORDINATING COUNCIL

Figure I.1 depicts the geothermal community in the United States, those entities with a direct stake in developing geothermal energy sources. Federal responsibilities and programs are divided among a number of agencies, whose activities are coordinated through the Interagency Geothermal Coordinating Council (IGCC), formally established by a Charter adopted in November 1977.

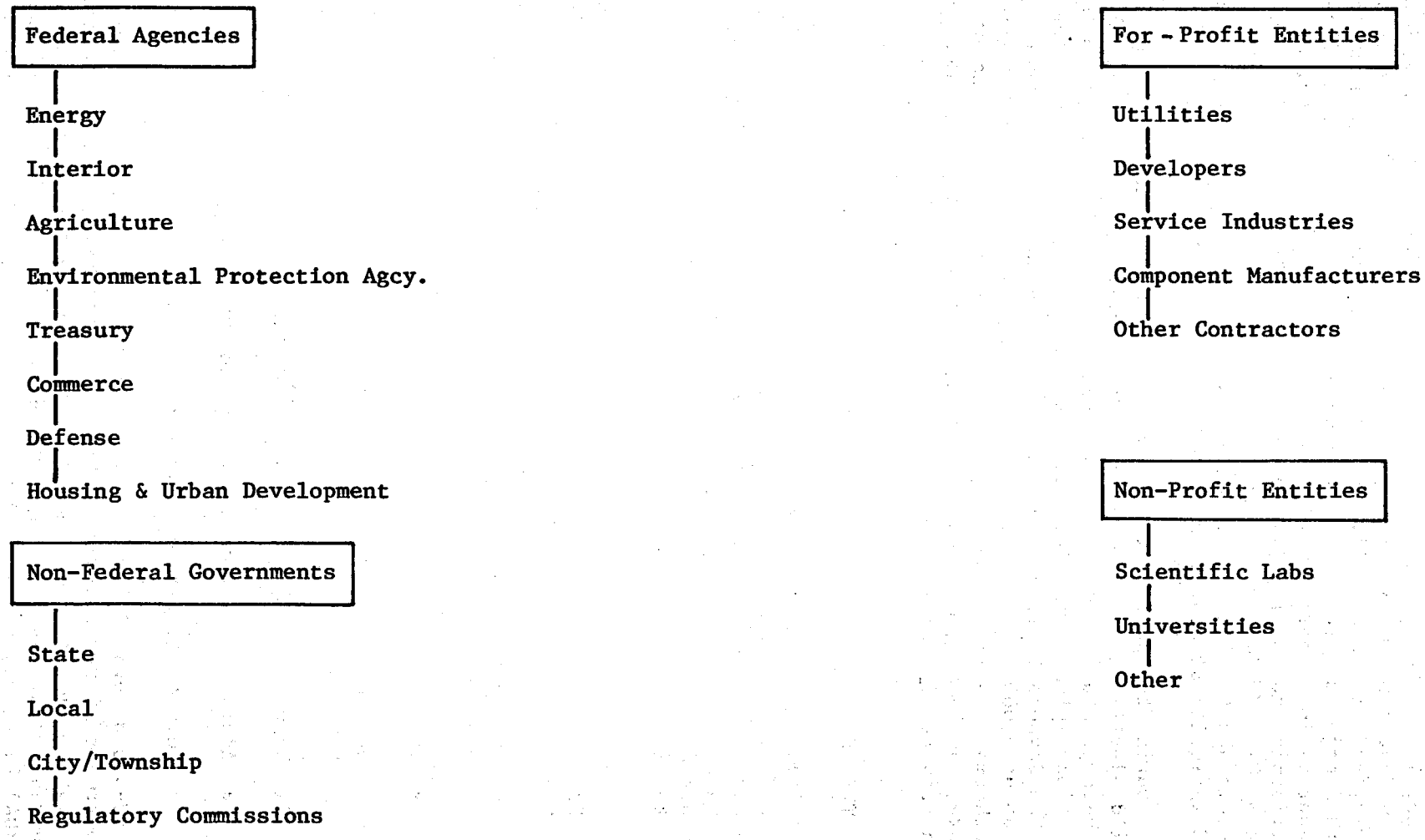
The IGCC got its start when Congress established the Geothermal Energy Coordination and Management project in Public Law 93-410, enacted September 3, 1974. The project was authorized to

- Coordinate and manage national geothermal energy R&D programs
- Determine and evaluate geothermal resources
- Develop exploration, extraction, and utilization technologies
- Demonstrate appropriate technologies
- Administer a loan guaranty program
- Develop commercialization strategies.

PL 93-410 delegated certain functions to specific agencies, for example, Department of the Interior, National Science Foundation, Department of the Treasury. The Project became the responsibility of the IGCC in 1974 when Congress established the Energy Research and Development Administration (ERDA) in the Energy Reorganization Act. The IGCC brings together all the Federal agencies that encourage development of geothermal

FIGURE I. 1

THE GEOTHERMAL ENERGY COMMUNITY IN THE U.S.



resources by private industry, and serves as an effective means for exchanging information among government agencies and formulating Federal policies. It develops detailed Federal program plans and goals, and defines actions and policies to be followed by Federal agencies to accomplish these goals.

C. HISTORY OF THE FEDERAL GEOTHERMAL PROGRAM

Although geothermal energy has been used in the United States since 1894 (see Table I.1), serious commercial interest did not begin until the late 1960's. The genesis of Federal geothermal activity can be said to have been the USGS's limited assessment, in 1969, of geothermal resources. This assessment was drawn from basic research conducted by USGS on a limited scale since 1945 as a part of its charter to assess national resources. At about the same time, the Bureau of Reclamation was looking at these resources as a means of mineral extraction.

By 1971 there was momentum enough to start a geothermal program in the Atomic Energy Commission. The AEC Act had been amended to mandate research into energy sources other than nuclear power. The Division of Applied Technology included Coal, Electrical Storage, Solar, and Geothermal offices. Even though the main emphasis was placed on geothermal technology, there was an attempt to relate the program to industrial applications. At approximately the same time, the National Science Foundation considered geothermal energy in its Research Applied to National Needs project. NSF thereafter became the lead agency for geothermal activities. In 1973 the USGS, AEC, and NSF prepared the first coordinated Federal geothermal program plan.

In early 1975 all of AEC's and the bulk of NSF's programs were transferred to the Energy Research and Development Administration (ERDA), created by the Energy Reorganization Act of 1974. The Non-nuclear Energy Research and Development Act of 1974 gave ERDA considerable additional authority, including incorporation of the geothermal program previously established by the Geothermal Research, Development, and Demonstration Act of 1974. ERDA was given programmatic geothermal functions, and also was given the authority to coordinate all geothermal activities of Federal agencies. DOI retained its traditional role of national resource assessment and leasing of Federal lands.

Originally ERDA's orientation to geothermal energy was primarily technological. Although demonstration projects were envisioned, no funds were appropriated for them. The ERDA activities were aimed at electric power production, almost entirely to the exclusion of non-electric uses. A formal commercialization program was established only with the organization of The Department of Energy (DOE) in 1977; however, the concept of involving industry in geothermal development had been implicit from the beginning of Federal involvement in geothermal activities. In 1975, ERDA's Division of Geothermal Energy (DGE) had started to phase in commercialization activities, but kept these activities closely tied to basic research. In 1979, the Division of Geothermal Resource Management was created under the Assistant Secretary for Resource Applications of DOE; research and development continued in DGE under the Assistant

Table I.1

SIGNIFICANT EVENTS IN THE DEVELOPMENT OF GEOTHERMAL ENERGY IN THE UNITED STATES

• 1894	District Heating in Boise, Idaho
• 1900	Hot Water to Homes in Klamath Falls, Oregon
• 1916	Power Generation at Geysers Resort
• 1927	First Exploratory Geothermal Wells Drilled in Imperial Valley, California, by Pioneer Development Company
• 1959	Small Pilot Plant Operated Near Niland, California on Sinclair No. 1 Well
• 1960	Commercial Electricity Generated from Dry Steam at The Geysers (Cal.)
• 1970	Geothermal Steam Act Passed
• 1972	NSF Becomes Lead Agency for Federal Geothermal Programs
• 1973	USGS, AEC, NSF Prepare First Federal Geothermal Program
• 1974	Geothermal RD&D Act Passed
	First Federal Lands Leased
• 1975	ERDA Formed; Division of Geothermal Energy Formed Primarily from NSF, AEC
	USGS Releases First National Geothermal Resource Estimates and Inventory
• 1977	DOE Formed; DGE Kept Intact
• 1978	NEA Tax Act Passed
	EPA Issues Pollution Control Guidelines for Geothermal Energy Development
	Successful Hot Dry Rock Experiment Conducted (New Mexico)
	First Geothermal Crop-Drying Plant (Nevada)
• 1979	USGS Releases Updated National Geothermal Resource Estimates and Inventory
	10 MWe Plant Built by Industry at East Mesa (Cal.)
	Streamlining Task Force Recommends to IGCC Measures to Speed Federal Leasing
	First Production from Federal Lands, at The Geysers (Cal.)

Secretary for Energy Technology. Late in the year, it was announced that DGE would be moved to Resource Applications as well.

D. ORGANIZATION OF FOURTH ANNUAL REPORT

This Report describes the measures taken in FY 79 to stimulate commercial development of electricity from geothermal resources and direct applications of geothermal heat. Unlike previous Reports, this document includes descriptions of private sector development as well as public sector activities. Due to the proprietary nature of much of the industry's work, however, it is not possible to obtain information about all facets of private development. Statements about private sector achievement, therefore, are indicative but not comprehensive.

This Report describes:

- The geothermal strategy and plan
- Utilization goals, estimates, and resource potential
- The Federal program for commercialization, technology development, policy development, and international activities
- Environmental developments
- Regional, state, and local government accomplishments, status, and plans
- Industry activity in geothermal development.

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