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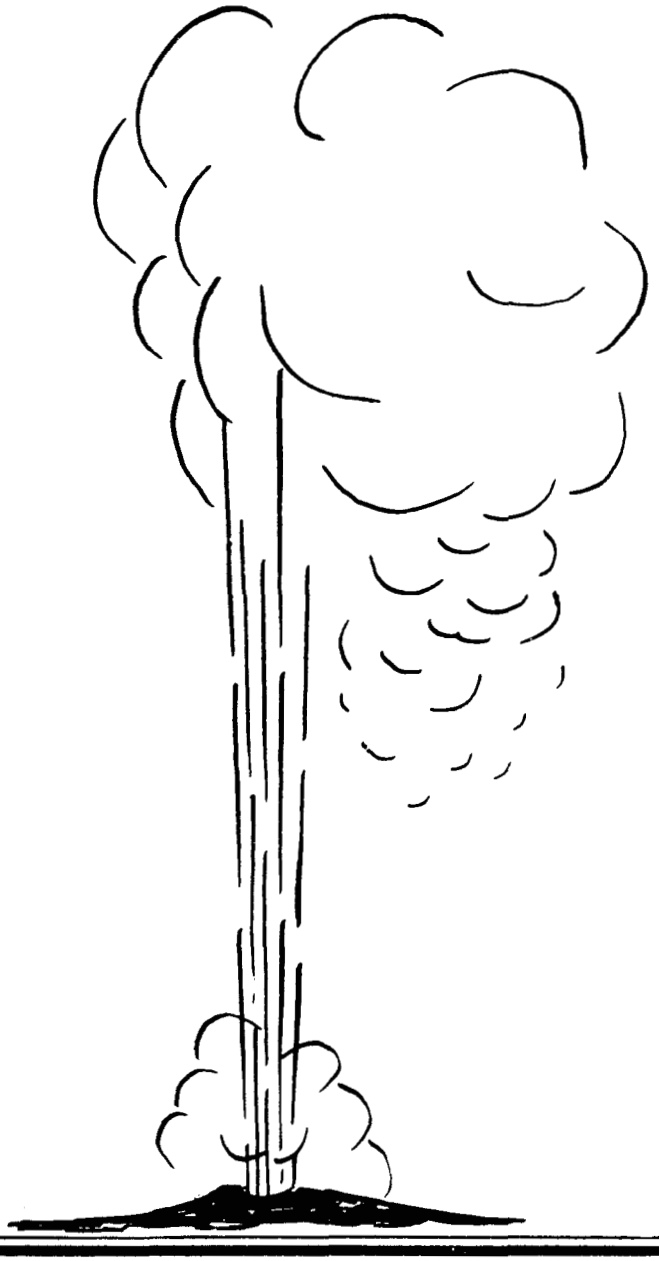

EFFECT OF PROPOSED FEDERAL TAX CREDITS AND FORGIVABLE LOANS ON GEOTHERMAL ELECTRIC POWER DEVELOPMENT

Hot Line Report

By
Thomas A. V. Cassel

November 1979

Work Performed Under Contract No. AC02-79ET 27242

Technecon Analytic Research, Inc.
Philadelphia, Pennsylvania

U. S. DEPARTMENT OF ENERGY

Geothermal Energy

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1. OBJECTIVE

At the request of Dr. Fred Abel and Mr. Randall Stephens of the U.S. Department of Energy/Division of Geothermal Energy, Technecon has evaluated the likely impacts of two proposed federal incentives for accelerating the development of geothermal resources for electric power production. The incentives are:

- An additional 20% investment tax credit applicable to both well field capital and power plant capital;
- A federal loan for 50% of the cost of exploration and confirmation wells which is entirely forgivable if the wells prove unsuccessful.

2. METHODS

The evaluations have been performed by the use of D.O.E.'s geothermal investment decision model (TCN2000) which was developed by Technecon under Contract No. ET-78-S-02-4713[1]. TCN2000 is presently capable of estimating the probability of progressive levels of development at ten Known Geothermal Resource Areas (KGRA's) in California and Utah. These resource areas are:

- Brawley, CA
- Coso Hot Springs, CA
- Cove Fort-Sulphurdale, UT
- East Mesa, CA
- Geysers (liquid dominated), CA
- Geysers (vapor dominated), CA
- Heber, CA
- Mono-Long Valley, CA
- Roosevelt Hot Springs, UT
- Salton Sea, CA

Collectively these ten areas represent almost half of the total electric energy potential from identified high temperature hydrothermal

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[1]See Cassel, et al., "Geothermal Investment and Policy Analysis with Evaluations of California and Utah Resource Areas", Report No. COO-4713-2, Technecon Analytic Research, Inc. and University of Pennsylvania, Philadelphia, October 1979.

resources in the United States[2]. More importantly, these areas comprise a representative mix of resource characteristics which includes: (a) sedimentary and igneous geology, (b) resource temperatures covering a range of 300F to 550F, (c) low and high well flow rates, (d) low cost and high cost power transmission, (e) relatively cheap and expensive competitive power costs, and (f) low salinity and high salinity resources. Thus, policy analysis based upon simulating development at these ten areas are expected to reflect relative policy impacts upon development of the larger, national resource base.

TCN2000 specifies each resource area by 75 input variables which define resource parameters, economic parameters and financial characteristics of the developing firms. Well field development is simulated for several progressive levels of power generation and a detailed cash flow analysis is performed. Probabilistic investment decisions are estimated, based upon the results of the cash flow analysis, for development by either major corporate firms or independently operating firms.

3. DISCUSSION

3.1 Additional Investment Tax Credits

The additional 20% investment tax credit (ITC) is applicable to both well field capital and power plant capital. It increases the total ITC available to well field developers to 30% for qualifying capital investments. Earlier work by Technecon (see footnote 1) indicates that, with a 30% total ITC, it is advantageous for the field developer to elect to expense (rather than capitalize) intangible well costs. This election is included in the present analysis.

Western electric utilities express an inability to use the existing power plant ITC because of a backlog of credits which exceeds IRS limitations. IRS guidelines limit current ITC's to 50% of tax liability. However, the proposed additional 20% ITC for geothermal power plants is applicable to 100% of tax liability and, therefore, should be usable by the utilities.

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[2]Muffler, ed. "Assessment of Geothermal Resources of the United States"; USGS Circular 790; Arlington, VA; 1979.

The effect of the ITC for power plant capital, as modeled by TCN2000, is realized in an increased competitive selling price for the geothermal resource. The competitiveness of geothermal electric power is determined at its point of delivery to a major transmission corridor. At this point, its total cost -- including resource "fuel" price, apportioned plant cost and apportioned transmission cost -- must compete with alternative types of baseload generation (e.g. coal-fired). The proposed additional ITC effectively reduces the geothermal power plant cost component and, thereby, affords an increase in the competitive resource price component. This price difference is presented in Table 1.

TABLE 1. MARGINALLY COMPETITIVE
HYDROTHERMAL RESOURCE PRICES*

	Without Proposed Incentives	With Proposed Incentives	Impact
CALIFORNIA AREAS			
• Brawley	16.7 - 17.7	17.7 - 18.8	+6%
• Coso Hot Springs	16.5 - 17.4	17.6 - 18.5	+6%
• East Mesa	15.9 - 17.2	17.0 - 18.4	+7%
• Geysers (Vap.Dom.)	18.8 - 19.8	19.4 - 20.7	+4%
• Geysers (Liq.Dom.)	16.6 - 17.2	17.5 - 18.3	+6%
• Heber	16.0 - 17.5	17.2 - 18.7	+7%
• Mono-Long Valley	14.2 - 17.8	15.3 - 18.9	+7%
• Salton Sea	17.2 - 18.4	18.0 - 19.5	+5%
AVERAGE CALIFORNIA	16.5 - 17.9	17.5 - 19.0	+6%
UTAH AREAS			
• Cove Fort/Sulphurdale	10.6 - 11.0	12.0 - 12.4	+13%
• Roosevelt Hot Springs	11.3 - 11.9	12.6 - 13.2	+11%
AVERAGE UTAH	11.0 - 11.5	12.3 - 12.8	+12%

*expressed in mills/kWh for the resource "fuel".

3.2 Forgivable Federal Loans

The forgivable federal loan for 50% of the cost of exploration and confirmation wells has two primary effects upon the cash flow analysis. First, it reduces front end "finding" losses attributable to an expected percentage of unsuccessful attempts prior to locating a producible resource. Second, it reduces the amount of capital exposed to risk during resource confirmation. Thus, the forgivable loan serves to both (a) reduce the return required from a producing field to recoup "finding" costs and (b) reduce the risk in locating a producing field.

Technecon's earlier analysis of well field cash flows (see footnote 1) indicates that $1.8 million are expected to be lost in unsuccessful deep wells prior to locating and confirming one producible discovery. This "finding" cost is reduced by 50% in simulations of the forgivable loan program.

The cash flow model in TCN2000 estimates that the costs of three deep wells (i.e. one successful exploration well plus two step-out confirmation wells) are exposed to risk prior to field development. This exposure is reduced by 50% in simulations of the forgivable loan program.

4. RESULTS OF ANALYSIS

The estimated effectiveness of the proposed federal incentives is illustrated in Figure 1. As shown, the incentives provide for an appreciable increase in the likelihood of geothermal resource development by both major corporate firms and by smaller independently operating firms. The marginal advantage is noticeably greater for the smaller firms. A net effect of these incentives is to narrow the gap between potential development by the major corporate producers and the independent producers, while increasing the likelihood of resource development by both.

An alternative measure of probabilistic resource development is expressed in terms of "expected power" (EP):

$$EP = \sum_{j=1}^{10} \sum_{i=1}^{N_j} \Pi_{ij} \cdot MW_{ij}$$

where Π_{ij} is the estimated probability of development of power level i at resource area j, MW_{ij} is the incremental electric power (e.g. megawatts)

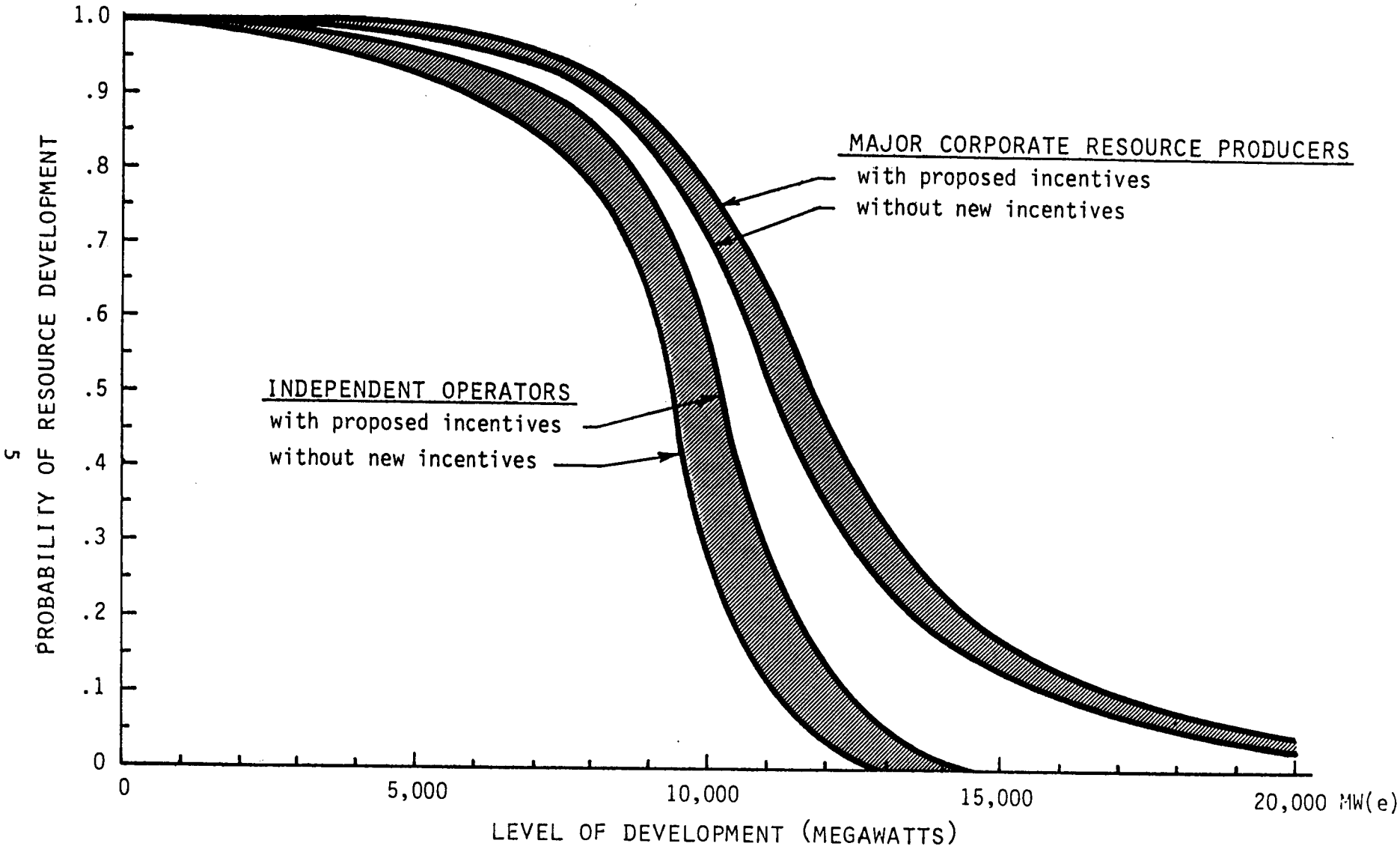

Figure 1. EFFECT OF PROPOSED FEDERAL INCENTIVES ON GEOTHERMAL ELECTRIC POWER DEVELOPMENT AT TEN CALIFORNIA AND UTAH RESOURCE AREAS.

of power level i at resource area j, and N_j is the number of increments of power development at resource area j. EP represents the integral of the curves illustrated in Figure 1.

Tables 2 and 3 present the estimated effectiveness of the proposed federal incentives in terms of the increased expected power that the incentives afford. As shown, the proposed incentives provide several hundred additional megawatts of expected power at the ten geothermal areas. Expected development by the major resource corporations increases 4½% and expected development by the independent firms increases 11½%.

A more dramatic effect is realized in terms of the likelihood of developing the first 50 megawatts at a given site. This initial development is burdened by heavy front-end resource "finding" costs which, in the absence of certain continued development, detract from net investment returns. Without the proposed federal incentives, the expected power from first plants alone at the ten areas amount to 264 megawatts by major corporate developers and 70 megawatts by independent operators. With the proposed incentives, these estimates increase to 299 megawatts and 159 megawatts for the two types of firms, respectively. These changes represent a 13% increase in expected initial resource development by major corporate developers and a 127% increase by independently operating developers.

5. CONCLUSION

The policy analysis presented here is based upon estimates of the likelihood of geothermal resource development as provided by D.O.E.'s geothermal investment decision model (TCN2000). The model relies on the best available current data and information concerning resource characteristics and industry decision criteria. Model results, therefore, are estimates of likely investment behavior as resources and corporate objectives are perceived today.

The proposed additional investment tax credit and forgivable loan program provide an appreciable incentive for accelerating the development of geothermal resources for electric power generation. For major resource corporations, the incentives provide for a 4½% increase in the total expected power development at ten KGRA's and a 13% increase in expected

TABLE 2. EXPECTED GEOTHERMAL DEVELOPMENT
BY MAJOR RESOURCE CORPORATIONS

	WITHOUT INCENTIVES	WITH INCENTIVES	CHANGE
BRAWLEY	586 MWe	617 MWe	+ 31 MWe
COSO HOT SPRINGS	36	60	+ 24
COVE FORT-SULPHURDALE	0	1	+ 1
EAST MESA	343	365	+ 22
GEYSERS (VAP.DOM.)[3]	1944	1985	+ 41
GEYSERS (LIQ.DOM.)	419	607	+188
HEBER	513	555	+ 42
MONO-LONG VALLEY	31	41	+ 10
ROOSEVELT HOT SPRINGS	753	775	+ 22
SALTON SEA	7036	7173	+137
TOTAL MEGAWATTS(e)	11661 MWe	12179 MWe	+518 MWe

TABLE 3. EXPECTED GEOTHERMAL DEVELOPMENT
BY INDEPENDENTLY OPERATING RESOURCE FIRMS

	WITHOUT INCENTIVES	WITH INCENTIVES	CHANGE
BRAWLEY	438 MWe	523 MWe	+ 85 MWe
COSO HOT SPRINGS	0	0	0
COVE FORT-SULPHURDALE	0	0	0
EAST MESA	232	312	+ 80
GEYSERS (VAP.DOM.)[3]	1560	1754	+194
GEYSERS (LIQ.DOM.)	0	14	+ 14
HEBER	331	445	+114
MONO-LONG VALLEY	0	3	+ 3
ROOSEVELT HOT SPRINGS	531	620	+ 89
SALTON SEA	5890	6358	+468
TOTAL MEGAWATTS(e)	8982 MWe	10029 MWe	+1047 MWe

[3]Represents development beyond Unit 15.

development of the first 50 megawatts at these sites. For independently operating firms, the incentives provide for a 11½% increase in total expected power development and a 127% increase in expected initial development.

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