TID--27431

Transcript of Proceedings

ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

ENERGY TECHNOLOGIES FOR THE WEST

WORKSHOP:

GEOHERMAL: ENERGY FROM THE EARTH

San Francisco, California

Tuesday, 21 September 1976

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1 ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

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8 ENERGY TECHNOLOGIES FOR THE WEST

9 WORKSHOP

10 GEOTHERMAL: ENERGY FROM THE EARTH

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18 9:15 P.M.
19 Tuesday,
September 21, 1976

20 California Room
21 Sheraton Palace Hotel
22 San Francisco, California
23
24
25

C O N T E N T S

2

SPEAKERPAGE

Dr. John W. Shupe,
Chairman, College of Engineering,
University of Hawaii

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Professor Hamilton Hess,
University of San Francisco

13

Robert G. Lacy,
Mechanical Engineer, San Diego Gas & Electric

20

Dr. Tsvi Meidav,
President, Geonomics, Inc., Berkeley, Ca.

25

Donald Finn,
Managing Director, Geothermal Energy Institute

32

John Arlidge,
Assistant to the Vice President,
Nevada Power Company

43

Jim Bresee,
Acting Director, Division of Geothermal
Development, ERDA

46

ERDA
9/21
9:15
pm
kshp.

3

P R O C E E D I N G S

1
2 MR. VALENTINE: We probably ought to get under way.
3 In doing that, let me explain, for those of you who may have
4 wished to talk about fossil fuels or fusion, or some of the
5 other alternative sources of energy, that this is the session
6 on geothermal energy, and we will discuss those subjects di-
7 rectly related thereto, probably.

8 The basis foremat is similar to that which you have
9 experienced earlier today, if you hae been able to participate.
10 If you have not, it is ten-minute presentations by each of
11 the members on the panel. And like I said, around 12:00 this
12 morning we will get to ideas and concerns that you may have
13 as people in the audience.

14 Let me assure you that there will be every intention
15 to maintain the ten-minute limitations up here, and to allow
16 you, the audience, all the opportunity that you should desire,
17 even if we go beyond the specified hour, to discuss with
18 those people who are capable of answering your questions, those
19 concerns that you may have.

20 And I would like to start off, if I could, with a
21 slide presentation. Recognizing that this room is somewhat
22 warm, and not desiring to have too many people checking their
23 eyelids for holes, we should start off with the last speaker
24 first. That would be John Shupe, Chairman, College of Engin-
25 eering, University of Hawaii, who has a brief slide presentation .

1 to back up his topic. John?

2 DR. SHUPE: Thanks. This is a pleasant surprise. I
3 thought that possibly I would have a few friends left at
4 11:30, but I am pleased to have this to begin with. I think
5 you have heard reference that Hawaii is probably most vul-
6 nerable of all states on her dependence on sea-borne petrol-
7 eum, so we are looking into a variety of alternatives. With-
8 out going into detail on those, geothermal is one that does
9 look fairly interesting, and we feel that it does have possi-
10 ble commercial application sooner than most of the others,
11 and I think with that minimum preamble, we will start running
12 through the slides. I think we only have about 40, so let's
13 start.

14 We know we have magma in Hawaii. We hope that we
15 have other forms. Our initial program was to investigate
16 these.

17 Next silde, please.

18 As many of you are aware, Hawaii was formed from
19 the northwest to the southeasterly direction. This is the
20 big island of Hawaii, which is down in the southeastern por-
21 tion, so it is the newest. Similarly, the island was formed
22 in the same direction. Five vocanoes -- Kohala the oldest,
23 next Manna Kea, then Hualalai, then Mona Loa and Kilauea.
24 Both Manna Loa and Kilauea are still active volcanoes, and
25 we reason that the likelihood of finding near-surface heat

1 would be greatest in the vicinity of recent volcanology, which
2 was not too brilliant on our part. So we did concentrate most
3 of our reconaissance in this area, but ultimately hope to
4 proceed up the island chain.

5 Next slide, please.

6 This is an overview of that area with Manna Loa in
7 the background, Kilauea in the foreground, Halemaumau crater,
8 which is the vapor coming at this time, to indicate the com-
9 plexity of the geological situation there.

10 Next slide, please.

11 We ran a variety of geophysical and geoscience sur-
12 veys -- the infrared where molten magma appeared. It showed
13 up kind of warm, which we suspected. We found no surprises
14 in these.

15 Next slide, please.

16 We ran a variety of others. This is a dipole resis-
17 tivity which indicates certain highs down in the Puna area.

18 Next slide.

19 We also looked into some mathematical modelling with
20 engineering, both from reservoir prediction, as well as some
21 of the environmental characteristics, if we penetrate the
22 fresh water lens.

23 The next slide, then, I believe is a summary of the
24 various tasks that we completed in phase I with a variety of
25 geophysical surveys over on the left side. We developed in

1 parallel, then, as I say, some of our engineering and en-
2 vironmental. Socio-economic was a very important aspect of
3 this.. We indicated four years ago that this would probably
4 hold up the development of geothermal. We still predict that
5 it will.

6 Next slide, please.

7 The funding that we got from this -- the amount is
8 not important -- but it does indicate the variety of sources
9 that we had. This, from the beginning, has been a cooperative
10 venture. That has been a very gratifying aspect of it. Our
11 state legislature put a couple of hundred thousand dollars in
12 the '72 fiscal budget for geothermal research, and this was
13 well before the crisis came along. So from my bias, I feel it
14 was a rather progressive step for a legislature to take.

15 We did get some NSF matching and started the program,
16 then, in the summer of '73. So what I am giving is roughly
17 a three-year progress report, then. NSF picked this up for
18 another year, and then ERDA took the program over in January
19 of '75. We did have some Hawaiian Electric Company money that
20 went into this initial one.

21 The next slide shows, then, our initial drilling
22 phase, where the legislature put another half million dollars
23 into drilling. ERDA came up with \$1,064,000, Hawaiian Electric,
24 another 45, which is a small amount, but it was helpful to
25 us in getting the ground prepared while we were doing a little

1 bit of wheel spinning on the other.

2 Since then, we have spent an additional \$800,000,
3 again primarily of ERDA funding; each incremental "success"
4 seems to require more funds, as the hole heats up, and we
5 need to shove in a slotted liner, or something of this nature.
6 Everything requires more money. The state has come up with
7 an additional \$65,000, and another private group. But the
8 bulk of the funding has come from ERDA for this program.

9 Next slide, please.

10 Over along the right along our Puna rift is where,
11 after two years of geophysical surveys, we decided was the
12 logical point to put this.

13 Next slide, please.

14 At the dedication, John Team (?) came out to
15 help dedicate it. This represents the various groups. At
16 our right of Team is our State Energy Resources Coordinator
17 and the mayor of the big island. So in Hawaii, natural
18 energy is extremely important, so we do get a good turnout.
19 We had the usual Hawaii blessing, which apparently worked. We
20 had a 7.2 earthquake about 15 miles from this about three
21 weeks later, and the rig stood beautifully.

22 Next slide, please.

23 This is an aerial view. It is on a recent, 1955
24 flow.

25 Next slide.

1 We started, then, in November of '75, immediately
2 ran into this tough basaltic rock and started grinding away
3 before we had any load on the bit, and used up tremendous
4 amounts of money.

5 Next slide.

6 We finally did get a 30-inch surface casing.

7 Next slide.

8 And we had rather a conservative casing program. We
9 had New Zealand consultants for this project and we had
10 been informed that there was no way that we could maintain the
11 circulation. So this casing program that was developed was
12 with this assumption. Actually, we did manage to maintain
13 circulation after we got below 400 feet, and had it through-
14 out.

15 But it is, those of you recognize this is a rather
16 complicated casing program -- and particularly in that top
17 400 feet, we ground and ground away in expanding out to 26
18 inches in order to get that casing in.

19 Next slide, please.

20 Once we got below our production casing at 2,200
21 feet, we used this eight-and-a-half button bit, and we did
22 have excellent progress then. We drilled the bottom 4,200
23 feet in less than three weeks with drilling and coring.
24 So that went reasonably well.

25 Next slide.

1 As we got to the bottom of this hole -- well, we
2 cored throughout. This was a scientific hole, with NSF and
3 ERDA and state funding in it. So we took cuttings on ten-foot
4 intervals and cores -- about ten of these. Our total depth
5 went to 6,450 feet. We started at 600 feet above sea level,
6 so we went somewhat more than a mile below sea level.

7 Next slide, please.

8 As we got to the bottom, we were somewhat pleased
9 to find the hole finally started to warm up. At that time,
10 the decision was reached, as I indicated, to go ahead and
11 proceed with clearing out the mud and putting in a slotted
12 liner and proceeding with the well testing. This is merely
13 a shot of the slotted liner.

14 Next slide, please.

15 We did go ahead and complete the well head.

16 Next-slide.

17 We put in the proper gauges and on July 22, we had
18 then a flow test.

19 Next slide, please.

20 This first slide was taken two minutes, at 1402, after
21 we opened the valve. This is a six-inch vertical valve. As
22 I say, we had the New Zealand consultants on this. We were
23 using the Russell James method which requires sonic flow.
24 We had excellent temperature in it as well. We had about
25 600° farenheit that we had measured down there. But there was

1 some concern that this would be a tight hole. We had very
2 little loss of circulation during the drilling, and some of our
3 preliminary pump tests -- we had had very little drop in
4 pressure. So we felt that this would be a tight hole. In
5 fact, some had predicted that it would blow itself dry in less
6 than 15 minutes..

7 So this was one reason we were using a relatively
8 small discharge too, but we did maintain --

9 Next slide, please.

10 -- sonic flow throughout. This is about seven
11 minutes into it, and you can notice that this plume gets pro-
12 gressively smaller.

13 Next slide, please.

14 This was about 15 minutes into the test. As I say,
15 with sonic flow, there was -- even four hours later -- there
16 was a tremendous amount of energy noise that came from the
17 well. The decibel count was about 120 on a C scale 200
18 feet from the well itself, which is about the same as a 747
19 at takeoff. So these pictures certainly do not give any
20 indication of the energy that was coming from this well.

21 Next slide, please.

22 We did open the horizontal valve briefly, primarily
23 to see that all of our valves were working correctly, and
24 some what of a PR shot. It proved very little.

25 Next slide, please.

1 SPEAKER: How many minutes after was that horizontal
2 shot taken?

3 DR. SHUPE: That was about 15 minutes also. I will
4 have one curve showing the pressure drop, and you can see
5 where that blip comes in.

6 This, then, was taken about an hour into the test.

7 Next slide.

8 This shows what our pressure variation was.

9 Next slide, please.

10 This is wellhead pressure. We also had lip pressure
11 which James takes. We had a very high immediate buildup to
12 close to 500 psi, then a very rapid drop. I do not know what
13 that first transient is up there around 400. The second one
14 down here is when we opened that horizontal valve for a
15 five-minute period. We did have that blip there. But then
16 it built back up.

17 And of course, whether it has leveled off after
18 four hours or not, of course, we really do not know yet. But
19 with the rather rough measurements that we had, it was at
20 least somewhat encouraging, because at the end of our four-
21 hour period, we still had a rate of flow of roughly -- the
22 estimate was 220,000 pounds per hour, estimated an enthalpy
23 of roughly 650. With an enthalpy of 650 Btu's per pound, the
24 estimate of about 15 percent conversion rate was still
25 roughly five megawatts of power from this thing at the end of

1 four hours.

2 Next slide, please.

3 This was a shot at the end of the four-hour period.

4 The last slide then, please.

5 This shows a fairly stable temperature variation
6 in that well, roughly a month later. We took Custer pressure
7 and temperature runs down the hole at one-week intervals from
8 there on in, and this is a fairly stable condition indicating
9 a high temperature range somewhere in the neighborhood of
10 300° Centigrade, or 600° fahrenheit occurs from about 3500
11 feet on down. So we probably have rather a small micro-
12 fracture there, a relatively low permeability, but over roughly
13 about a 2,500 foot column. So there might be reasonable rate
14 of flow from this.

15 The lights, please.

16 We took a variety of samples of steam and water from
17 the well during the test. The quality surprised us tremendous-
18 ly. It is pretty close to fresh water, much better than the
19 quality of the wells in the vicinity. So in discharging it,
20 we are actually improving the quality of our five wells around
21 it. We are going ahead and running more tests on both air
22 steam and water samples that we took, and are in the process
23 of designing a silencer and will start, then, a more compre-
24 hensive flow test lasting, probably, four to six weeks, around
25 November 1.

1 It is premature to know whether we have a commercial
2 winner there, but we are sufficiently encouraged that we are
3 working through the state with the Hawaiian Electric Company
4 and others, while we are going through these testing processes,
5 to start parallel work in a variety of other areas. But I
6 have used up my time, so I will not discuss those. Thank you.

7 MR. VALENTINE: Thank you very much. That was
8 very interesting. And following that, and after having seen
9 the beautiful island of Hawaii and what you can do in that
10 kind of surroundings, I would like to ask, if I could, Dr.
11 Hess, from the University of San Francisco. Just prior to
12 introducing him, I would like to indicate that following him
13 will be Bob Lacy. I understand, Bob, you have some slides.
14 And if we could have that slide presentation ready, then --
15 Prof. Hess?

16 PROF. HESS: We are going to move from the technical
17 to the philosophical, a change of pace. And I would say that
18 the speaker following, who will be having some slides, I pre-
19 sume of current technologies and geothermal operations might
20 well be used as illustrative material for one part of my own
21 presentation, speaking of some of the environmental problems
22 of geothermal.

23 The past several years have witnessed a growing en-
24 thusiasm for the development of geothermal resources. Facili-
25 tating legislation has been passed on the Federal and state

1 levels. A variety of agencies have been involved, Federal
2 and state; AEC, NASA, Department of Defense, Bureau of Reclama-
3 tion, Department of Interior, and now ERDA, have all been
4 actively involved.

5 But you have little actual development of geothermal
6 resources that has taken place. This fact is a source of
7 embittering frustration to committed advocates of geothermal
8 energy, and the reasons behind it are being sought in a number
9 of governmentally sponsored studies and industry analyses.
10 It is my intention to offer a brief analysis of the situation
11 from the standpoint of the environmental interest sector.

12 In the broader context of world and national energy
13 policy and energy industry commitments, geothermal is still an
14 exotic alternative, or at best, a marginal energy source. And
15 it would seem to be a marginal energy source into the fore-
16 seeable future. In terms of world politics and economics,
17 petroleum interests dominate the energy sector, and by sheer
18 inertia, if nothing else, exclude the serious entrance of
19 competitive sources.

20 In the United States, the commitment of the Federal
21 government and the utilities to nuclear power has led to the
22 effective relegation of geothermal, together with solar and
23 other undeveloped energy sources, to the status of optional
24 extras. In my opinion, these factors will continue to prevent
25 the development of the favorable conditions for serious

1 governmental or marketplace interest in geothermal, unless
2 or until radical policy shifts are brought about.

3 Such shifts will require basic attitudinal changes
4 with regard to our management of the depleting fossil fuels
5 and a de-emphasis of the nuclear alternative. The development
6 of a climate favorable to geothermal will also require financial
7 incentives which are now largely lacking, and a demonstration
8 of the capability of technology to convert earth heat energy
9 to commercially usable energy, and the proving of resource
10 reserves to be both vast in quantity and widespread in availa-
11 bility over an extended period of time.

12 We are here faced with a chicken and an egg situa-
13 tion. Technological development and the proving of reserves
14 will not take place in the energy market without either the
15 commitment, shifts having already taken place, or without
16 subsidized financial incentives. Government financing and
17 perhaps also government management are needed to move the
18 situation from dead center.

19 But governmental policies and commitments themselves
20 are part of the problem. We are brought inescapably back to
21 the matter of orientations and attitudes which are basically
22 cultural in nature. The only discernible solution to the
23 problem is also cultural: growing awareness throughout
24 world society that the continuing and unbridled consumption
25 of petroleum and coal for energy production is unjustifiable,

1 and that the nuclear option is too fraught with hazards to be
2 worth the risk.

3 Turning to more concrete issues which I believe
4 affect geothermal development at the present time, it is
5 frequently charged that bureaucratic delays and environmental
6 concerns are strangling the infant industry. I would point
7 out that bureaucracy knows no favorites, and that environmental
8 considerations are touching industrial activity, and indeed,
9 most human activity across the board.

10 Many of the bureaucratic checkpoints themselves have
11 been instituted in the interests of environmental protection.
12 No one is particularly happy with the way that the mechanisms
13 of environmental protection are presently operating. They
14 need to be streamlined in certain ways. And on the other
15 hand, they may need to be made more effective in a number of
16 respects. But they are undoubtedly here to stay. Energy
17 production and other forms of industrial activity no longer have
18 unquestioned priority.

19 They have to be balanced in a system of trade offs,
20 with the interests of a clean and healthy planet and of the
21 demands of land use. It has been the fate of geothermal
22 to have made its effective debut at nearly the same time that
23 the National Environmental Policy Act and the California
24 Environmental Quality Act were established as law.

25 Geothermal has consequently had to face conditions

1 and restrictions virtually unknown in earlier years to other
2 forms of energy resource production. In my opinion, the two
3 most serious obstacles facing geothermal resource development,
4 from the governmental sector, are the result of institutional
5 malfunctions on the Federal, state and local levels.

6 These are found in the environmental impact reporting
7 process and in the land use question. Environmental impact
8 reports or statements are required for all major actions on
9 Federal lands and all actions on state and private lands in
10 the state of California which have significant adverse impact
11 on the environment. Geothermal operations unquestionably are
12 actions which have significant impact. Environmental impact
13 reports are informational documents which are intended to
14 assist permit granting agencies to make environmentally re-
15 sponsible decisions concerning projects which they are called
16 upon to license.

17 Although improvement has been notable in certain re-
18 spects during the past year, we are still in a growing pains
19 stage in the implementation of the impact reporting process.
20 Prospective developers are concerned with the time that the
21 process takes, and the environmentalist sector and potentially
22 affected public are concerned with the objectivity and the
23 adequacy of the reporting and whether the decision makers are
24 in fact taking environmental findings into account.

25 The almost universal lack of land use planning in

1 areas of geothermal potential on both Federal and private
2 lands, and state lands as well, is a major governmental mal-
3 function, and consequent point of abrasion in relation to
4 geothermal project proposals. Many areas offer no particular
5 land use problems. Other areas are moderate in their land
6 use sensitivities. But some areas are highly sensitive to
7 the intrusion of an industrial use in competition with resi-
8 dence and recreation and with natural values.

9 A concerted and cooperative planning program on the
10 Federal, state and local levels, with structured public
11 participation in that program, is needed to resolve the
12 land use conflicts which have already arisen and which will
13 continue to arise in geothermal resource areas. Such planning
14 should have in-built flexibility to accommodate the results
15 of future technological advance, which will presumably allow
16 geothermal operations to take place in closer proximity to
17 non-industrial use areas than is now the case.

18 The land use problem in geothermal is made all the
19 more acute by its heavy land requirements in areas of develop-
20 ment. Geothermal operations effectively occupy one-and-a-half
21 square miles for every 100 megawatts produced. If, for
22 example, California's electrical energy needs are 100,000
23 megawatts by the year 2000, and if one-third of it were to be
24 supplied by geothermal, 1,500 square miles of land would be
25 required.

1 Considering the fact that geothermal energy must
2 be developed where it is available, land use problems may
3 rapidly become unmanageable in the absence of effective
4 planning if development escalates. And that is particularly
5 in light of the fact that geothermal resource areas are fre-
6 quently in the areas of other values.

7 Geothermal has been frequently hailed as a clean
8 source of energy. Those who are familiar with it know that
9 it has its own problems. Geothermal has certain advantages
10 environmentally. But it also has problems. Present problems
11 include extensive cut and fill operations in hilly terrain
12 with consequent land form alternation, visual impact, erosion,
13 downstream siltation, water pollution from accidental spillage
14 of geothermal brines, condensate or drilling muds, odor and
15 air pollution from hydrogen sulfide, other non-condensables,
16 and particulate matter.

17 Possible long-term adverse effects on living organisms
18 in regions of development from these gasses and chemicals re-
19 mains a problem. Industrial noise, visual impact, are also
20 problems involved.

21 If geothermal power and the utilization of geothermal
22 resources in general has defined the kind of public acceptance
23 that it needs to succeed, indeed, if it is to be allowed to
24 make the contribution to the energy supply that is capable of
25 making, the means for its production, I believe, must be

1 revolutionized within technology so as to eliminate or dras-
2 tically reduce its present impacts in the locale of pro-
3 duction. And certainly the impacts of geothermal development
4 are subject to such progress in their elimination. This
5 is certainly the point in history when priority attention
6 should be given to the environmental problems in relation to
7 geothermal for geothermal to find that acceptance which it
8 needs to become, in the public eye, a truly clean energy
9 source. Thank you.

10 MR. VALENTINE: Thank you, Prof. Hess. Not only did
11 I stumble on your name, but I forgot to give you the recogni-
12 tion due as the chariman of the geothermal section of the
13 Sierra Club, which I am sure is an important guardian of the
14 environment.

15 Next, I would like to introduce, as I said I would,
16 Bob Lacy from San Diego Gas and Electric, who has another one
17 of those demonstrations for you, if you would bear with us.

18 MR. LACY: Thank you, Denny. I would like to thank
19 ERDA, too, for the opportunity to tell you about what we are
20 doing in the Imperial Valley. What I would like to do is to
21 show you some slides of a ten-megawatt binary cycle test
22 facility that is now in operation in the Imperial Valley.

23 If I can have the first slide.

24 Thank you. We started working in the Imperial
25 Valley -- that is, San Diego Gas and Electric Company did, to

1 develop geothermal resources about six years ago. The pur-
2 pose of this presentation, as I indicated, is to give you
3 a brief history of our activities and to give you just a
4 minute or so about some of our future plans.

5 To give you some geographic perspective, the Im-
6 perial Valley lies east of our service territory. The resi-
7 dents of that area are served by the Imperial Irrigation
8 District. Our service territory is outlined in yellow on
9 this slide. The distance from San Diego to our perspective
10 sites is in the neighborhood of 120 to 140 miles, so that is
11 one obvious reason why we are particularly interested in
12 geothermal energy.

13 At the present time, though, no substantial trans-
14 mission exists between these sites and our service territory.
15 Consequently, energy from the first generating unit that
16 we plan for the Valley will probably go to the customers of
17 IID. Our activities are directed toward the development of
18 four sites in the Valley. We and our partners have leases of
19 varying size at each of these sites. We have done substantial
20 work at two of them, Niland and Heber, and have started work
21 on a third, East Mesa.

22 Our efforts started back in January of 1971, when
23 the company, acting through New Albion Resources Company, a
24 subsidiary of SDG and E, joined Magma Power to begin drilling
25 wells. Wells were drilled in two areas, both Niland and Heber

1 These wells show promising characteristics and additional
2 wells were drilled to help define, as best we could at that
3 time, the extent and potential of the resources we were deal-
4 ing with. In '72, flow testing at Niland was conducted for
5 about ten days in an attempt to determine the reservoir,
6 information related to flow characteristics, temperature sta-
7 bility and the mineral content of the brine. And by the way,
8 we are talking hydrothermal, brine, and in the case of Niland,
9 mineral contents as high as 250,000 parts per million.

10 The results of those flow tests were encouraging
11 enough, and I suppose we were naive enough, to warrant further
12 testing. We also decided at this time to begin the detail
13 design for a test facility, a nominal ten-megawatt facility,
14 to determine the process and the equipment most suitable for
15 economical and reliable power generation with this energy
16 source.

17 After two years of field tests using a variety of
18 cycles and truck mounted equipment the design of the
19 existing facility, began in November of '74, and was completed
20 in early 1975. I am not going to go into this cycle. If
21 anybody has any questions later, we can throw this slide up
22 again, and I will spend some time on it. Suffice it to say
23 that the system involves flashing the brine to steam in four
24 stages, scrubbing the steam, and passing that scrubbed steam
25 through heat exchanges where it gives up its energy to

1 isobutane, which is the working fluid. The isobutane cir-
2 culates in a closed loop, and it is in return cooled by
3 irrigation water.

4 Site preparation for the facility construction was
5 started in April of last year and completed in June. The
6 installation of the transmission line to the site was com-
7 pleted on June 4. We need approximately two-and-a-half
8 megawatts of outside power to drive the pumps, as well as other
9 miscellaneous equipment. At this time, we have not installed
10 a turbine or a generator. However, the transmission line has
11 the capability of handling the net output of the plant, or
12 about seven-and-a-half megawatts, should we decide to go
13 ahead and install a turbine generator.

14 This power would go to IID for distribution in the
15 Valley. Construction of the facility itself was started
16 in June of last year and is now complete. Equipment and sys-
17 tems started in December of last year, and we have now com-
18 menced an 18-month operation period of the facility. The
19 major areas of investigation that we are exploring or expect
20 to encounter during the operation of the facility are first,
21 to determine the temperature and the pressure at which brine
22 can be extracted over long periods of time. This information
23 will indicate the amount of energy present in the reservoir.

24 Secondly, it will be to determine the performance
25 of the reservoir under extraction and reinjection conditions.

1 And we are reinjecting the spent brine here. Third, to over-
2 come the loss of production due to scaling in the well itself;
3 fourth, to overcome erosion in scaling in the equipment -- that
4 is, the hardware above ground -- and to improve the quality
5 of steam separation; finally to develop metallurgical techniques
6 needed to withstand the abrasive nature of the brine that we
7 are dealing with.

8 The estimated cost of the facility, including 18
9 months of test programs -- and by the way, this picture was
10 taken during the dedication of the facility on June 4 -- the
11 cost of the facility, including the 18 months of operation,
12 is approximately \$8 million. In July of last year, ERDA
13 joined the company in a joint project agreement for the con-
14 struction and operation of the facility. The costs are shared
15 50-50 by the company and ERDA.

16 The facility is owned and managed by the company,
17 and in addition to jointly funding the experiment, ERDA is
18 providing technical support, and I cannot underestimate the
19 importance of that support to this operation, in the form of
20 redirecting portions of its current R&D program, as well as
21 carrying out specific new studies of problems which we encounter.
22 The company and ERDA will jointly analyze and report the re-
23 sults of the technical program for public use.

24 In addition, ERDA is conducting environmental
25 studies -- and I just penned this in, Dr. Hess -- to support

1 this operation, first to identify baseline conditions and
2 finally, to assess the impact of the facility on the environ-
3 ment. As I indicated, the facility is in operation 24 hours
4 a day, knock on wood. The results of the operation to date
5 have been very encouraging, more encouraging than we had
6 anticipated.

7 A few words about our -- this is my company, now --
8 our plans for the future, our goals, at least: first, the
9 start-up and testing of the facility that I just talked
10 about; secondly, the construction of a 50-megawatt demonstra-
11 tion unit to be located at the Heber site for operation in
12 late 1980; and finally, the construction of two 50-megawatt
13 commercial units at Heber and Niland by operation by 1982.
14 This sounds rather optomistic, but we have found that without
15 setting goals, you do not get anything done. And these are
16 our goals. Thank you very much;.

17 MR. VALENTINE: Thank you, Bob. That concludes our
18 slide show, so if we could have the rest of the lights on,
19 too, to catch anybody we can out here. Now to move into some
20 of the other elements associated with geothermal development,
21 and some of the things one might consider before they get
22 into it, I would like to call on Dr. Tsvi Meidav, President,
23 Geonomics Incorporated, Berkeley, California. Doctor?

24 DR. MEIDAV: Since you said that the slide show is
25 over, I guess I cannot show my slides.

1 MR. VALENTINE: I am sorry. I was not aware that
2 you had slides.

3 DR. MEIDAV: I have a few, so let me show them.
4 Basically, what I wanted to do is discuss some aspects of the
5 size of the geothermal resource and to get an appreciation of
6 what it is, what it could be, and therefore to say how very
7 far we are from the full utilization of the geothermal re-
8 source. This rather dramatic picture from Hawaii is, perhaps,
9 a very picturesque demonstration of what is down there under
10 the surface of the earth at depths of anywhere between ten
11 to 30 kilometers everywhere.

12 These temperatures of 1,000 degrees centigrade are
13 an expression of the tremendous amount of heat, the earth's
14 heat, which is under out feet.

15 Next slide.

16 In the United States, abnormal heat flows are
17 characteristic to the western third of the country, and these
18 white dots are areas of heat manifestation in the form of
19 hot springs with temperatures of higher than 100 degrees
20 fahrenheit. In general, we may relate these to plate tectonics,
21 to the fact that the Pacific plate has been subducting or
22 been thrust under the American plate. Vulcanism has been
23 rampant for the past ten million years in that area.

24 And so, in many parts of the western United States,
25 we have very large heat reservoirs at a relatively shallow

1 depth. A simple calculation that John Banwell and myself
2 conducted some years ago suggested that the total stored
3 heat, utilizable or not, under the United States, is several
4 times greater, about one order of magnitude greater than all
5 the known coal, oil, or uranium that is available to that
6 depth. That does mean that the heat energy to that depth is
7 utiliazble. We need some concentrated heat in order to be
8 able to make use of it.

9 Next slide.

10 I believe that this schematic is by now, to most
11 of you rather obvious, but the objective of our exploration
12 is to locate those areas that are porous and permeable, where
13 for one reason or another, convecting magma or cooling magma
14 is located at a relatively shallow depth, and to the extent
15 that we are successful, by the variety of geological, geo-
16 chemical, and geophysical techniques that are available to us,
17 to locate them we are likely to be successful in developing
18 a geothermal reservoir.

19 Next.

20 Let us look for a moment, at what is the amount of
21 energy that is available within the earth at various depths,
22 or its various temperature ranges. The units here are on
23 the left, and are given in joules per cubic centimeter of rock.
24 And on the right hand side, they are given in thousands
25 of megawatt years per cubic kilometer, gigawatt years per

1 cubic kilometer.

2 And the graph that you see here is the total mechani-
3 cal energy, available at a given temperature. As we look at
4 this scale, we see that at relatively low temperatures, say
5 200 degrees centigrade, the amount of stored energy per
6 cubic kilometer, is relatively small. But as we go to the
7 right on this temperature axis, to temperatures of the order
8 of 500 degrees centigrade, and as we get higher towards the
9 melting point of rocks, the amount of stored heat per cubic
10 kilometer is fantastically large.

11 One cubic kilometer of near molten rock, say rock
12 at 900 degrees centigrade or so, would contain about 30,000
13 megawatt years of equivalent electrical energy in one single
14 cubic kilometer. That is a tremendous amount of energy, and
15 it does not take very many cubic kilometers of rock of this
16 type to provide a very large amount of useful energy to the
17 extent that convection of water is present in the area, to
18 the extent that that water can conduct the heat, or to the
19 extent that we have technology to introduce cold water and
20 extract the water as hot water some distance away.

21 By way of example, let me point out that some calcu-
22 lations of the source of heat in the geysers area in northern
23 California suggest to me that there is an intrusion of magma,
24 perhaps presently active, perhaps an activity that may have
25 stopped in the recent geologic past, of about 1,000 cubic

1 Kilometers of molten rock, and the geysers field presently
2 being developed is a mere speck which is a superficial ex-
3 pression of a tremendously larger heat source below it,
4 perhaps several orders of magnitude greater.

5 And so from the point of view of heat energy, I
6 doubt that the present development of geothermal power in the
7 geysers would ever exhaust the heat source. No doubt the steam
8 energy would be exhausted much before the heat energy would.
9 The same may be said with regard to most other geothermal
10 reservoirs around the world.

11 Next slide.

12 This is a picture of the geysers power plants which
13 are in the area that I have discussed before.

14 Next.

15 A concept that is being presently examined with
16 increasing seriousness is indeed that of mining heat from
17 the rock. The concept originally proposed is one which would
18 utilize either chemical or nuclear explosives to create an
19 artificial cavity at a depth, and two holes drilled into that
20 cavity. One hole would provide cold water, the other one
21 some distance away, would gather the heated water which has
22 been heated by both the conduction from the hot rock as well
23 as the heat provided by the nuclear or chemical explosive.

24 Public concern about nuclear explosives has ruled-
25 the nuclear alternative out, and present experiments are

1 concerned mainly with utilization of either artificially
2 created fractures or perhaps the utilization of natural
3 fractures, i.e., faults that do exist in the earth. Calcu-
4 lations indicate that if we have a sufficiently large surface
5 area of these fractures, we can derive a tremendous amount of
6 heat from the so-called hot dry rock.

7 As I have pointed out earlier, the total stored
8 heat below surface in the United States to depths of ten
9 kilometers throughout the country is a couple of orders of
10 magnitude greater than the total coal, oil or uranium energy
11 known or suspected to exist within the continental United
12 States.

13 Next.

14 This is the Cerro Prieto plant, utilizing a so-
15 called liquid dominated steam. There are no liquid dominated
16 plants in the United States as of yet, although both the
17 Heber and the Niland, and the Roosevelt Hot Springs fields in
18 the United States are likely candidates to be exploiting that
19 type of steam in the near future. And of course, the Valles
20 Caldera -- I may have forgotten a couple of others. East
21 Mesa probably is a candidate, and maybe one or two more that
22 are still in investigatory stages.

23 May I have the lights.

24 I have discussed here the utilization of geothermal
25 energy for power production purposes because that is where the

1 crunch, at present, is. However, it would be very important
2 to point out that geothermal energy is far better suited for
3 direct heat uses than for power production purposes. The
4 best thermal efficiencies that we obtain from any of the
5 presently available power conversion processes is of the
6 order of 14 or 15 percent.

7 On the other hand, if we make direct use of the
8 heat for either comfort or space heating, for drying of wood,
9 for processing of products, we can get efficiency as close
10 to 100 percent as we consider practical or economical. It
11 depends only on the quality of insulation that we wish to
12 have and the size of the heat exchanges that we have. But
13 certainly efficiencies of the order of 80 or 90 percent are
14 quite practicable.

15 Therefore, there is no doubt that a far greater atten-
16 tion to the direct heat uses of geothermal energy must and
17 will be given in the future. Thank you.

18 MR. VALENTINE: Thank you, Doctor. Before we get
19 going and I make any more comments about the lights, do any
20 of the other panelists have a surprise that I do not know
21 about in the way of films in their pocket or slides?

22 MR. FINN: I have slides.

23 MR. VALENTINE: Do you have slides also, Don? Okay.
24 Are you going to include those in your presentation?

25 MR. FINN: Oh, sure.

1 MR. VALENTINE: A person that needs no introduction,
2 I am told -- although I was not here this morning -- I am
3 told that he has already addressed a portion of this audience,
4 anyway. I think we have an opportunity tonight to concentrate
5 on some of his expertise, gathered over the years. Don Finn
6 is managing director of the Geothermal Energy Institute, and
7 Don, you are on.

8 MR. FINN: Since geothermal is really people -- that
9 is the resource, people who can find it, bring it to the
10 wellhead, sell it and use it -- Tsvi mentioned the Valles
11 Caldera. I see that we are talking to ourselves again, by
12 and large. When men like John Kilkenny, whose company is
13 the only operator in the United States selling steam, and
14 men like Ben Bayliss from Magma, who started this business
15 for us, are in the audience, they should be up here. I should
16 not be up here. If we see a gentleman by the name of Tucker
17 back there, he could tell us all about the environmental
18 problems as a professional. And Tro Gross can tell us how to
19 find it.

20 But I guess, taking Hamilton Hesse's admonition that
21 we are supposedly committed but frustrated advocates, these
22 are the people. And we are not that frustrated, really. We
23 own the resource.

24 May I have the first slide.

25 It has been the fashion in these proceedings, I know,

1 to start with a quote. So I sent to the Library of Congress
2 for interesting quotes. I thought I would share two with
3 you anyway, to set a theme: 1945, Admiral William Lahey of
4 the United States Navy, in the Oval Room of the White House
5 with Harry S. Truman: "Mr. President, that is the biggest
6 fool thing we have ever done. The bomb will never go off,
7 and I speak as an expert in explosives."

8 The other one I wanted to share with you is from
9 1844, the Commissioner of Patents in the United States: "The
10 advancement of the arts from year to year taxes our credulity
11 and seems to presage the arrival of that period when further
12 improvements must end." Since I did not know who was going
13 to be in the audience, I thought I would take that slide.

14 May I have the next slide.

15 I just want to let you know that in Lebanon, New
16 York, there is a fault line that strikes north northeast,
17 and into Williams College and up to Bennington, Vermont.
18 There are 17 hot springs. The Marquis of Lafayette in 1756
19 planted a sycamore twig that is now 16 feet in circumference.
20 Sycamores like hot water, and that is one way of finding hot
21 springs in the east.

22 May I have the next slide.

23 That is the hot spring in Lebanon, New York. So
24 there is a trickle up there. Who knows what will happen if
25 the near normal program that Jim Bresee has gets going.

1 Next slide.

2 As a frustrated advocate in Yellowstone, the point
3 being that -- not so much Yellowstone, but how about Mt.
4 Lassen, how about the wilderness areas? We have got to focus
5 with the Forest Service to open up the forest surface lands,
6 if we are ever going to get into Fremont County, Idaho, into
7 Mt. St. Helens, into the biggest plays. This is an insti-
8 tutional problem. We have got to face it. The resource is
9 there, but can we get at it?

10 Next slide.

11 We have the leases, remember. There is a frustrated
12 advocate who took \$10 million of Mr. Howard Hughes' money,
13 and according to "The Goyer" (?), McNorton has three or four
14 hundred million dollars' worth of the resource; had it at
15 the well heads in '72. This is '76. Luckily, they broke
16 ground last week and on May 1, 1976 PG and E says, at 15
17 mils a kilowatt hour on a 60 megawatt machine, gross 55, and
18 that his client will get the money out. He has 15 percent
19 of that, John Callan.

20 Next slide, please.

21 So it can be done. The geysers, for those of you
22 who have not seen it -- this is an old picture I like.

23 Next slide.

24 And here is what Ben Bayliss and John Kilkenney have
25 done. They have taken something and made something out of it.

1 Dr. Hess -- rightfully so, it is a beautiful area, really,
2 it is remote -- and he lives up there. He does not want to
3 have the smells. So does Mr. Tucker -- or the noise. And I
4 can tell you that everybody is concerned about that.

5 I can also tell you that if it was not for Dr. Hess
6 and others, perhaps the utility involved would not have been
7 moved to do the work it has done. But it is doing it.

8 Next slide.

9 Just to give you an idea of well spacing.

10 Next slide.

11 That is what it used to look like before Mr. Kilkenny
12 and his associates and colleagues figured something out about
13 reservoir engineering. You do not have to do that any more.

14 Next slide.

15 Another view of it.

16 And the next slide.

17 You have seen that one.

18 Next slide.

19 Just some of the technology that Ben Bayliss could
20 talk to you about.

21 Next slide.

22 Cerro Prieto, the silencer.

23 Next one.

24 Cerro Prieto again, the cooling tower.

25 Next one.

1 This we might stop on. This is what the USGS said
2 in 7-26. This is what the National Research Council is going
3 to say in January, 1977, according to the present draft.
4 They are going to cut it off at 180 degrees centegrade, rather
5 than 150 degrees centegrade, on the theory that we do not
6 have advanced technology. That is, we do not have total
7 flow machines, helical screw machines, bladeless turbines,
8 KRRV's, or binary cycles, that all we have is the dry steam
9 technology.

10 Therefore, on a 180 degrees centegrade base, they
11 are going to say on the liquid dominated resource, 2,525
12 quads; vapor dominated, 53 quads, only the geyser. Mr.
13 Joel Renner (?) of the USGS tells us we do not have any
14 dry steam outside the geysers. Normal gradient, 180,000
15 quads; dry hot rock, 150,000 quads and zero from the lavas.

16 Next slide, please.

17 This is my talk, but no time for it. Just to give
18 you an idea, I think that the business is a mining man's
19 business for exploration until you come to drilling the well
20 and operating the field. Then it is the oil man's business.

21 Next slide, please.

22 I also think the economics are the mining business,
23 and that is what that means to say. We do not have the time
24 to go into it.

25 Next slide.

1 This is the program, if ERDA wants to get a program
2 from industry's point of view. This is what we have to do.
3 So let's go through them.

4 Just go through it, silde by slide, please.

5 I think the speakers downstairs were wrong, and I
6 think Hamilton is wrong. The oil companies do not control
7 this business. The law says that any one person can only
8 have 20,480 acres of Federal land in any state, and that in-
9 cludes Union Oil Company. The vast majority of leasees are
10 not oil companies. That 20,000 acre limitation hurts every-
11 body. It has got to be changed.

12 Next slide, please.

13 If we are going to have the Federal government say
14 that because two men who are out looking for a resource over-
15 lap a leasing application in the same area, and that makes
16 it a known geothermal area, and therefore it has to go to
17 competitive bid, we are kidding ourselves. We have seen the
18 result of it. We are just not going to have a leasing program.
19 We are not going to get the land out, and it is not going to
20 get developed. That has got to get changed.

21 Next slide.

22 On the one hand, we are between the horns of a great
23 dilemma. Unless we get the leases out, we do not have some-
24 thing to drill on. We do not have a tax status. We cannot
25 raise the money to do it unless you are Union Oil Company and

1 can take your profits that you made in the oil business in the
2 30's and 40's and pour it into geothermal these days.

3 But getting the land out is going to be a problem
4 when, as, and if the business ever gets off the ground. But
5 remember that industry has applied for those leases and owns
6 the resource, unless somebody wants to take it away from them
7 by some fiat.

8 Next slide.

9 If we are going to be stuck with the Congressional
10 attitude of "let the courts decide who owns geothermal, the
11 feoffstate owner or the patentee, or the Federal government
12 as a reserve mineral owner, and we are going to litigate this
13 for the next three to five years, unless we have an escrow
14 agreement both inside and outside of KGRA's, we are going to
15 block development, certainly at the geysers, where development
16 is blocked because of these legal issues.

17 Next slide, please.

18 I have referred to the --

19 Next slide, please.

20 -- acreage limitation. This is the single greatest
21 problem, in my opinion, restricting geothermal development
22 today, the fact that the Congress has decided -- or it is
23 the Ford Administration, and amazingly, Sen. Ted Kennedy and
24 the Ford Administration have formally opposed tax relief for
25 the geothermal industry. Therefore, if you are going to go

1 into the oil and gas laws, we may not currently expense our
2 intangibles. We must capitalize intangibles and capital
3 items. We cannot depreciate them before production. And
4 we must pay ad valorem taxes in the meantime, even though you
5 do not have revenues to pay them. The Administration and
6 the Treasury Department says that if this was changed, the
7 operators of the geysers would have a windfall, and the business
8 does not need incentives.

9 I have to say I think much of the Ford Administra-
10 tion. I have a minute left. I would just like to disagree
11 with Dr. Hess, if I respectfully may. I think Hamilton is
12 a great theologian, but I do not think, really, that he is
13 fair when he tells of the environmental horrors of geothermal.

14 May I have the lights, please.

15 The simple fact of the matter is that I think
16 Richard Bowen's analyses, both at the Pacific Conference, and
17 Dr. Ott in Kruger's book on geothermal energy, make the point
18 that this is the environmentally preferable resource that
19 we can have today. We do not know where solar is going to
20 go yet.

21 There is no mining, no milling, no ore processing.
22 There really is no fuel transportation, storage, or fabrication.
23 We do not have radioactive waste disposal problems or par-
24 ticipulates. We have H_2S , but we have Stratford process, and it
25 is going to be on unit 15 thereafter, and the engineers say

1 it is going to work. I hope Mr. Tucker believes that. He
2 may have a few reservations until he sees it working in
3 Sonoma. It helps clean up the smell that comes over beautiful
4 Lake County.

5 I think there is a balance, however, on the environ-
6 mental side of geothermal. I would point out that according
7 to David Howell, the computer whiz of the geothermal business,
8 that if we had 10,000 megawatts on what Dr. Meidav predicts
9 is a very vast land area -- I think it is 378,000 acres
10 and the KGRA is extended -- if there were 10,000 megawatts,
11 that the ad valorem taxes to the county would be six-and-a
12 half billion dollars -- billion dollars -- over 30 years.

13 If we had intangibles on that, it would be \$51
14 million in intangible deduction to get there and the depletion
15 would be \$14 million. That is the simple tale. My time is
16 up.

17 I had a prepared statement that was a little more
18 vigorous than I have said here today. I would just say that
19 ERDA is a mixed bag, as I see it. I am delighted to see the
20 new program that Jim Bresee has brought out on the non-electric.
21 I think that is one of the best things they have done. With
22 \$2 million dollars they are, I think, going to have one of
23 the most successful little programs in the world. And yet
24 we see \$4 million being spent on the administration of a loan
25 guarantee program. We do not see an application in there.

1 That may be the albatross that is going to hang us
2 up, because what we need, I think we would all agree, are a
3 couple of power plants demonstrating different techniques to
4 utilize and convert this energy. And the hangup, the alba-
5 tross of the loan guarantee program, is going to be that as I
6 understand it, ERDA is going to be inhibited from making
7 demonstration grants, if you could do it through the loan
8 guarantee program, even though there are no applications in
9 there, and even though a lot of people are not going to use
10 it.

11 So there is that problem. I think we just need some
12 time and effort and people, and hopefully, if the peanut vendor
13 becomes the president, and he collapses what Mike McCormick,
14 I am told, says -- "He kept FEA alive to give ERDA some
15 competition" -- and he winds them all together, wherever this
16 goes, hopefully we will see some continuity in the programs
17 and some real encouragement of industry.

18 For those of you who have not seen it, I commend to
19 you -- it is a fine piece of work. It is free, too. It is
20 available from the Fish and Wildlife Service in Sacramento
21 from Bill Spaulding. It was really written by Jim Kanig (?).
22 And it is the finest published, up to date, as of December '75,
23 piece of work, explaining what geothermal is, and then step by
24 step, mapping the KGRA areas and giving a time table for
25 development. And Jim, without violating any client confidences,

1 has done a superb job of saying, "Look. This is what industry
2 has." And I would make the point, and I disagree with the
3 distinguished padre from Fresno who remarked downstairs that
4 this conference seems to be rigged -- if there is one thing
5 this conference is -- there are no major oil companies par-
6 ticipating in it.

7 I criticize the conference because the people who
8 own and are going to develop and operate the resource are not
9 here. I do not see how ERDA can help industry if they are
10 not going to have them here. Maybe it is not appropriate to
11 have industry at this particular kind of meeting. This is
12 for the public and the public input. But I come back to
13 ownership, being a capitalist, and knowing the people who own
14 vast tracts of land and what their plans are, I would say
15 that geothermal is a bit of a submarine.

16 There are some events that are going to happen in
17 the next few months that will startle a lot of people. But
18 on the other hand, the industry as such is stalled dead in
19 its tracks because, as the Congressional Office of Technology
20 assessment has stated in its comparative analysis of the pro-
21 gram, it really is not a technological problem for the dry
22 steam and the wet steam. It is an institutional problem -- the
23 taxes, the environmental problems.

24 Certainly I commend ERDA for the geopressure program.
25 If that is a winner, we are all the better off for it. Thank

1 you.

2 MR. VALENTINE: Thank you, Don. I was afraid you
3 were not going to leave any questions unanswered there for
4 a second. But we are on our way, and John Arlidge, the
5 Assistant to the Vice President for Nevada Power Company is
6 here to discuss some of the experiences that they have had
7 with ERDA in the geothermal program, I think. John?

8 MR. ARLIDGE: It is not quite with ERDA. Don
9 caused me to reflect a little bit. We are sitting here talking
10 to ourselves again. I met Don Finn, the second man you always
11 meet when you look at geothermal, about the early 1960's.
12 And as you saw, Don is a baseball, hot dogs, apple pie, geo-
13 thermal, and motherhood person. Tsvi, I met him with Bob
14 Rex working in Imperial in the '60's. I first ran across
15 Hamilton Hess down in El Centro about 1968. He had about
16 a 40-minute dissertation on hell fire and brimstone.

17 When we got through, we figured if we developed geo-
18 thermal, our families and ourselves would be banished from the
19 Garden forever. Denny, I met in 1974 in Santa Barbara, dis-
20 cussing legal problems, of why geothermal is not developing.
21 Jim Bresee and I were in Salt Lake City yesterday discussing
22 problems, why isn't geothermal developed.

23 Everyone knows, I think, that there is an energy
24 crisis, and it is severe enough that we should be taking
25 advantage of each of our energy resources. Geothermal energy

1 is a potential source for the utility industry. It has been
2 estimated by some that it could provide one percent or even
3 100 percent of our generation requirements between now and
4 2000.

5 I do not believe it can provide 100 percent, but if
6 it can provide one percent, we should develop it. Incredible
7 as it may seem to you, under Federal policy and regulations,
8 it will not be developed. The Federal government owns and
9 controls virtually all the potential geothermal areas in the
10 United States. After 25 years of legislative history, it
11 passed the Geothermal Steam Act in 1970. Almost six years
12 have passed. Out of the 300 million acres controlled by
13 Federal ownership, none has been produced.

14 Federal and state governments are still arguing over
15 who owns it, and regardless of who owns it, who is going to
16 control it. The Federal government's environmental laws,
17 tax laws, and the Federal and state disputes will prevent its
18 development. Some applaud this. It is highly doubtful that
19 the industry will find that it is beneficial to develop this
20 to any significant level under the existing stringent and
21 unrealistic regulations.

22 The Geothermal Steam Act differs greatly from the
23 Mineral Leasing Act, as Don pointed out. Further Federal
24 regulations forbid the filing of a power plant site until a
25 commercial field is developed. No one in their right mind wi

1 devote the time or the energy or the money to develop a com-
2 mercial field without at least reasonable assurance that a
3 power plant site could be obtained.

4 Two further restrictions, if there were no other
5 problems, would preclude utilities from participating in this
6 resource. They are the lease terms which call for readjustment
7 and possible cancellation at ten-year intervals. The second
8 one is that Federal agents have the authority to arbitrarily
9 shut down a power plant without notice.

10 The possibility of such unilateral and arbitrary
11 actions are, to say the least, hardly consistent with the
12 tremendous long-range planning and huge investments demanded
13 by a successful utility operations. As if all that were
14 not enough, we still face the usual environmental problems --
15 the noise, odor, land use, aesthetics, disposal of condensates,
16 et cetera.

17 The development of this resource, as in other re-
18 sources, will call for realistic compromises between environ-
19 mental desires and energy needs. And so, as desperately as
20 we need to take advantage of geothermal energy, nature's
21 gift, we certainly are not encouraged to do so under Federal
22 policy and regulations. We must come to a general agreement
23 to force the Federal Government and state agencies to modify
24 their policies and regulations so that we can develop geo-
25 thermal energy and all other energy sources needed. Thank

1 you.

2 MR. VALENTINE: In concluding the formal part of
3 this program, and just prior to questions by the audience,
4 or discussion, I should say, from the audience -- because
5 I think there probably or may well be considerable discussion
6 between members and participants on the panel, along with
7 members of the audience who are equally as distinguished.
8 I would like to present Jim Bresee, Acting Director, Division
9 of Geothermal Development for the Energy Research and Develop-
10 ment Administration, to offer some observations of his own.

11 MR. BRESEE: Thank you, Mr. Chairman. I decided
12 to wait until we had concluded the remarks of the other
13 participants and see if I could not make a few summary com-
14 ments and take as little of your time as possible to get
15 through them, so that we can get on into the more interesting
16 portion of the problem. As far as I am concerned, the real
17 benefit of this program will begin when we do have a chance
18 to exchange ideas with those of you who have sat through a
19 long day and put a lot of time into participation, and I am
20 sure, have things to offer us. I look forward to that portion.

21 Let me make a few observations. The geysers field,
22 which was described by several participants, is the only
23 field in the United States presently under development.
24 There are a little over 500 megawatts presently at that site,
25 but with rather firm projections to go to 1,500 megawatts by

1 1985. At 500 megawatts, it represents the largest single
2 development in the world. You might be interested in knowing
3 that there are eight other countries in the world that use
4 geothermal energy for electric power production, and several
5 others that use it quite extensively for non-electric use.

6 I would agree with Tsvi Meidav that non-electric
7 use looks like it may turn out to be, in the long run, an even
8 more important application of the energy resource. We are
9 very delighted when we find resources as high as 200 degrees
10 centigrade to exploit. This is very old, very low temperature
11 resource, in terms of electric power generation, where modern
12 power plants frequently exceed 600 degrees centigrade, when
13 they are fossil fueled.

14 We are dealing with, therefore, very low energy
15 efficiencies for electric power production. But combined
16 electric and non-electric applications may be quite signifi-
17 cant. It is said that the non-electric applications in the
18 world today exceed the electric by a factor of about five.
19 It is very hard to pin down the total amount of non-electric
20 applications when you consider you could include all the
21 spas and health resorts in the world as a non-electric appli-
22 cation.

23 And just how efficiently the heat energy is used
24 in these facilities are not quite clear. But in this country
25 at least, we now produce one tenth of one percent of our

1 electric power from geothermal energy. I would agree that
2 going to one percent -- in other words, increasing by a
3 factor of ten -- the percentage utilization, would be a
4 big step forward. I am optimistic enough to believe that we
5 can do better, and that on a national basis, by the end of
6 the century, we may actually reach several percent, in the
7 range three to five percent, if we can get through both
8 technical and non-technical obstacles in the way of the de-
9 velopment and carry out the development in an environmentally
10 acceptable manner.

11 That national figure may be a little misleading,
12 because as several people have observed, we are talking about
13 a western development, principally. It does appear that the
14 15 western states -- and by that, I am including Texas and
15 Louisiana because of geothermal pressure -- but the 15 western
16 states, on a percentage basis, may make use of geothermal
17 energy on a much larger scale than this few percent nationally.
18 In fact, it is entirely possible that the state of California
19 could produce as much ten percent of its electric power from
20 geothermal energy. This, in a state that uses so much oil
21 now, oil and natural gas, could be a tremendous improvement in
22 the electric power base.

23 I might mention that the Federal program's geothermal
24 budget has been rising rather rapidly. In fact, in the
25 President's budget of fiscal '77, geothermal energy as an

1 energy technology received the greatest percentage boost of
2 any of the energy technologies, all the other, non-nuclear
3 and nuclear, over 40 percent increase between '76 and '77.

4 Our budget, after Congressional action, which was
5 also increased another ten percent, will exceed \$50 million.
6 When I began work four years ago in geothermal energy in the
7 Federal budget, the total Federal budget at that time was
8 \$5 million. So there has been some progress, at least, in
9 trying to get more of the limited energy resource dollars into
10 this very important technology.

11 At a meeting that several of us attended during the
12 last couple of days in Utah, where we discussed with indus-
13 trial representatives and state and local government repre-
14 sentatives the problems in the development of geothermal
15 energy, there was an announcement made which pleased me a
16 great deal, and which many of you might not have heard: that
17 is, that the Magma Power Company is planning to build a ten-
18 megawatt pilot plant, based upon a liquid reservoir at East
19 Mesa, within the next couple of years.

20 They do expect to have this power plant in operation
21 producing power by about 1979. So it will give us a bit of
22 a let up in getting this under-utilized liquid dominated
23 resource. The earliest that I would expect a commercial
24 power plant at the 50-megawatt scale to be operating would be
25 in 1980.

1 I might comment a little bit on some of the insti-
2 tutional issues that Don raised. His comments are certainly
3 well taken. We spent a little bit of time at the Utah
4 meeting talking about some new approaches that ERDA has been
5 undertaking in cooperation with other agencies to try to
6 reduce some of these non-technical obstacles to the develop-
7 ment of this resource.

8 For example, the Department of the Interior has
9 agreed, as a result of interagency discussions, to recommend
10 to the next Congress that the acreage limitation that Don
11 referred to, be raised by at least a factor of two, up to
12 above 50,000 acres per state. We also expect to have regula-
13 tion changes which reduce the impact of overlapping lease
14 applications in terms of producing KGRA's. We hope to greatly
15 speed up the leasing of Forest Service lands. We have
16 been working closely with McGuire, Director of Forest Service,
17 and are writing letters to his boss, Secretary Butz, and
18 have talked to the Congress about trying to get additional funds
19 into the environmental assessment activities necessary to get
20 those Forest Service lands leased.

21 ERDA put about \$100,000 of its funds this past fiscal
22 year into doing one special study at Long Valley which is
23 predominantly Forest Service land, in order to get that par-
24 ticular leasing program under way. It should begin early in
25 1977.

1 I was very disappointed -- many of us who are trying
2 to see this energy technology grow -- I was very disappointed
3 with the decision of the Congress to eliminate the Fanin
4 Amendment from the Tax Reform Bill that has just been com-
5 pleted. This would have provided some of the tax relief that
6 other energy technologies have had, and which geothermal
7 needs even more, because of the much longer period between
8 the beginning of geothermal development and the beginning
9 of cash flow. That amendment was stricken from the tax bill
10 and apparently is dead for this session.

11 In the meantime, we have gone ahead with Treasury
12 and have gotten them to agree to recommend changes in the
13 tax law which would provide approximately two-thirds of the
14 financial benefit that would have accrued from the Fanin
15 bill. This will be also introduced into Congress early next
16 year.

17 A few words in defense of the loan guarantee -- par-
18 ticularly since one of the major participants in administering
19 this program, Diane Nastish, is down in the front row, and
20 I know that she and others here at the San Francisco office
21 have put an awful lot of effort in trying to get the program
22 off the ground. It does appear that it is finally making
23 headway. When you consider that it was published in the
24 "Federal Register" in May and became effective in June, and
25 we are now just barely three months into the program, the fact

1 that four or five applications are to be filed within the next
2 several weeks I think is an indication of movement, and I
3 commend the San Francisco office for putting in the necessary
4 time to get such a complex but important program rolling.
5 I think that is enough general comments about geothermal
6 energy from my side. I am very interested in comments from
7 your side.

8 MR. VALENTINE: I am directed to point out to those
9 of you still remaining, and of those of you remaining, those
10 of you desiring to speak, that there are microphones located
11 in the room. However, I would think that there is not enough
12 ambient noise to demand you use those unless your voice is
13 tremendously hoarse or low. I would like to, at this time,
14 open it for your questions of members of the panel. And
15 please also direct your questions to a particular member of
16 the panel, if appropriate, or at large.

17 And time allowing, if members of the panel feel
18 that they would also like to comment on a matter or become in-
19 volved in brief discussion on an issue that may be confusing,
20 please do not hesitate to do so. Questions?

21 That is amazing. You know, on occasion, I had an
22 opportunity to be involved in debates on the nuclear initiative
23 And if there is one thing I gained from that experience, beside
24 bruises, it was that geothermal is going to be the answer.
25 And now I am confused from what I have heard. So let's go.

1 Yes.

2 MR. HARPER: Well, a lot of comments have been made
3 about how you come to these meetings and talk to each other.
4 Well, you ain't talked to me. I am Carl Harper. I am on
5 the legal staff of the Lake County Energy Council. We are
6 a 1,400 member group who represent people very concerned about
7 development in Lake County. The primary thing that concerns
8 us is what is happening in Sonoma County right now.

9 In other words, you have developers and you have
10 the utilities. The developers come and sell you on the pro-
11 ject, and there is no doubt that many of them are excellent
12 companies and mean exactly what they say. But then it is
13 the utility that makes you live with it. PG and E has refused
14 to change its dirty diapers in Sonoma, and we smell the H₂S,
15 not just a little -- a lot. And this is a real problem. We
16 have not made much headway.

17 It may just be that our board of supervisors is
18 going to have to sue sonoma. It may just be that that is the
19 way it is going to have to go.

20 One of the real problems that I want to address to
21 ERDA is the fact that -- what is it -- four-and-a-half million
22 dollars plus has been sent into Imperial County, and so far
23 we have gotten about \$50,000 into Lake County. The group
24 that I represent is not just your knee-jerk environmentalists.
25 We are for intelligent development, but that means a lot of

1 things to a lot of different people. To some people, in-
2 telligent development means, put a plant in somebody else's
3 back yard, and get the energy in for yourself.

4 We are definitely going to make sure that it is
5 done right. There are good people in Lake County. We have
6 an excellent Planning Commission. We have air pollution con-
7 trol officer who is one of the best in the state -- maybe the
8 best in the state. We have some good Young Turks working
9 for the planning staff. But you have got to put money into
10 our county. We are a poor county. We cannot even give our
11 deputies a raise. It is a very, very poor county. ERDA and
12 the Energy Commission have got to take up the slack, because
13 not only do new technologies have to be shown to the people
14 in Lake County -- and that is going to require development,
15 because we have not seen anything in Sonoma that makes us
16 want to have it in our county.

17 But not only that, it is also a mammoth planning
18 task. We are sitting on top of a tremendous resource. I want
19 to see it developed. I want to see people make money. I want
20 to see energy come out, but it has got to be done right. And
21 it is going to require a mammoth planning process. It is
22 going to require dollars. And that, gentlemen, has got to
23 come from the Federal government and the state government,
24 because it is the people who are ultimately going to benefit
25 from this energy.

1 So I just would like to ask ERDA what you have in
2 mind for Lake County.

3 MR. FINN: Could I just reply to the preliminaries
4 on PG and E, and so forth?

5 MR. VALENTINE: Yes. Go ahead. Sure.

6 MR. FINN: Mr. Harper, I am a member of the Geo-
7 thermal Association of Lake County. As far as I know, the
8 vast majority of people who own property in the county, who
9 are registered voters and taxpayers, are in favor of geother-
10 mal, through my association with that committee.

11 MR. HARPER: Do you live in Lake County?

12 MR. FINN: No, sir. I do not live in Lake County,
13 but I visit there and am delighted to do so. I do not know
14 how long you have lived in Lake County. Not too long, I
15 would suspect, although I do not know you. The newcomers to
16 the county -- and who they may be -- and I take that some of
17 your members are associated with the Dawn Horse Community.
18 We know them of Polk Street here in San Francisco, and up there,
19 I guess it is Seagull Springs.

20 We have run into them. They make statements like
21 you have made which are, I think --

22 MR. HARPER: Who is "they"?

23 MR. FINN: Members of your council, like yourself.
24 The Dawn Horse Community people make slanderous statements,
25 outrageously unfactual statements. When you say that --

1 MR. HARPER: Who is "they"?

2 MR. FINN: The members of your council, sir.

3 MR. HARPER: There are two members of the Dawn Horse
4 Community that are members of a 1,500 member council. What
5 are you trying to get into, Mr. Finn?

6 MR. FINN: Your statement, sir, your completely non-
7 factual, slanderous statement that PG and E has not changed
8 its dirty diapers. If you do not know that the California
9 Public Utility Commission has ordered and is supervising
10 PG and E to retrofit units 1 through 10 to clean up the H₂S,
11 then you do not know what you are talking about. And if you
12 do not know that units 15, 13, and now they have filed for
13 16 and 17, are going to be outfitted with the Stratford
14 process to clean up the H₂S, and you represent that PG and E
15 is not doing what it has been told to do and is not taking
16 advantage of the best available known technology known to
17 man, and you seem to be against -- and are not offering us
18 anything for -- I question your motivation. I question who
19 you really represent and talk for.

20 I do not agree with you that ERDA has to pour money
21 into Lake County. As I pointed out, the resource is there.
22 The income from the taxes are going to be enormous -- for
23 what, about 30,000 people in the county?

24 MR. HARPER: 25.

25 MR. FINN: And again, I say the property owners --

1 Lake County is virtually leased, across the county, for geo-
2 thermal development. The landowners are receiving rental
3 revenues for the leasing of those properties, and I do not
4 agree with you that things are not going well. When the
5 CPUC and when the air and water quality regulators of this
6 state have issued all the permits necessary to build unit 15,
7 and are requiring PG and E to retro-fit its units, they are
8 doing it as best any good engineering skills can do it, I
9 think the evidence is that industry will do what they can
10 practically and humanly do, with good intentions.

11 I am no spokesman for PG and E. I am on the other
12 side of them. I want to see them move faster than they do.
13 But they do a great job, I think, for a very large organiza-
14 tion. I just want to reply to you in that way, sir.

15 MR. HARPER: The only comment I have to that is the
16 fact that the Lake County Board of Supervisors is very pro-
17 geothermal, and they are considering suing Sonoma County
18 for the fact that H₂S continues to come over. Over a period
19 of years, we have griped, we have threatened them, and it has
20 continued. If you would like to hear that from Fain Tucker,
21 you can hear the same thing from him.

22 MR. FINN: I read the "Santa Rosa Democrat," and that
23 is just politics. It is good defense to the lawsuit, and --

24 MR. HARPER: It is not good politics, if you live
25 there and you smell it. That is a simple fact.

1 MR. VALENTINE: Excuse me, if I can interject just
2 for a second. The discussion is interesting. When is the
3 PUC order supposed to be -- it is effective, in that they
4 are doing it, but when are they supposed to have it done?

5 MR. FINN: They have a review every few months, and
6 they are testing a variety of systems that are not all work-
7 ing that well. They have gone through several of them, and
8 they have engaged all sorts of consultants to get the best
9 available engineering advice as to how to retrofit these
10 things. I think they have a variance from -- they are ex-
11 ceeding the air quality standard, which is not a health stan-
12 dard. It is a smell standard, because you can smell it. It
13 has to be eliminated, but not because it is a health hazard
14 in any way.

15 I think John Kilkenny may know better than I. But
16 I think they have three years, a three year time table. But
17 they have just got to, or they will shut them down.

18 MR. HARPER: It is the local air pollution control
19 district that he is talking about, not the --

20 MR. FINN: No. I am talking about the California
21 Public Utilities Commission. They have an outstanding order.

22 MR. HARPER: That is on unit 15.

23 MR. FINN: All units.

1 question is, how much money is ERDA bringing into Lake County,
2 and when is it going to start coming?

3 MR. BRESEE: I have had several conversations with
4 Fain Tucker, and I will be taking part in your next con-
5 ference in October. I look forward to having continued dis-
6 cussion with him and with you at that time.

7 Fain and I have talked about this problem of lack
8 of ERDA funding directly to the county. I urged him on several
9 occasions to prepare some sort of proposal which we could
10 deal with, and I still look forward to receiving one. In terms
11 of what funding ERDA is applying to Lake County's problems,
12 it is considerably more than the \$50,000 you quote. I would
13 be glad to go over in detail the environmental studies which
14 we feel will be useful in trying to help solve what I am
15 sure is a very serious problem from your standpoint. I look
16 forward to discussing it further with you when I am there in
17 October.

18 MR. HARPER: One of the points that we would like
19 to get across is that it is not just the technology that is
20 involved. It is the planning process.

21 MR. BRESEE: It was that side of the needs of the
22 county that Fain and I discussed over the phone. And I guess
23 when I am up in October we will have a chance to go over it
24 in more detail. But we would like to help. We recognize that
25 there are problems there. The State Energy Commission also

1 recognizes that there are unsolved environmental problems
2 associated with past developments, and I am sure we all want
3 to move as rapidly as possible toward a solution of those
4 problems.

5 MR. HARPER: Not just trying to stress the negative
6 in terms of environmental problems that are unsolved, but trying
7 to stress the positive -- and that is whenever you go about
8 development, you want to do it in the right way. That re-
9 quires planning. In Lake County, you are talking, like Mr.
10 Finn says -- virtually the entire county is leased. You cannot
11 have a power plant on every single leasehold, so there is a
12 tremendous planning job that has to be done there that cannot
13 be done with the resources of this county.

14 MR. VALENTINE: Thank you. Another question? You
15 guys do not have any problems. What are you telling me?
16 There are not any questions.

17 MR. MINER: I was curious to know how many loan
18 guarantee applications you have had to date?

19 MR. BRESEE: That is an easy question: none. The
20 first applications should be coming in within a couple of
21 weeks, and it is my understanding there will be about five
22 between now and the end of October.

23 MR. MINER: You made a point that you are changing
24 the regulations?

25 MR. BRESEE: There have been a series of identified

1 problems with the existing regulations. I am sure they will
2 be changed. We have not started any formal procedures to
3 change them. But particularly as we go through the actual
4 processing of these first applications, we will get a
5 better idea of where there are difficulties or ambiguities
6 or uncertainties.

7 Incidentally, any of you who have had connection
8 with the loan guarantee regulations know that they were first
9 issued in draft about a year ago and went through three or
10 four draft reviews using as much advice from industry, from
11 county representatives, state governments, and so forth --
12 and still, as you know, governments are less than perfect,
13 and the regulations, I am sure, need improving. But we will
14 gradually try to get a better set of regulations out.

15 SPEAKER: How is the \$50 million funded down into
16 the various categories?

17 MR. BRESEE: Approximately \$15 million in research
18 and advanced technology, which includes resource assessment
19 work; approximately \$20 million in utilization programs,
20 including such things as the dry hot rock, geopressured
21 activities; there is about \$5 million in work in environmental
22 institutional, regulatory programs; there is about \$4 million
23 in expected costs associated with the loan guarantees which,
24 incidentally are not administrative expenses. I would like
25 to correct that misunderstanding. These are expected defaults

1 during the first year of operation, from a \$30 million total
2 estimated default over a period of the lifetime of the loans,
3 totalling \$200 million.

4 Three numbers -- let's see if I can explain them.
5 We expect to be able to approve as many as \$200 million worth
6 of loans the first year. And of that, the expectation is that
7 there may be \$30 in defaults, a one in seven ratio, and that
8 of the \$30 million, \$4 million will occur the first year.
9 Those are descending estimated numbers. I am not sure I am
10 up to the full \$50 million, but I will try to correct it when
11 I get access to some --

12 MR. MINER: How much of the \$50 million goes to
13 National Laboratories?

14 MR. BRESEE: Approximately \$20 million. There
15 would be \$30 million outside of the National Labs. I would
16 like to explain the pattern changes in ERDA funding. I think
17 it might be edifying.

18 The first year of ERDA's existence, which was
19 fiscal '75, \$20 million was spent, \$15 million in the National
20 Labs. The second year, \$32 million spent, \$19 million in the
21 National Labs. The third year, which is fiscal '77, \$50
22 million, approximately the same, \$19-20 million. Our policy
23 is to maintain laboratory funding level and to put all the
24 increases into university and industrial contract work.

25 MR. MINER: Could you give me a percentage figure on

1 how much, percentage-wise, goes to private industry?

2 MR. BRESEE: Yes. I can take those numbers I just
3 gave you. The first year it was 25 percent; the second year,
4 it was approximately 38 percent; the third year it will be
5 60 percent -- increasing percentages.

6 MR. MINER: To private industry.

7 MR. BRESEE: To private industry.

8 SPEAKER: I have heard some comments on a new re-
9 gional perspective that ERDA is looking at. Could you perhaps
10 comment on the status of that question, or how it is going to
11 be used?

12 MR. BRESEE: Yes. As the program began, a good deal
13 of it was activities inherited from the AEC and from NSF.
14 It became obvious after about a year into the program, that
15 there was a need to shift our emphasis toward what has been
16 called regional or field planning so that we would look, with
17 the help of local or regional entities, the San Francisco
18 operations office of ERDA, the Jet Propulsion Laboratory, SRI,
19 the California State Energy Commission, for example, all
20 working together to try to determine to try to determine what
21 the possible geothermal growth scenario in California might
22 be, looking locally at the possible future of the energy here.

23 We are doing the same thing in the Northwest. We
24 are starting the same program in the Texas-Louisiana area
25 connected with geopressured. We will be starting a similar

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1 program in the Great Basin states. Each of these planning
2 activities, then, has associated with it requirements, techni-
3 cal requirements, and field experimental activities, which
4 then demand resource planning in terms of Federal involvement.

5 So we are trying to go from a series of regional
6 scenarios developed in conjunction with the state and local
7 governments, as well as industrial groups, back to planning
8 the allocation of the limited Federal funding. This is a
9 change that has been going on over the past six to eight
10 months. We are also, at the same time, contemplating a re-
11 organization of the division to make it structurally easier
12 to carry out this type of activity.

13 It is part of a general effort, I think, in ERDA
14 to decentralize its management as much as possible and to take
15 advantage of knowledge on a local level, and management
16 capability on a local level, to improve our priority system.

17 MR. VALENTINE: I think we are getting close to
18 closing this up, and before we do, just for my own references,
19 I would like to have an indication of how many people yet
20 remaining in the room have no professional interest in geo-
21 thermal, but are here because they are what we would call
22 a concerned citizen.

23 (5 or 6 members of the audience raised their hands.)

24 MR. VALENTINE: Okay. Thank you. I was just won-
25 dering where we were.

1 MR. FINN: Can I add one comment to something Jim
2 has said?

3 MR. VALENTINE: Yes, Don.

4 MR. FINN: Jim referred to PG and E's plans to have
5 1,500 megawatts at the geysers by 1985. I have PG and E's
6 latest prospectus, which is an amazing prospectus. They are
7 offering seven-and-a-half million shares of stock \$23, I
8 guess the largest stock offering ever made in this country.
9 It is the first time they have ever sold public stock, too,
10 since they have gone public.

11 The latest count is 2,300 megawatts by about 1988,
12 1685 scheduled for installation, they are going to be ordered,
13 and the rest in a planning stage awaiting Union Oil and
14 others to find a little more steam, as is thought can be done,
15 which tells you something about PG and E's ability to predict
16 the future a little bit.

17 And I just might say that in reading the prospectus,
18 I note that although Jim is right, there are only 502,000
19 kilowatts net, 522 gross, installed at the geysers, that is
20 5.7 percent of the generation of PG and E's system, while
21 nuclear is only .6 percent. On the other hand, according to
22 the prospectus, we have got 2,000 megawatts of nuclear at
23 \$985 million scheduled for 1977 at Diablo Canyon. Those
24 plants will never come on in 1977, because of the seismic
25 safety and generic problems now raised by the NRC. The interest

1 on that investment and the need to purchase additional power
2 is going to raise that effective cost, perhaps up to \$1,000 a
3 kilowatt before they are through, and they do not know whether
4 they are going to be able to meet the seismic safety standards.
5 The uncertainty is devastating.

6 And yet on the other hand, where is geothermal
7 going to go? I think it is going to follow this. PG and E
8 tells us that they have dipped into their treasury stock and
9 they have exchanged 767,000 shares of \$23 stock carrying \$1.88
10 a share dividend, for a 35 percent interest in 9.1 million
11 pounds of uranium. That is \$45 a pound in the ground, and
12 they hope that Union Oil Company, who are the managers of that
13 uranium project, can pull it out.

14 If they are going to start buying uranium in the
15 ground and coal in the ground, as they have done in Utah,
16 perhaps it will not be too long that we will see some of the
17 utilities buying steam in the ground.

18 MR. MINER: What is the payoff in mils, presently,
19 the rate increase?

20 MR. FINN: PG and E is estimating 15 mils of
21 January 1, 1978.

22 MR. VALENTINE: You know, I am told that some of
23 these problems are best solved, not in a parlor sitting
24 theater-style, but in a pub sitting in a line, and I would
25 like to invite everybody to continue their conversation

1 informally, seeing that it is past 11 o'clock, and thank
2 those of you who have had the interest to participate in
3 this portion of ERDA's discussion. Thank you.

4 (Whereupon, at 11:10, the workshop was adjourned.)
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