

NOTICE CONCERNING COPYRIGHT RESTRICTIONS

This document may contain copyrighted materials. These materials have been made available for use in research, teaching, and private study, but may not be used for any commercial purpose. Users may not otherwise copy, reproduce, retransmit, distribute, publish, commercially exploit or otherwise transfer any material.

The copyright law of the United States (Title 17, United States Code) governs the making of photocopies or other reproductions of copyrighted material.

Under certain conditions specified in the law, libraries and archives are authorized to furnish a photocopy or other reproduction. One of these specific conditions is that the photocopy or reproduction is not to be "used for any purpose other than private study, scholarship, or research." If a user makes a request for, or later uses, a photocopy or reproduction for purposes in excess of "fair use," that user may be liable for copyright infringement.

This institution reserves the right to refuse to accept a copying order if, in its judgment, fulfillment of the order would involve violation of copyright law.

STATUS OF DOE'S INTERNATIONAL COOPERATIVE EFFORTS IN GEOTHERMAL ENERGY

John E. Metzler

Office of Technical Cooperation
U.S. Department of Energy
Washington, D.C. 20585

ABSTRACT

The US Department of Energy is involved with bilateral arrangements with Italy, Mexico, New Zealand and Japan, and in three multilateral International Energy Agency Agreements. These activities provide each participant technical benefit, and serve to accelerate the introduction of geothermal energy utilization worldwide as well as serving foreign policy objectives. The chief benefit to the Department of Energy has probably been to its reservoir modelling efforts, which have been improved and evaluated by employing the data and case histories provided by various countries.

INTRODUCTION

The US Department of Energy (DOE) currently has bilateral agreements with Italy and Mexico; is negotiating agreements with Japan and New Zealand; and is involved with three multilateral cooperative efforts through the International Energy Agency (IEA). DOE benefits from these agreements chiefly through access to unevaluated data and operating experience which are or were otherwise unavailable to it in the US, and which are needed to validate and improve reservoir models. Such efforts help in estimating the US and the world's geothermal resources. For foreign participants, cooperation with DOE in general improves their understanding of their resources and how best to exploit them, and provides additional insight into new techniques and technologies being developed in the US, and a chance to evaluate their worth. Cooperative activities are also part of the US Government's conduct of foreign policy and serve such objectives as improving ties with allies and reducing world dependence upon oil.

BILATERAL AGREEMENTS IN EFFECT

Italy

An Agreement Between the US Energy Research and Development Administration (ERDA) and the Ente Nazionale per l'Energia Elettrica (ENEL) on Cooperation in the Field of Geothermal Energy Research and Development was signed June 3, 1975 and subsequently renewed five years later by an exchange of letters. Since 1975, ERDA has become DOE and ENEL's geothermal R&D activities have been consolidated into a single organization, the Unione Nazionale

Geotermale or UNG. The proponents in charge of this Agreement are Dr. J. Salisbury, Deputy Director, Division of Geothermal Energy, DOE, and Professor L. Paris, Director of ENEL's research programs. The purpose of the cooperation is to develop technology for electric power applications and to improve equipment and techniques for assessing geothermal resources. The Agreement is broken down into five projects areas. Their status is as follows (with project leaders in parenthesis):

Project 1: Stimulation of Hot Dry Rock and Hydrothermal Resources (M. Smith of LASL and P. Ceron, Assistant Director of UNG). This project concerns itself with the identification of sites and techniques for stimulation and the actual conduct of such stimulation tests. Most of the activity has been so far information exchange. LASL, as a result of observing a stimulation test at Larderello, is now testing Italian high temperature cementing techniques at Fenton Hill. Future work is to focus on exchanging information on explosive stimulation of difficult formations. Italy has been invited to observe the fracture tests at the Geysers, scheduled for mid 1980.

Project 2: Utilization of Hot Brines (C. McFarland, DOE, and G. Allegrini, in charge of engineering at UNG). In 1975 both sides felt that they had common problems in developing their highly saline fields. However, upon closer inspection, they were found to be sufficiently different that a mutually beneficial basis for collaboration could not be established. Only limited amounts of information have been exchanged to date.

Project 3: Reservoir Definition (P. Witherspoon, LBL, and R. Cataldi, in charge of foreign projects for UNG). This project seeks procedures for optimizing techniques of resource assessment and reservoir engineering. Through the efforts of Patrick Muffler of the USGS who spent September 1976 to September 1977 in Italy, the publication "ENEL Studi e Ricerche: Geothermal Resource Assessment and Reservoir Engineering" resulted. It reviews efforts to apply known resource assessment techniques to actual case studies; to extend techniques from the oil and gas industry to the geothermal case in order to improve estimating techniques of

reservoir capacity, extent and behavior; and to validate mathematical models of fields with actual performance data. In general, ENEL supplied operating data and case histories acquired over decades and DOE supplied analytical techniques. Joint activities are currently underway to refine these techniques.

Project 4: Deep Drilling (S. Varnado, Sandia Laboratory, and U. Cigni, responsible for all power plant operation and construction at UNG). Implementation of this project has been stymied by problems in scoping out the cooperation. In the future, activities are to focus on well-test and laboratory researches of mutual interest related to deep drilling.

Project 5: Environment (A. Jelacic, DOE, and G. C. Stefani, in charge of UNG's Geomineralogical Services). DOE is working with ENEL to determine the environmental effects of hydrogen sulfide and radon associated with the production of geothermal energy. Each side is also exchanging information on seismic activities at Larderello and the Geysers induced from geothermal energy production.

A DOE-ENEL symposium is scheduled for October 20 to 22, 1980 at LBL to review all progress made under the Agreement over the past five years.

ERDA signed an Agreement with Consiglio Nazionale delle Ricerche (CNR) and ENEL in May 1976 to exchange and maintain a computerized file of information and data on geothermal well and field sites, their physical characteristics, and their economics throughout the world. DOE is responsible for collecting data essentially from the Western Hemisphere, and CNR and ENEL from the rest of the world. The Technical Information Center at Oak Ridge, Tennessee, USGS (for its GEOTHERM information system), and LBL (for its GRID system) have exchanged some information with CNR. However, the little demand for the information so far indicates that the establishment of this Agreement may have been premature.

Mexico

The Agreement Between the Comision Federal de Electricidad (CFE) of the United Mexican States and the US Energy Research and Development Administration, signed July, 1977 has allowed DOE to study with CFE the geologic setting and hydrothermal circulation of the world's only liquid-dominated field with seven years of production history. Much of the information exchanged is applicable to the development of the geothermal resources in the Imperial Valley, California, and to CFE's plans to exploit further the Cerro Prieto field. Robert Gray is responsible for the DOE-CFE program in DOE and works closely with Marcelo Lippman, the Agreement's Technical Coordinator at LBL. Eng. Hector Alonzo Espinoza is the Executive Coordinator for CFE at Cerro Prieto.

Of the seven task areas under the Agreement, the first three tasks (geology and hydrogeology,

geophysics, and geochemistry) supply facts and insights from which an accurate, dynamic model of the Cerro Prieto field can be developed (under task 4, reservoir engineering) and used to determine safe production rates, optimum well spacing, and the life of the reservoir. The USGS and CFE are determining the extent of subsidence (task 5) caused by the extraction of geothermal fluids. Under task 6, DOE and CFE are working together in planning a large scale reinjection operation. Under task 7, information dissemination, two conferences have been held, one in San Diego in September, 1978, and another in Mexicali, B.C. in October, 1979; future conferences are to be held at 18 month intervals and workshops for experts in the various task areas are to be scheduled when needed.

Currently, DOE and CFE are considering adding an annex to the Agreement to include cooperation at the Los Azufres field, 150 km West-Northwest of Mexico City. To date CFE has performed resistivity, telluric, magnetometric, self-potential, and surface-geologic surveys, and drilled at least 15 deep wells. Los Azufres will provide both sides the opportunity to study a high temperature, fractured volcanic geothermal field using the most-up-to-date geological, geophysical, and geochemical techniques, and to use the data to enhance reservoir engineering techniques.

PENDING BILATERAL AGREEMENTS

Japan

On May 2, 1979 the Governments of the United States and Japan signed an Agreement on Cooperation in Energy and Related R&D. This Agreement absorbed an earlier Implementing Agreement between DOE and the Agency of Industrial Science and Technology (AIST), Ministry of International Trade and Industry (MITI), in the Field of Geothermal Applications, signed June 15, 1978. B. DiBona, Director of DOE's Division of Geothermal Energy, and M. Ikematsu, Director, Development Program (Geothermal Energy), Sunshine Project, AIST are in charge of the Agreement's implementation for geothermal energy.

In May 1979, the first US-Japan Geothermal Coordinating Committee met in Washington, D.C. to review each other's programs and to determine topics of mutual interest (chiefly binary cycles and hot dry rock) and next steps. In August 1979, US and Japanese experts held a review session of each other's work in the areas of binary cycles, total-flow concepts, and the economics of the hot dry rock concept, as part of a Japanese delegation's tour of US geothermal facilities. Since that time, DOE and AIST have been negotiating final provisions of an agreement whereby Japan will contribute to the DOE Hot Dry Rock project at Fenton Hill on the same basis as the Federal Republic of Germany (FRG) under an IEA Agreement (see below).

New Zealand

As an outgrowth of the long and successful informal interactions between US and New Zealand specialists

in geothermal energy, DOE and the Department of Scientific and Industrial Research of New Zealand are currently considering a Memorandum of Understanding that will allow exchanges of information, short-term visits and assignments of personnel, joint planning of tests and methodologies, and cooperative programs and projects in the areas of well drilling and completion; high temperature logging; brine chemistry and materials; fluid stimulation production techniques; reservoir engineering; studies of two phase flow; and brine and waste disposal.

MULTILATERAL ARRANGEMENTS -- IEA

In the wake of the 1973-74 oil crisis, various member countries of the Organization of Economic Cooperation and Development (OECD) signed in 1974 an Agreement of an International Energy Program to strengthen cooperation on energy policy. The International Energy Agency was then established in Paris to administer the Agreement as an autonomous body within the OECD. The four elements comprising the IEA program are:

1. Energy Research, Development and Demonstration (RD&D),
2. Information on International Oil Markets,
3. Emergency Oil Sharing, and
4. Producing and Consuming Country Dialogue.

The objectives of the IEA RD&D program are to assure that those technologies which can increase the supply of energy and/or reduce world dependence on oil are developed and applied; to avoid unnecessary duplication of effort wherever possible; and to make more effective use of resources through joint programs and projects. The IEA has set up a Committee on Energy Research and Development which consists of representatives of the member countries and is supported by a small Secretariat staff. The Committee has various working parties under it, one of which is the Working Party for Geothermal Energy, composed of specialists from Austria, Belgium, Federal Republic of Germany, Italy, Japan, Sweden, Switzerland, Turkey, the United Kingdom, the United States and the European Community.

Currently, there are three Implementing Agreements in effect under the Geothermal Working Party. Their status is as follows:

1. Geothermal Equipment: In May, 1979, ENEL, CFE, the New Zealand Ministry of Works and Development, and DOE signed an Implementing Agreement for a Program of Research, Development and Demonstration on Geothermal Equipment. The one and only annex to the Agreement (so far) lays out the specifics of the testing of a 1.2 MWe Helical Screw Expander, developed for DOE by Hydrothermal Power Co., Limited, of California, at test sites in Mexico, Italy and New Zealand. The performance, reliability and economics of this advanced piece of equipment over a broad range of geothermal resource conditions is to be assessed by the host country. The Helical Screw Expander is undergoing testing at Cerro Prieto in 1980 and is to be shipped to Italy before 1981. An Executive Committee oversees

the test program, and has met twice, once in August, 1979 in Washington, D.C. and again in June, 1980 at Cerro Prieto.

2. Hot Dry Rock Technology: In September, 1979, Kernforschungsanlage Julich GmbH (KFA) in West Germany and DOE signed an Implementing Agreement for an RD&D program on Hot Dry Rock Technology to last for four years. Under the Agreement's conditions, the Bundesminister fur Forschung und Technologie will make annual cash contributions equivalent to 25% of DOE annual funding of the Fenton Hill project, up to \$2.5 million. German scientists and technicians are to participate in the management and conduct of experiments and obtain raw data. Japan is currently considering participating in the Fenton Hill project under the same conditions as the FRG.

3. MAGES: In October, 1977, KFA, the National Swedish Board for Energy Source Development, the UK Natural Environment Research Council, and DOE signed an Implementing Agreement for a Program of R&D on Man-Made Geothermal Energy Systems (MAGES). Japan signed the Agreement in April, 1979. Each participant shared equally in the cost of the study, which was conducted by the Operating Agent, KFA. The study evaluated the technical and economic merits of MAGES and provided recommendations for future laboratory and modeling activities, and field tests at the pilot plant level. The project ended June 30, 1979 and a final report was issued to the participants in late 1979. The Geothermal Working Party is now considering extending the MAGES Agreement to a "hardware" phase, possibly a MAGES experiment in Western Europe. If so, it and the Fenton Hill project would provide a valuable basis from which the applicability of the Hot Dry Rock/MAGES concept to various geologic settings could be evaluated.

ACKNOWLEDGMENTS

I wish to thank the many people of DOE and its contractors who were kind enough to provide the information to me to make this article possible.

REFERENCES

- ENEL Studi e Ricerche: Geothermal Resource Assessment and Reservoir Engineering, EEA Larderello Workshop, Larderello, September 12-16, 1977
- Proceedings/Actas of the First Symposium on the Cerro Prieto Geothermal Field, Baja California, Mexico, September 20-22, 1978, San Diego, California, LBL-7098