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THE DOE GEOTHERMAL RESEARCH AND DEVELOPMENT PROGRAM

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ABSTRACT

The author reviews the progress of geothermal development since the Geothermal Steam Act of 1970 and discusses the present status of geothermal technology and the recent accomplishments of the DOE geothermal program. He then describes the present DOE budget picture and program planned by DOE, giving a context for reservoir engineering research and development.

INTRODUCTION

I am pleased to be here today at the 8th Annual Reservoir Engineering Workshop to review for you the DOE geothermal program. As you are aware, DOE has reevaluated its program priorities across the board. This has required a realistic appraisal of our energy options and needs and a redefinition of the Federal role in research and development, in line with the Administration's policy of reducing Federal deficits and reducing interference in the free market.

The Fiscal Year 1983 program is being finalized by Congress and the President and it reflects a transfer of commercialization activities to the private sector and an emphasis on the critical long-range high-risk research and development that industry is not expected to undertake alone.

HISTORICAL REVIEW

To give a context for the present program, I will review briefly the geothermal program of the last twelve years.

In 1970 when the Geothermal Steam Act was passed giving leasing access to public land that contained more than half the geothermal resources, geothermal activity was very small in the United States. Boise and Klamath Falls had rather old district heating systems and Pacific Gas and Electric Company was producing 78 megawatts at The Geysers steam field with no hydrogen sulfide control and with the liquid effluent discharging into a creek. About 100 exploratory wells had been drilled in the Western United States and at that time the key technical barriers were a) the limited knowledge of the nature and extent of the resource, b) the limited knowledge of reservoir behavior under production conditions, c) the high risk and cost of geothermal drilling, d) the unknown cost and the technical challenge of meeting environmental concerns, e) the large total investment cost, f) the unknown economical potential for exploiting geopressured resources and hot dry rock.

The progress in resolving the technical problems, with the help of the USGS, industry, the universities and the DOE Labs has been considerable. Some highlights are:

1. National maps of the potential resource have been produced, with detailed maps for the Western states.

2. About 25% of the resource is considered (by the USGS) to be discovered. Improved geophysical techniques have assisted greatly in this determination.

3. About 600 wells have been drilled. Drilling costs have been reduced by about 25% but still remain high. Fracture zones are still much harder to drill than matrix-permeable rocks.

4. Reservoir models for production capacity and longevity are being used with limited success.

5. Air quality concerns are being met at fairly high cost but injection of spent brine remains a problem area.

6. Binary systems, low cost materials and components, and chemical treatments are becoming available to reduce total power plant cost up to 25% but further reductions are needed.

7. The economic potential of hot dry rock and geopressured are still not known.

A major goal of the Federal program in the last decade was to stimulate the growth of industry and this has resulted in the availability of a number of commercial items in the private sector. These include:

1. Magnetotelluric and passive seismic exploration techniques.

2. Precipitators/clarifiers and scale inhibitors to handle high salinity corrosive brine.
3. Wellhead size flash, total flow and binary power systems.
4. High-temperature elastomers and polymer concretes.
5. Improved drag and roller-bit drills using polycrystalline diamonds and new seals and bearings.
6. Water and mud-driven turbo-drills for directional drilling.
7. Cavitating water-jet cleaning for piping and heat exchangers.
8. High-temperature electronics and sensors for well logging.

CURRENT STATUS

Industry reports that there are now several hundred industrial firms of various sizes involved in geothermal field development and power plant design and construction. Recent estimates show that the U.S. private sector investment in geothermal energy development exceeded $230 million in the year 1981. There are now 19 power plants on line--totalling 902 MW at The Geysers, 30 MW at the Imperial Valley and 3 MW in Hawaii. Forty-three new power plants are planned to be on line by 1990 adding an additional 2234 MW. Direct heat uses totalling 12.5 trillion BTU per year are now operational and a similar amount of additional capacity is in the planning stage.

During the past fiscal year, the DOE program has accomplished a number of important activities including:

1. Completing the proof-of-concept experiment for the hot dry rock system at Fenton Hill.
2. Completing short term tests of the geopressured resource characteristics of nine existing oil and gas wells on the Gulf Coast.
3. Completing negotiations on the final design and long lead time procurement for the 50 MW binary geothermal demonstration project at Heber, California.
4. Completing the operational tests and shut down of the 5 MW pilot plant at Raft River.
5. Developing lost-circulation zone mapping techniques.
6. Completing the evaluation of the helical screw expander in Italy, and transferring it to New Zealand where tests are now well under way.
7. Developing the design and completing the fabrication of carbon dioxide and pH probes for monitoring brines in hydrothermal power systems.
8. Completing the user-coupled hydrothermal resource definition drilling program.
9. Testing seismic and electromagnetic exploration techniques in the geothermal environment for injection monitoring.

Summarizing the present status of the technology and economics of geothermal development, the present picture seems to be:

1. The generation of electricity from vapor-dominated resources is cost-competitive and presents no significant technical problems, other than finding a cost-effective method for H_2S control.
2. The exploitation of liquid-dominated resources is economically marginal except at a few high grade sites.
3. Drilling and completion technology has improved and advanced approaches offering lower costs are emerging.
4. Reservoir uncertainty remains a major problem and it is compounded by the lack of adequate low cost exploration techniques, logging instrumentation and reservoir engineering.
5. The available materials and geochemical techniques are not yet adequate to provide economic solutions for injection of fluids and prevention of corrosion.
6. Environmental control technology is available for air and water emission but only at significantly high cost and the control of subsidence is still an uncertainty.
7. Stimulation of poorly producing wells has proved to be an expensive and uncertain technique.

PRESENT BUDGET PICTURE

In planning the DOE geothermal program for the current fiscal year, we have followed policy guidelines which place an emphasis on research and development--but without abandoning on-going projects that represent firm earlier commitments. For example, we plan to continue the Heber demonstration plant and to complete the work on the direct heat field experiments. We plan to complete the second-phase loop operation of the hot dry rock research at Fenton Hill and to conclude our work on geopressured well testing.

In fiscal year 1983, we plan to continue working in energy conversion technology associated with moderate temperature resources, including the development of direct contact binary technology and research on the binary fluid equations-of-state and transport properties. We will also continue development of temperature and corrosion resistant materials and conduct research on scale control and slurry elimination. In the geosciences, we plan to continue development and field testing of advanced geoscience technologies to enhance exploration success and reservoir management through improved geophysical and geochemical techniques.

Reservoir engineering is and will continue to be one of the most important aspects of the DOE geothermal technology development program. In the present program structure, we are carrying reservoir engineering under the category of geoscience technology, where we emphasize both resource definition and injection technology. Both of these items fit well within the new priorities and they clearly both require considerable development in the discipline of reservoir engineering.

CONCLUDING REMARKS

I have not attempted to review in any detail the contribution made to geothermal development by reservoir engineering because I can see how well it will be covered in the program before us. I still find it remarkable that we are able to make any conclusions from the scant data we are able to obtain about the phenemona occurring in the unseen depths of the earth. It is through the powerful, theoretical work and the extensive practical work performed by many of the experts here at this conference that we have achieved the present level of understanding and can hope to reach the goals we have set for ourselves. I wish this workshop every success.