GEO-HEAT CENTER

FINAL REPORT

Geothermal Energy Program:
Information Dissemination, Public Outreach,
and Technical Analysis Activities

April 1, 1999 to December 31, 2001
USDOE Grant No. DE-FG01-99-EE35098

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DISCLAIMER

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PROJECT ACTIVITY -- EXECUTIVE SUMMARY

The project team consisting of the Geo-Heat Center (GHC), Geothermal Resources Council (GRC), Geothermal Education Office (GEO), Geothermal Energy Association (GEA) and the Washington State University Energy Program (WSU) accomplished the following activity during the 33-month period of the grant.

Geo-Heat Center. The GHC staff responded to 4,414 requests for technical analysis/technology transfer from 46 states, the District of Columbia, and 80 different countries. The majority of the inquiries/responses were for general information (39%), geothermal heat pumps (23%), resource and well data (12%), and equipment (8%). Eleven issue of the *Quarterly Bulletin* were published which included 67 articles (31 written by GHC staff), and were sent to 2,200 subscribers (450 of which were to international - later reduced to 50 due to increased mailing costs). GHC staff made 64 presentations (12 of which were international), wrote 40 technical papers, attended 48 professional meetings and were involved in 15 training sessions. The GHC web site, http://geoheat.oit.edu, received an average of 352 users/day in 1999, 526 in 2000, and 987 in 2001 - a 41% annual compounded increase. The number of downloaded files per day increased from 94 in 1999, to 167 in 2000, to 435 in 2001 - a 67% annual compounded increase. A total of 4,303 publications were distributed to individuals.

Geothermal Resources Council. The GRC had three tasks under this grant: (1) maintenance of the GRC on-line geothermal library; (2) production of the GRC *Transactions*; and (3) GRC printing/distribution of the DOE quarterly *Geothermal Technologies* newsletter. The GRC library features six on-line databases, including: Basic Library, GRC *Bulletin*, Power Plants, Direct-Use/Heat Pumps, U.S. Vendors, and OIT Geo-Heat Center *Bulletin*. The GRC web site is backed by a physical library that contains over 23,000 geothermal citations. The GRC On-Line Library logged approximately 1,400 viewers/month. The GRC produced three issues of the *Transactions* (Vol. 23, 24 and 25) in conjunction with the GRC Annual Meeting. A total of 355 papers were published in these three issues. Ten issues of the DOE *Geothermal Technologies* newsletter were distributed by GRC as an insert in the GRC *Bulletin*. A total of 1,000 copies of each issue were distributed, plus 300 copies shipped to NREL for internal and public distribution.

Geothermal Education Office. The GEO had two main activities under this grant: (1) providing information and training; and (2) developing and distributing educational materials. The main activity under training was holding three *Introduction to Geothermal Workshops* in conjunction with the GRC Annual meetings in 1999, 2000 and 2001. Annual attendance ranged from 45 to 68. As part of the second activity, the GEO maintained and enhanced their website:

www.geothermal.marin.org; continued to respond to email and telephone queries - amounting to about 1900 during this period; designed and produced a display booth which was used at Earth Day,Clean Power Day, ENERGEX2000, and GRC Annual Meetings, and won the GRC/GEA *Most Informative Award* at the 2000 Annual Meeting; produced a video and slide show which is widely used - the video has also been translated into Spanish and Japanese; and continues to provide outreach, consulting, and collaborative services to organizations and companies such as Fuji Electric, DOE's GeoPowering the West initiative, Western Area Power Authority, the NewHour with Jim Lehrer (PBS), Microsoft's Encarta CD-ROM Encyclopedia; California's Renewable Energy Marketing Board; Calpine Corporation; International Geothermal Association; Project WET (National Water Education for Teachers Program); and many others.

Geothermal Energy Association. The object of GEA's participation in this grant was the organization of a series of workshops and technical sessions. The efforts were focused on regional trade development in Central American and East Africa. Interest and cooperation was provided by the World Bank, AID, the Department of State and USGS. Workshops were held in September 1999, September 2000, March 2001 and May 2001. In addition, a Geothermal Town Meeting was held in September 2000, at the GRC Annual Meeting/GEA Trade Show. A draft of a "white paper" was produced in early 2001 that incorporated the ideas presented at previous meetings. The report: *"Status, Barriers and Solutions to the Development of Geothermal Energy on the International Marketplace"* was then further edited by Karl Gawell of GEA and Steve Hirsch for INEEL, and the results presented during the GRC Annual Meeting in 2001. The final paper was republished in shortened form in the GRC Bulletin.

Washington State University Energy Program. WSUs Energy Program has worked on two main projects: (1) the proposed geothermal district heating project for Mammoth Lakes, CA; and (2) the heating of the Columbia Gorge Resort, WA. The principle investigator, Dr. Gordon Bloomquist has also participated in conferences and authored a number of papers, which include: International Geothermal Day, Oregon 1999 in Klamath Falls; the European Geothermal Conference; International Summer School; GRC Annual Meetings; World Geothermal Congress 2000 in Japan; and the International District Energy Association meetings. Technical assistance was provided to projects employing geothermal heat pumps, both to private developers, the Bonneville Power Administration and the Department of State. Work also began with the Seattle City Light, Volcan Power and Northwest Geothermal relative to the purchase of up to 100 MWe of geothermal power. Dr. Bloomquist also helped organize sessions for USDOE Green Power Summits in San Diego and Seattle, and assisted DOE with preparation of geothermal RFPs, reviewing proposal and made presentations at GeoPowering the West meetings.

Town Hall Meeting. This grant was augmented in 2000 to provide for a Geothermal Town Hall Meeting at the GRC Annual Meeting/GEA Trade Show in San Francisco. The event was broadcast worldwide over the Internet for two hours, and the broadcast of the event remained available on-line for one year following the meeting. The program covered a series of topics: the environmental advantages of geothermal energy, GeoPowering the West, highlights of outstanding geothermal facilities, interviews with key industry and government leaders, and review of geothermal research efforts. It was viewed by individuals in more than half of the states and over a dozen foreign countries. Hosted by GEA -- GRC, GHC and GEO members participated.

Cash and In-Kind Professional Services.

Cash contributions:

Geo-Heat Center:	$80,119.18
Washington State University:	$20,453.60
Subtotal:	$100,572.78

In-kind professional services (details can be found in the quarterly reports):

Geo-Heat Center:	$125,925.00
Geothermal Resources Council:	$172,500.00
Geothermal Education Office:	$ 57,581.25
Geothermal Energy Association:	$ 34,990.79
Subtotal:	$390,997.04
Total Contributions:	**$491,569.82**

Grant Requirements:

Cash:	$ 93,562
In-kind professional services:	$284,850
Total:	**$378,412**

We have, thus, exceeded our contracted contributions by 30%.

Geo-Heat Center
Final Report
April 1, 1999 to December 31, 2001

The objective of this project was to continue on-going work by the Geo-Heat Center (GHC) to develop and disseminate information, provide educational materials, and enhance technology transfer that would assist industry and government efforts to increase the utilization of geothermal energy resources in the United States and developing countries, by means of electric power generation, direct utilization and geothermal heat pumps.

Specific objectives for the GHC included:

- Providing information and training to potential developers, designers and users of geothermal energy, mainly in the area of direct utilization;
- Maintaining and updating a technical library and comprehensive databases of research, applications, resources information, and maps;
- Developing and disseminating resource, engineering, economic, and environmental information, analyses and project descriptions to potential developers and users;
- Developing and distributing educational materials; and
- Analyzing and identifying opportunities in both domestic and international markets for organizations to implement cost-effective projects using geothermal energy.

TECHNICAL ANALYSIS/TECHNOLOGY TRANSFER.

The GHC staff provided responses to 4,414 requests/responses during the period April 1, 1999 to December 31, 2001 (11 quarters or 33 months), which is slightly different from the contract period; however, in order to provide continuity from out last USDOE contract that ended on 31 March 1999, we are reporting for the full quarter of the first period (see Figure 1 for numbers by quarter). Expenses were only charged against the contract staring on the contract date of May 7, 1999. The reporting period ended on December 31, 2001, as a new USDOE contract started on January 1, 2002. The no-cost contract extension time from January 1, 2002 to March 31, 2002 was used for summarizing the data and preparing the final report.

These requests/responses were from 46 different states (except IA, MS, RI and VT) and the District of Columbia and included 519 international contacts (11.8%) from 80 different countries: 10 in Africa, 24 in Asia, 3 in North America, 7 in Central America and the Caribbean, 6 in South America, 27 in Europe, and 3 in Oceania. A total of 2,546 contacts (57.7%) were by email of which 573 (22.5%) could not be identified as to location. A breakdown of requests relative to applications are: General (38.9%), GHP (22.5%), Resource/Wells (12.1%), Equipment (8.0%), Electric Power (4.3%), Space Heating/Cooling (3.0%), Resort/Spa (2.9%), Greenhouses (2.5%), Aquaculture (2.5%), Industrial (1.3%), District Energy (1.2%), and Snow Melt (0.7%). Within the General category of requests, 58.1% from professional people or organizations, 11.2% were from students, 2.8% for database information, and 27.9% from other categories.

Of the total 4,414 inquiries/responses, 31.5% from individuals (including students), 29.7% were from private companies, 15.7% from government agencies (federal, state and local), 12.2% from educational institutions, 10.6% from organizations such as ASHRAE, and 0.2% are unknown. Thus, the majority (61.2%) came from private companies and individuals, those most likely to implement a geothermal project.

In addition, approximately 200 emails concerning papers for the country updates for WGC2000 and over 200 phone calls/emails from the Geothermal Resources Council were responded to by Geo-Heat Center staff.

Examples of Major Technical Assistance Projects:

Lakeview, OR Prison: Kevin Rafferty was in contact with several members of the Kitchell Engineering staff of Portland and Sacramento; Oregon Office of Energy; a local mechanical engineer; and a local civil engineering firm in Klamath Falls, to provide resource information on a site in Lakeview, Oregon (90 miles east of Klamath Falls). The plan discussed with them was the acquisition of land for the drilling of a geothermal well to serve a new prison. A site visit was made to log existing wells.

ASHRAE:. Kevin Rafferty has reviewed several publications for the American Society of Heating, Refrigeration and Air-Conditioning Engineers, on geothermal heat pumps, and he continues to work on the ASHRAE Handbook chapter on geothermal.

OIT Pump: Kevin Rafferty worked closely with a member of the OIT physical plant on the specifications for new well pump. The well casing was TV'd and arrangements were made for a swaging tool to straighten the casing to permit insertion of the pump bowls. The pumps was subsequently replaced and is operating successfully.

Reno Industrial Park: Kevin Rafferty has agreed to assist in the development of a geothermal industrial park east of Reno, NV. The project is in the very initial stages.

Heat Pump Project: Kevin Rafferty did a feasibility study for a GHP to heat a pool at a condominium project in the San Francisco Bay Area. The major recommendation was for them to starting using a pool cover which would provide about 65% energy savings.

Canby, CA: Kevin Rafferty provided assistance to the Canby, CA district heating project. The focus is currently on the disposal permit for the river. However, he has assisted with permitting issues and reviewed the design of the system. The project has received funding from USDOE and the California Energy Commission. Work is ongoing.

Santa Rosa, CA: Kevin Rafferty looked at plans of an apartment complex (new construction) near Santa Rosa. Due to the low well temperature (110°F) and the very low space heating energy requirements, it looked like the best way to go would be to feed the geothermal directly into the domestic hot water system if it meets drinking water standards. Paul Brophy of EGS, Inc., Santa Rosa, CA will check the water chemistry.

Tennessee closed loop borehole regulations: Kevin Rafferty spent a good deal of time corresponding with US EPA in Atlanta and Tennessee Department of Environmental Services regarding new rules for the regulation of vertical closed loop boreholes in that state. Kay Thrasher, PE, a consultant in TN and a fellow member of ASHRAE TC 6.8 asked Kevin to become involved in the issue. Basically, the State wanted to classify closed loop boreholes as Class V injection wells for regulation purposes. This is undesirable since it places the holes in a regulatory framework far more complicated and burdensome than necessary given the minimal threat posed by the holes. He did some research on the EPA Underground Injection Control (UIC) program and Class V wells. It appears that the federal EPA disagrees with the TN opinion and that the boreholes do not meet the definition of injection well in the legislation. Kevin wrote several emails and letters to the TN state regulators. It appears that they are having second thoughts about this and have scheduled a hearing to rescind the new regulation in favor of something more reasonable.

Klamath Falls. Kevin Rafferty visited two homes here in Klamath Falls to explain in detail the operation of the geothermal systems to their owners. He labeled all valves and showed them which are the key valves to shut off in the event of a problem. This was arranged by Jeff Lord, the private investigator who met with us several times regarding a well that was having problems. GHC staff members have also temperature logged a number of wells in town.

Klamath Falls. John Lund and Tonya Boyd assisted a local apartment house manager and engineering consulting firm with suspected hot water leakage under the apartment buildings. It was originally thought that water came from a broken geothermal water injection line, but was subsequently found to be leakage from some buried hot springs along the "A-canal" in town. Base in field temperature measurements, a report with suggested solutions to the problem was given to the consulting firm.

Switzerland. John Lund provided a letter of explanation and support to the Societe Suisse pour la Geothermie in Biel, Switerland concerning taxation of residential geothermal heat pump systems. The Swiss Geothermal Society will use the ideas presented in this letter to argue against the proposed taxation.

China. The Geo-Heat Center staff met with three representatives from the Beijing Polytechnic University and Beijing Municipal Commission of Science and Technology concerning proposed used of geothermal energy for the venue of the 2008 Summer Olympics in Beijing. We discussed both direct-use and geothermal heat pumps with them, and gave them a tour of the various Klamath Falls heating systems. We also provided them with numerous technical publications. They were to visit other sites and manufacturers of equipment in the U.S.

INFORMATION DISSEMINATION/PUBLIC OUTREACH.

Geo-Heat Center Quarterly Bulletin. Eleven issues of the Geo-Heat Center Quarterly Bulletin were developed and published by the GHC staff. These were mailed to approximately 1,800

domestic subscribers and 450 international ones. In mid-2001, international mailings were suspended (except to libraries) due to the high cost of overseas postage (at about $5.00 per copy). New U.S. Post Office regulations require that international publications be sent airmail. A total of 67 articles and the *Geothermal Pipeline* were published, of which 31 were written by GHC staff members.

The main theme of each issue was as follows:

Vol. 20, No. 2 (June 1999): "Small Geothermal Power Projects," 4 articles (1 by GHC staff)
Vol. 20, No. 3 (September 1999): "Downhole Heat Exchangers," 5 articles (5 by GHC staff)
Vol. 20, No. 4 (December 1999): "International Geothermal Days - Oregon 1999", 6 articles (1 by GHC staff)
Vol. 21, No. 1 (March 2000): "U.S. Direct-Use Update," 5 articles (3 by GHC staff)
Vol. 21, No. 2 (June 2000): "Zinc-Meters-Snow," 4 articles (1 by GHC staff)
Vol. 21, No. 3 (September 2000): " Spas and Balneology," 11 articles (7 by GHC staff)
Vol. 21, No. 4 (December 2000): "GEA/GRC Geothermal Excellence Awards," 6 articles (1 by GHC staff)
Vol. 22, No. 1 (March 2001): "Geothermal Heat Pumps (GHP)," 8 articles (5 by GHC staff)
Vol. 22, No. 2 (June 2001): "Geothermal in Europe," 7 articles (1 by GHC staff)
Vol. 22, No. 3 (September 2001): "Moana Geothermal Area, Reno, NV and Small-Scale Geothermal Designs," 6 articles (5 by GHC staff)
Vol. 22, No. 4 (December 2001): "Geothermal Drilling," 5 articles (1 by GHC staff).

All issues can be accessed on the GHC web site at: http://geoheat.oit.edu/bullet.htm.

Outside the Loop. This was a quarterly newsletter for geothermal heat pump designers and installers that was published between January 1998 and Spring 2000. Nine issues of *Outside the Loop*, were published and mailed to between 500 and 1,500 subscribers. These issues, supported by the Geothermal Heat Pump Consortium, were co-edited by Kevin Rafferty of the GHC and Steven Kavanaugh of the University of Alabama. Unfortunately, funding ran out for support of the printing and mailing, thus the newsletter is no longer published. However, copies of the nine issues are in high demand, and are available electronically. All issues of *Outside the Loop*, can be accessed on the Geo-Heat Center web site at: http://geoheat.oit.edu/otl/index.htm.

Technical Papers, Presentation and Tours.

During the 33-month period of this grant, Geo-Heat Center staff made 64 presentation (of which 12 were international), wrote 40 technical papers (of which 15 were published internationally), attended 48 professional meeting, were involved in 15 training sessions, used our display at eight events, and gave 15 tours to visitors of the Oregon Institute of Technology and City of Klamath Falls geothermal district heating systems.

The details of the presentations, papers, list of conferences attended, etc., are presented in our quarterly reports.

Training Sessions

Kevin Rafferty presented sessions on the Direct-Use of Geothermal Energy at three introductory geothermal workshops organized by the Geothermal Education Office (GEO), Tiburon, CA at the 1999, 2000 and 2001 Geothermal Resources Council Annual meetings (Reno, San Francisco and San Diego). These sessions were attended by approximately 30 persons, mostly K-12 teachers from the local area.

Kevin Rafferty has made numerous presentations at American Society of Heating, Refrigeration and Air-conditioning Engineers (ASHRAE) meetings and workshops throughout the country on ground source (geothermal) heat pumps. These were each attended by approximately 50 professionals (engineers and architects) who are involved in the design of heat pump systems. He has also made similar presentations at U.S. Army Corps of Engineers workshops.

John Lund and Toni Boyd made presentations on the direct-uses of geothermal energy and on geothermal website use at the "European Summer School on Geothermal Energy Applications," Geothermal Training Center, University of Oradea, Oradea, Romania. Approximately 40 students attended this school from eastern European countries, Turkey and Greece.

Toni Boyd also attended and John Lund made five presentations at a short course on "Heating with Geothermal Energy: Conventional and New Schemes" in Kazuno, Japan, in connection with the World Geothermal Congress 2000 (WGC2000), attended by 20 students. Retired GHC director, Paul Lienau, also made several presentations, and edited the published lecture notes.

GHC Web Page Update.

The Geo-Heat Center web page, maintained by Toni Boyd, added the following publications to our website: http://geoheat.oit.edu. At present, the web site has over 2,000 files.

- Eleven issues of the Geo-Heat Center Quarterly Bulletin
- Seven issues of Outside the Loop Newsletter
- Twenty-one technical papers
- Updated the direct-use data base at periodic intervals

The website activity by calendar year is as follows:

	1999	2000	2001	
Average users per day:	352	526	987	(see Figure 2)
Average hits per day:	2,684	3,922	5,277	
International:	7.3%	6.8%	6.0%	
Downloaded files per day:	94	167	435	(see Figure 3)

As can be seen from the above data, our website activity has increased significantly over the three year period. This is, in part, due to the number of files available on the site, which also increasing over this time span. The number of users increased by 41%, the number of hits by 25% and the download files by 67%, over the three-year period, compounded annually. The total number of downloaded files was 239,697 over this period. Downloaded files are probably more important than users and hits, as this represents actual technical papers and articles being copied by potential users. We also noticed, that in quarters where the downloaded files and user numbers are high, our technical assistance activity is low, and visa-versa. So, either way, we are serving the customers (see Figures 1, 2 and 3).

The top downloaded files are only reported here for 2001, as many more publications were available at this time than in 1999 and 2000; though, similar results are noted for the latter two years.

Top downloaded files in 2001	(Session downloads)
- Geothermal Heat Pump Owner Info. Survival Kit	4,234
- Historical Volume circular	2,735
- GSHP - Manufacturers list	1,230
- Geothermal Power Generation paper	1,198
- Scaling in Geothermal Heat Pumps Systems paper	1,132
- Guide to Geological Info. for GSHP Site Character.	988
- Outside the Loop Newsletter #3-1	910
- Outside the Loop Newsletter #3-2	818
- Quarterly Bulletin 20-2 (Small Power Projects)	790
- Quarterly Bulletin 21-3 (Spas & Balneology)	741
- Direct Heat paper	704
- Aquaculture Information packet	698
- Greenhouse Information packet	685

Geothermal Library

During the period of the grant, 105 new publications were added to the library, which now has 5,749 total publications. These can be accessed through the Geothermal Resources Council website: www.geothermal.org. We do not lead out these publications, but, copies of most can be made upon request.

Publications Disseminated

The GHC provided publications to individuals according to the following topics for the period. These can be ordered from our website, but are often given to visitors at the Center.

Topics	No. Publications
Geothermal Heat Pumps	817
Space Heating/Cooling	240
Greenhouses	305
Aquaculture	310
Equipment	596
Resources/Wells	1,113
General	922
TOTAL	4,303

Assistance with Technical Meetings

World Geothermal Congress 2000 (WGC2000), Tokyo, Japan, May 28-June 10, 2000. John Lund was the subcommittee chair for collecting the country updates for reporting geothermal development from 1995-1999 (since WGC'95). Previously, a total of 70 papers were reviewed by GHC staff, with detailed comments sent to each author for improving and correcting their paper. An additional 20 papers were reviewed by Toni Boyd and Donna Gibson of our staff for English and grammar. Toni Boyd has also helped with uploading country update papers to the system. John Lund and Toni Boyd attended WGC2000, where a World Geothermal Overview, and the U.S. Direct-Use Update papers were presented. The latter paper was co-authored by Lund and Boyd. John Lund was one of the co-editors of the CD-ROM proceedings from the conference.

International Geothermal Days - Oregon, 1999, Klamath Falls, OR, October 10-16, 1999. The GHC staff was actively involved in the preparations of this series of workshops, seminar/course which was held on the Oregon Institute of Technology campus. The school consisted of workshops on Small-Scale Power Projects, and Geothermal Heat Pumps; a course of Direct Utilization of Geothermal Energy; and evening computer seminars on Software for Geothermal Heat Pumps and HEATMAP© software utilization. The program also included three field trips to: Medicine Lake (Glass Mountain) Power Projects in California; Klamath Falls area direct utilization; and a field trip of power plants and direct-use between Klamath Falls and Reno. The latter field trip ended up in time for the GRC Annual Meeting in Reno. In cooperation with Calpine Energy Co., several local Native Americans attended the session on Small Scale Power Projects.

Dr. Kiril Popovski of Macedonia and John Lund were the co-chairs of the conference. A total of 115 persons attended the conference, representing 30 different countries. The details of the conference are described in GHC Quarterly Bulletin, Vol. 20, No. 4 (December, 1999). John

Lund, Toni Boyd, and Kevin Rafferty presented several technical papers on direct-use and geothermal heat pumps. A two-volume proceedings was published of the conference papers: *Small-Scale Electric Power Generation & Geothermal Heat Pumps* consisting of 19 papers (12 on power and 5 on heat pumps) for 192 pages, and *Direct Utilization of Geothermal Energy* consisting of 36 papers for 227 pages. An additional three papers that arrived late, were published in the GRC Quarterly Bulletin mentioned above.

Elko Geothermal Meeting: Kevin Rafferty assisted with organizing a meeting on geothermal for the Nevada Water Resources Association held on October 25, 2001 in Elko, NV. The Geo-Heat Center co-sponsored the meeting. Topics covered were direct use and power generation. Attendees were mostly groundwater professionals, but included representatives of gold and silver mining operations in the area.

Translation of Guidebook

The *Geothermal Direct-Use Engineering and Design Guidebook* (1998), edited by John Lund, is being translated into Polish, a chapter in each issue of *Technika Poszukiwan Geologicznych - Geosynoptkyka i Geotermia* starting with Volume 1 in 1998. This is a bi-monthly publication of the Minerals and Energy Economy Research Center of the Polish Academy of Sciences in Krakow, Poland. To date, six chapters have been translated and the first four published in this journal.

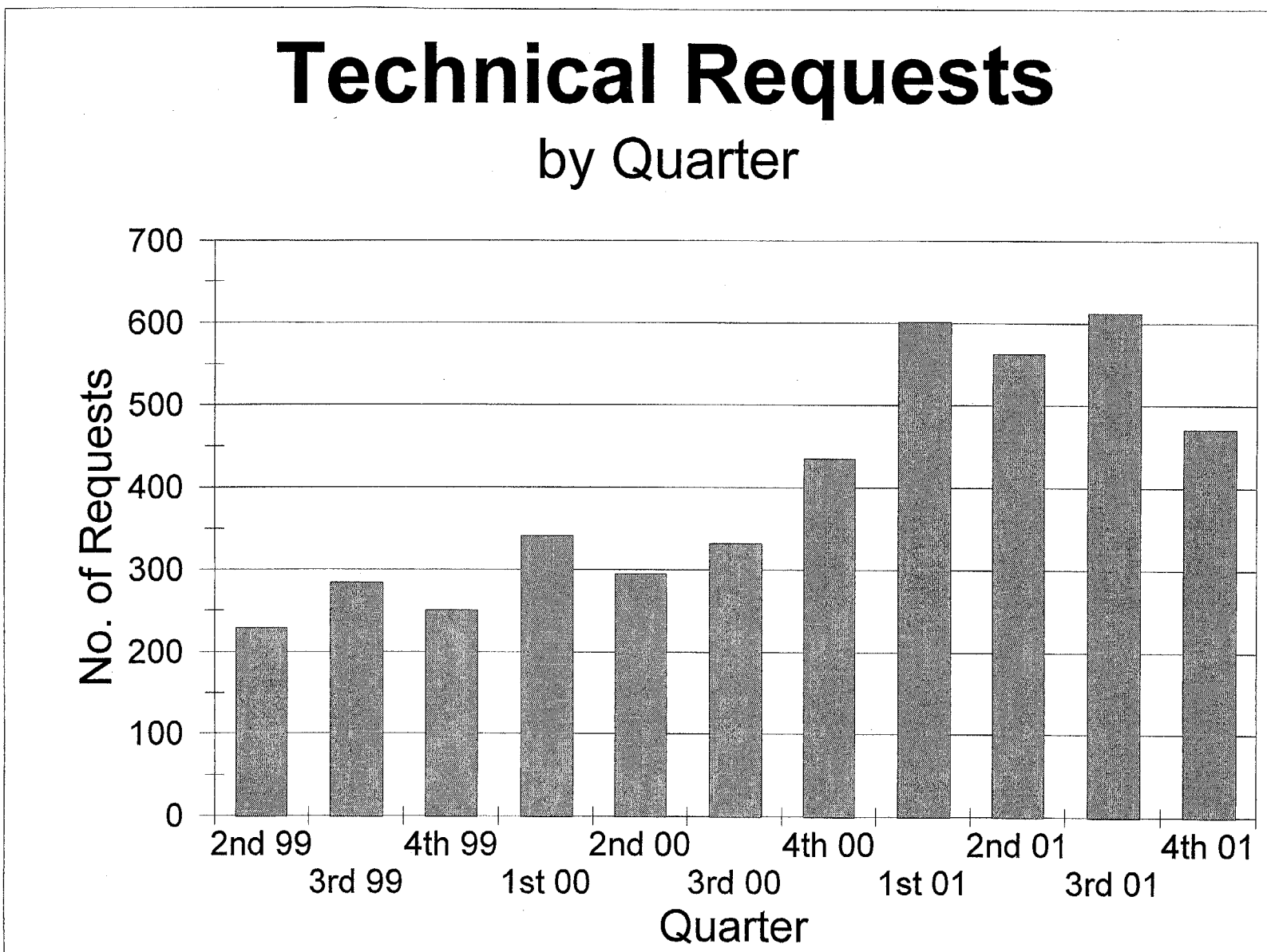
We also had an inquiry to translate the Guidebook into Turkish from Professor Dr. Zafer Ilken, as a board member on behalf of the Izmir Branch of Mechanical Engineers Chamber. Permission has been granted providing they do not change the intent or meaning of the written material and that credit be given to the Geo-Heat Center with acknowledgment to USDOE.

In-Kind Services Contribution

The Geo-Heat Center share of the grant was $766,610 from USDOE ($157,964 in FY99, $310,938 in FY00, and 297,708 in FY01). The original proposal (revised for FY2001), gave cash and in-kind services contributions by GHC/OIT of $120,926 ($28,416 in FY99, $48,649 in FY00, and $43,861 in FY01). Thus the total proposed USDOE grant and GHC/OIT contributions amounted to $887,536

The actual total contribution by the Geo-Heat Center/Oregon Institute of Technology for this grant is: $80,119.18 in cash, and $125,925 for in-kind service, for a total of $206,044.18.

Thus, the total contract with the USDOE grant and the GHC/OIT cash and in-kind services amounted to: $972,654.18, of which the GHC/OIT portion was 21.18%. This well exceeds the proposed 10% contribution made in the original proposal.


Technical Requests
by Quarter
No. of Requests
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600
500
400
300
200
100
0
2nd 99
3rd 99
4th 99
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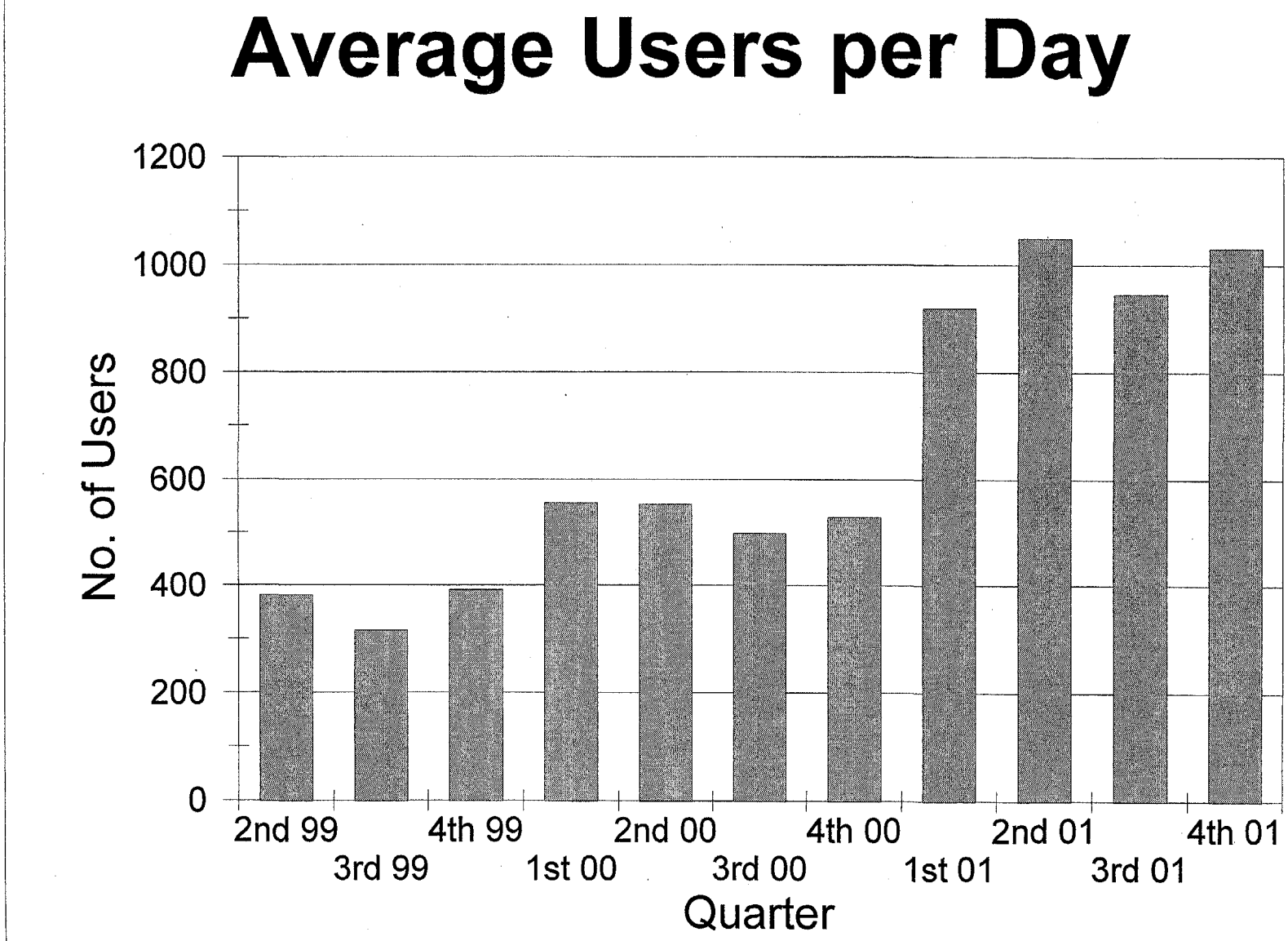
1st 01
2nd 01
3rd 01
4th 01
Quarter

Figure 1.


Average Users per Day
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400
200
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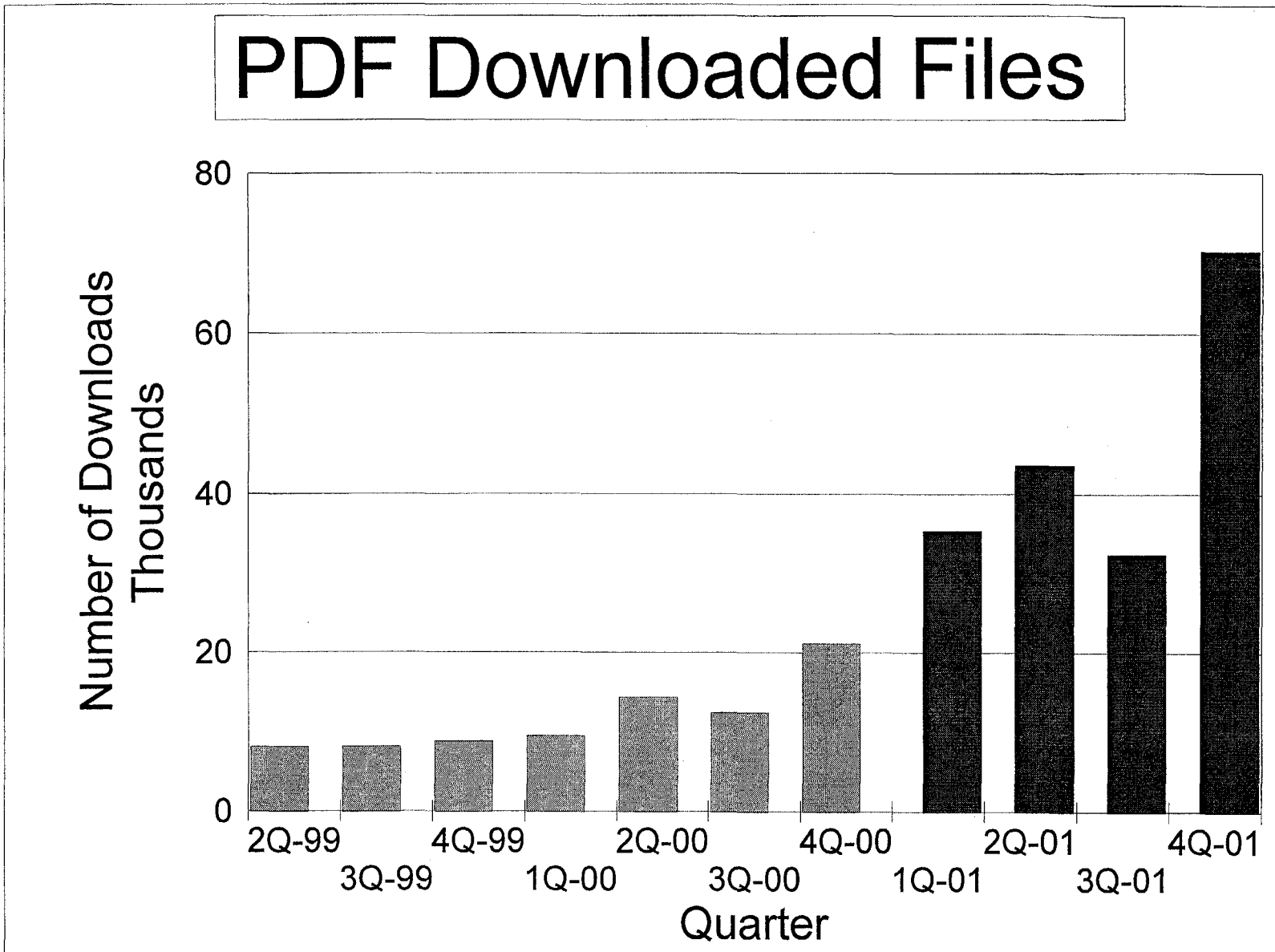
Quarter

Figure 2.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Thousands
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3Q-99
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3Q-00
4Q-00
1Q-01
2Q-01
3Q-01
4Q-01
Quarter

Figure 3.

Final Report

Geothermal Resources Council
2001 Second Street, Suite 5
Davis, California 95617-1350

DOE Instrument No. DE-FG01-99-EE35098
Geothermal Energy Program: Information Dissemination, Public Outreach, and Technical Analysis Activities

Following is a Final Report on accomplishments by the Geothermal Resources Council (GRC) under contract instrument DE-FG01-99-EE35098, the result of a joint proposal with other organizations and the Geo-Heat Center at the Oregon Institute of Technology. Under the contract, the GRC continued ongoing work to develop and disseminate information, provide educational materials and enhance technology transfer to assist the geothermal energy industry and government efforts to increase geothermal utilization in the United States and around the world. GRC tasks under the contract included:

1) Maintenance of the GRC On-Line Geothermal Library;
2) Production of the GRC *Transactions*; and,
3) GRC printing/distribution of DOE quarterly *Geothermal Technologies* newsletter.

Maintenance of GRC On-Line Geothermal Library

This project was accomplished by the GRC in accordance with Objective 2 in the contract: "Maintaining and updating technical libraries and comprehensive data bases of research applications, resource information and maps, maintained as both physical and Internet information sources for the public."

The GRC On-Line Library (accessed on the Internet at www.goethermal.org) is the world's largest and most comprehensive geothermal technical resource of information and data for governmental, academic and research organizations for their use in conjuction with projects, functions and programs. It also serves as a free-access public information source. The GRC Library features six on-line databases, including: Basic Library, GRC *Bulletin*, Power Plants, Direct-Use/Heat Pumps, U.S. Vendors, and OIT *Geo-Heat Center Bulletin*. It also features regular additions of information on GRC events (e.g. Annual Meetings and educational functions), including PDF files of printed materials. The GRC web site is backed by a physical library that contains over 23,000 geothermal citations, constituting the world's largest single and most comprehensive geothermal technical resource of information and data.

Besides rapid accessibility to technical literature and preservation of library hard copy and on-line databases for future use by geothermal researchers and developers worldwide, a significant benefit of the GRC On-Line Library is assistance to U.S. companies that export geothermal goods and services.

The GRC On-Line Library was successfully and economically maintained during the contract period due to GRC's low administrative, personnel and overhead costs. The GRC web site is under continuous development and improvement, with one (1) full-time person devoted to it, whose wages and overhead were covered by funding under the grant. The GRC On-Line Librarian handled the library collection and development of the web site, working closely with the GRC web server, SolarHost (REPP-CREST).

During the contract period, GRC Library databases were continuously updated, and subscriptions to various publications were renewed. Collection of documents was an ongoing process during the contract period, with keywords developed for most listings, and database additions regularly entered. In addition, purchases of various publications and geothermal articles were made to update the library. During the contract period, the GRC On-Line Library logged approximately 1,400 viewers each month (over 16,000 per year), resulting in scores of specific requests for hard copy information each year.

Production of GRC *Transactions*

This project was accomplished by the GRC in accordance with Objective 2 in the contract: "Developing and distributing education materials to audiences with specific interests in geothermal energy, to increase the public's awareness of the potentials of this sustainable resource through various mechanisms, including publications, audiovisual media and the Internet."

The GRC has produced a comprehensive volume of *Transactions* in conjunction with its Annual Meetings (every August, September or October) since 1977. Each year, the volume contains the complete text (with figures, maps, photos and illustrations) of an average 100 technical papers covering the gamut of geothermal topics and fields of interest presented at its associated Annual Meeting by U.S. and international geothermal professionals from around the world. Published as a high-quality, durable case-bound book, the GRC *Transactions* is a standard reference and key information and technology source — a superbly produced reference for the geothermal industry and community on the latest advances in resource characterization, technologies and methods for geothermal resource exploration and geothermal commercial development.

During the contract period, Volumes 23, 24 and 25 of the GRC *Transactions* were produced for their respective GRC Annual Meetings. Much of the work in preparation of the volume was performed by GRC staff, which put out worldwide Calls for Papers, cataloged and organized draft papers for review, set up review by up to 15 qualified, volunteer geothermal professionals each year, returned papers to authors for revisions and corrections, and cataloged final submissions. GRC staff (Executive Director) also worked

closely (including setting up contents, chapters, and proofing) with the GRC professional layout out source, John Bassett (A.D. Marketing, Sacramento, CA) to produce camera-ready copy (disk) for publication by Commerce Printing Services (Sacramento, CA).

The 1999 *Transactions* volume contained 100 papers; the 2000 volume contained 120; and the 2001 volume contained 135 papers — evidence of diligence by the Annual Meeting Technical Committees and GRC staff in securing technical works not only for presentation at those years' Annual Meetings, but for publication in the *Transactions*. In-kind service for this task included author preparation time for submission to the GRC, calculated at 40 hours each for 100 authors @ an average consulting fee of $75/hr., for a total in-kind contribution of $300,000 per volume, or $900,000 for the contract period. Three-hundred copies of each of the three volumes were printed, according to the contract. With this volunteer service and financial assistance from DOE, the price for the *Transactions* each year was kept to a low $65, ensuring maximum dissemination of the volume. For each, all but a few are now left at the GRC, as library copies and for sale.

Printing and Distribution of DOE quarterly *Geothermal Technologies* Newsletter. This project was accomplished in accordance with Objective 2 in the contract: "Developing and distributing education materials to audiences with specific interests in geothermal energy, to increase the public's awareness of the potentials of this sustainable resource through various mechanisms, including publications, audiovisual media and the Internet."

The U.S. DOE Office of Geothermal Technologies newsletter, *Geothermal Technologies*, is produced by editors at the National Renewable Energy Laboratory (NREL - Golden, CO) and DOE Headquarters (Washington, D.C.). This quarterly, two-color, 8-page newsletter provides an effective quarterly summary of current federal geothermal research and development projects, and other geothermal development news. To cost effectively reach the U.S. and worldwide geothermal community, the GRC prints the newsletter for DOE, and stitches it as a centerfold feature in its periodical magazine, the GRC *Bulletin*. This method effectively takes advantage of the GRC's low handling and printing costs, and low worldwide postal and express distribution costs to a well-established list of primary, U.S. and international geothermal contacts, including GRC members and subscribers. The number of newsletters coincides with the number of magazines printed by the GRC, currently 1,000 per issue (plus 300 copies of the newsletter and 50 copies of the magazine shipped to NREL for internal and public distribution).

During the contract period, 10 DOE newsletters were produced and distributed by the GRC to its worldwide membership (and NREL, as described above), including 4 in 1999, 4 in 2000 and 2 in 2001 (per NREL).

Respectfully Submitted,

Ted J. Clutter
GRC Executive Director

GEOTHERMAL EDUCTION OFFICE
FINAL REPORT
May 7, 1999 through September 30. 2001

PROVIDING INFORMATION AND TRAINING

Public Information Workshop: *Introduction to Geothermal Energy*

The Geothermal Education Office (GEO) produced three *Introduction to Geothermal Workshops* in conjunction with the GRC Annual Meetings in 1999, 2000 and 2001. Total attendance ranged from 45 to 68 per year, including about 70% teachers. In 2000, GEO was certified to grant Continuing Education Credits to teachers for this workshop through California's Sonoma State University. GRC Annual Meeting registrants and spouses were a growing part of the audience, reflecting GEO's broadening of the workshop focus. This workshop is the only free geothermal presentation at the annual meetings and attracts representatives from local environmental and energy organizations, utilities and government agencies. Many in-kind hours are donated annually by geothermal industry experts.

DEVELOPING AND DISTRIBUTING EDUCATIONAL MATERIALS

Maintenance/expansion of communications systems

• *Maintain and Enhance GEO Web Site: "geothermal.marin.org.*

GEO expanded and improved its website, adding a *Geothermal Energy Slide Show*, an updated *Global View Map*, an *Energy Timeline*, an advanced article on *Geothermal Energy*. The National Science Teacher Association has honored GEO by linking to the GEO website as part of their SciLinks program. The selection criteria were very stringent: Accuracy, Authority, Currency, Design, Interactivity, Objectivity, Quality of writing, Uniqueness and Workability. The GEO website is also linked from websites of USDOE, Idaho National Engineering and Environmental Lab, Bonneville Power administration, California Energy Commission, National Renewable Energy Laboratory, Geothermal Resources Council, Geothermal Energy Association, International Geothermal Association, Oregon Institute of Technology's GeoHeat Center and many other energy, educational and environmental organizations.

Dissemination of information in response to requests

• *Continued Response to E-Mail and Telephone Queries.* Within this time period GEO responded to about 1900 requests for public information and educational materials (booklets, brochures, posters, fact sheets, curricula, bookmarks, etc.) about geothermal energy received via phone, email, mail and fax. Combined with the outreach dissemination (see below) GEO distributed a total of about 36,000 individual items. GEO also responded to about 725 emailed questions, answering and/or forwarding technical questions to industry expert volunteers. GEO also supplied GRC, GEA, OIT and USDOE and others with GEO-produced materials.

Publications produced/edited during this contract period:

Geothermal Energy, article in Microsoft Encarta's 2000 CD-ROM Encyclopedia with a distribution estimated by Microsoft at 750,000, and estimated readership of several million.

Geothermal Energy (GRC/GEO) poster, redesigned and reprinted 10,000 copies.

Geothermal Resources Worldwide, comic Book, edited in collaboration with California Division of Oil, Gas and Geothermal Resources, to make more generic. 10,000 copies printed.

Electricity from Geothermal Energy Activities Guide for high

school teachers -- lessons/activities for physics, earth and environmental sciences and social studies was completed in 2001 – to accompany the video.
Geothermal Bookmarks - Hot Web Sites. GEO has twice updated, reformatted, and reprinted the bookmarks and distributed about 16,500 copies.
A Global View of Geothermal Energy (Map), updated and reprinted (a favorite of industry)..
Database of geothermal power plant contacts for field trips.

Public outreach assistance to individuals, companies and organizations

• *Geothermal Energy Exhibit Booth.* GEO designed and produced a booth display whcih won the GRC/*GEA Most Informative Award* at the Annual Meeting in 2000. GEO supplied materials for distribution to the public and helped staff a Geothermal Booth at Clean Power Day in San Francisco in June 1999, at Earth Day venues in San Francisco and Sacramento, at the World Energy Congress in Houston, and exhibited at the ENERGEX in Las Vegas 2000 and at GRC Annual Meetings in 1999, 2000 and 2001. GEO also supplied materials for distribution at numerous additional environmental, energy, and educational conferences.

• *Video, Slide Show and Audio Visual Support:* During the contract period, GEO worked with several geothermal companies to distribute the GEO video *Geothermal Energy: A Renewable Option* to schools and public libraries in areas where they have projects, including Oxbow Power Group, NCPA, Calpine Corporation, and the China Lake Naval Air Weapons Center, resulting in the distribution of about 500 videos to schools and libraries in three states. GEO also supplied videos to Calpine's Geysers Visitor Center. In response to industry requests, the video has been translated into Spanish and Japanese and was featured at the 2000 International Geothermal Congress in Japan. The USDOE, GRC, IGA, GEA, GEO and others routinely feature the video in their booths. Total distribution during the contract period, including to schools, utilities, energy agencies and others was about 1500 videos.

• *Introduction to Geothermal Energy Slide Set* . The set of 122 35mm slides has been pushased by the major geothermal companies and provided to DOE, OIT, University of Washington Energy Office, GEA, and others and is routinely loaned for geothermal presentations. It has been added to the GEO website as a Slide Show with explanatory text and made available as a Powerpoint file on a CD. GEO grants numerous about a dozen requests each month for use of photos and graphics from the slide set and footage from the video to energy and environmental authors, university professors, teachers, educational organizations, environmental groups, governments, television stations and students.

Continued Outreach, Consulting and Collaboration Services

GEO collaborated on and provided materials for educational projects. Selected examples:

- Fuji Electric, collaborated in translation and production of video in Japanese.
- International Geothermal Congress, Japan, 2000: provided video with translated Japanese narration and reprints of CADOGG's glossary of geothermal terms translated into five languages. Edited paper for presentation.
- U.S. DOE Geopowering the West Internet Town Meeting, provided graphics/text from Slides
- Western Area Power Authority (WAPA), provided outline, text and graphics for elementary renewables curriculum
- The NewsHour with Jim Lehrer (PBS): provided video and materials used in a story on electricity deregulation seen on more than 250 public television stations across the country
- World Energy Congress, Houston: staffed booth, provided materials and video for US DOE Office of Geothermal Technologies
- EnergEx 2000, Las Vegas. Staffed booth, with staff from OIT GeoHeat Center

- Clean Power Day at the Capitol: Sacramento, CA, staffed booth/provided materials, with GRC
- Earth Day Conservation Fair: Sacramento, staffed booth/provided materials, with GRC
- Oxbow Power, Calpine, NCPA, China Lake Naval Air Weapons Center: distributed videos
- Geysers Pipeline Press Conference: provided speakers, with GRC and Lake County, CA
- Microsoft: geothermal article for Microsoft's Encarta CD-ROM Encyclopedia, w/ Oit and EGI
- National Energy Education Project (NEED), drafted geothermal writeup and list of facts that should by understood upon high school graduation, with GEA and Unocal Geothermal
- Project WET (National Water Education for Teachers program): co-author and edit geothermal supplement to accompany Project Wet Curriculum, with Council for Environmental Education, University of Montana and Idaho Water Resources and Research Inst, University of Idaho
- GEA Public Policy Workshop (at 2001 GRC/GEA Annual Meeting), presented a talk on Working with the Media (at the invitation of Karl Gawell, Executive Director of GEA).
- Video interview and video tribute to Joe Aidlin, pioneer in the geothermal industry, with Tom Sparks, at the GRC Membership Luncheon
- GEO has granted rights for use of footage and graphics to numerous individuals, companies and organizations
- California's Renewable Energy Marketing Board – participated on Educational Committee to coordinate K-12 educational efforts in support of public information about renewables under deregulation.
- Marin County Council of Mayors: GEO arranged for a representative of the Renewable Energy Marketing Board to speak about the availability of renewable energy in California.
- Joint Oceanographic Institutions, provided materials for a geothermal presentation
- California Energy Commission, provided energy timeline for inclusion on CEC website.
- McGraw Hill and numerous other U.S. and International publishers, graphics for textbooks
- National Public Radio (and the work with newspapers)
- American Museum of Science and Energy (AMSE) a government funded (DOE) energy museum in Oak Ridge, Tennessee (and numerous national and international television stations)
  provided video footage.
- International Geothermal Association, slides for inclusion in the 2002 IGA Calendar
- Pembina Institute for Appropriate Development, slide for use in Environmental Education and link to Re-Energy Website, www.re-energy.ca
- Steve Hirsch, USDOE, slides for presentations promoting Kenyan geothermal development
- Bonneville Power Administration, pdf of the GEO Pacific Northwest Curriculum for inclusion on their website and on a CD of educational resources for teachers
- *Invitation to World Geothermal Congress, Turkey 2005.* GEO provided footage to Orhan Mertoglu for use in a video advertising the event. This Turkish production was used at the World Geothermal Congress in Japan in July and at the GRC Annual Meeting in San Francisco in September.
- Center for Resource Solutions (CRS, which administers the Green-e renewables certification program for electricity suppliers), GEO arranged for a group of Japanese tourists to take a tour of Northern California Power Agency plant at The Geysers and arranged for a field trip for CRS staff to Calpine's power plants at The Geysers.
- Calpine Corporation distributed between 700 and 800 copies of the comic book at its event on September 28 celebrating 40 Years of Geothermal Production at The Geysers.
- Project Learning Tree and WestEd, provided consulting in development of energy curriculum editing services on a paper to be presented at the World Geothermal Congress in Japan by a member of the staff of the California Division of Oil, Gas and Geothermal

Submitted by

Marilyn Nemzer
Executive Director

GEOTHERMAL ENERGY ASSOCIATION

209 Pennsylvania Avenue, SE ■ Washington, DC 20003 U.S.A.

Phone: (202) 454-5261 ■ Fax: (202) 454-5265 ■ E-Mail: daniela@geo-energy.org

Final Report

Objective 1 of this grant was significantly advanced by a series of workshops and technical sessions organized by the GEA. As a result of this effort, the World Bank Group is developing a new geothermal finance initiative that was outlined and discussed at the March 2002 International Energy Agency meeting. This effort also spurred new interest by the Bank, the US government and industry in pursuing geothermal development in Eastern Africa, which is expected to be the focus of a regional trade development workshop to be held in Nairobi, Kenya in August of 2002. This will also contributed to the US effort leading up to the World Conference on Sustainable Development in South Africa in September 2002.

This effort started with an initial workshop under the grant bringing together over 60 country, government, industry, and financial representative in September 16, 1999 focusing on the geothermal potential in Central America and East Africa. The workshop featured speakers from industry, federal agencies, the embassies of countries in the two regions, and international/multilateral organizations. That workshop was held at the L'Enfant Plaza Hotel and was a building block of later efforts. Through it there developed consensus that both Central America and East Africa were areas where additional work was warranted to develop the understanding of all parties about geothermal potential, obstacles to development, and methods to move new projects forward.

A follow-on session focusing specifically on sustainable development and geothermal energy held the following on September 14, 2000. It involved renewable energy industry, major environmental groups, federal agency personnel, DOE personnel and others. Presentations were made about geothermal and other renewable potential in the region and a round table discussion ensued. It became evident through this session, and the previous meeting, that a key component was developing a new approach for international organizations and national governments to support of geothermal development.

As a result of this conclusion, discussions were held with DOE and others about holding a scoping meeting about how to approach this problem. That meeting was held on March 1, 2001, and in April a draft "white paper" was produced that incorporated the ideas presented at that meeting. It was agreed that this white paper, together with target country summaries for Central American and East Africa would be the subject of a workshop in May.

With the additional cooperation of officials from the World Bank, AID, the Department of State and USGS, the white paper was distributed and invitations issued to a May 25 workshop. The workshop was held in Washington, D.C. with significant additional participation by written comments both before and after the meeting. The white paper which had been distributed two weeks in advance of the workshop was systematically reviewed in the group forum. Two dozen people participated in the

review session, representing a broad range of expertise in geothermal energy, government and financing.

At the workshop, the World Bank Group representative discussed their vision for a new GEF/World Bank program to support geothermal development. They expressed appreciation for the effort underway which stimulated much of their interest in formulating their new initiative, and urged that continued collaboration help refine their concepts.

Karl Gawell of GEA and Steve Hirsch for INEEL reviewed all comments made at the workshop and prepared a preliminary report entitled "Status, Barriers and Solutions to the Development of Geothermal Energy on the International Marketplace," August 2001. This preliminary report was reviewed informally by DOE, World Bank and selected other experts and afterwards presented at a review session in August held at the Geothermal Resources Council Conference. The GRC conference which is the largest annual geothermal event was chosen to obtain maximum exposure and participation. Steven Hirsch also made a presentation during the formal conference sessions on the paper, and subsequently the final paper was republished in shortened form in the GRC Bulletin.

Through the support of DOE, a Geothermal Town Meeting was also held on September 26, 2000 at the GRC Annual Meeting/GEA Trade Show. The event was broadcast worldwide over the internet for two hours, and the broadcast of the event remained available on-line for one year following the meeting. According to the internet host, I-Show, there was continuous demand for the two hour program and it was viewed by individuals in more than half of the states, and over a dozen foreign countries. The program covered a series of topics: the environmental advantages of geothermal energy, GeoPowering the West, Highlights of outstanding geothermal facilities, interviews with key industry and government leaders, and a review of geothermal research efforts.

Karl Gawell
Executive Director

WASHINGTON STATE UNIVERSITY – ENERGY PROGRAM, OLYMPIA, WA

Final Report – Geothermal Energy Program Information, Dissemination, Public Outreach and Technical Assistance Activities Contract #DE-FG02-99EE35098

Two projects with which we have worked really stand out: Mammoth Lakes, California and the Columbia Gorge Resort. Both of these projects continue to move ahead with plans for implementation of geothermal systems.

We have worked with the Mammoth Lakes Water District on a number of activities, all directed toward realization of a geothermal district heating project. We have assisted the Water District in negotiations with the Mammoth Pacific Power Plant relative to the purchase of power plant effluent, worked with the Water District board in evaluating alternative scenarios for building out the district energy system and attended meetings with numerous potential consumers of the system.

Relative to the Columbia Gorge Resort, we have assisted the developer in negotiations with the Washington Department of Ecology in obtaining additional water rights and injection permits. We have also worked closely with the project developer and his A&E firm on system design and operational issues. The project proponent is now in receipt of a contract with NREL for Phase I technical studies and we hope will be successful in being granted funds for Phase II relative to construction.

We have participated in a number of conferences and have authored a number of papers under the period of this project. Some of the more important of those include Geothermal Days, Oregon 1999 organized by the International Summer School on the Direct Application of Geothermal Energy, The European Geothermal Conference, Geothermal Resource Council Annual Conference and conferences and workshops covered by the International District Energy Association. We have prepared materials for an exhibit booth on geothermal district heating and exhibits at several IDEA sponsored events.

We have also worked with a number of projects employing geothermal heat pump technology and have written articles relative to maintenance issues as well as project economics. Technical assistance was provided to not only private developers but also to the Bonneville Power Administration and the Department of State.

We prepared a number of papers for the World Geothermal Congress held in 2000. Papers were prepared on geothermal district energy, software for geothermal district energy analysis, project management and finance and geothermal heat pumps.

We have contributed video footage to several entities producing geothermal videos.

In late 2000 we began to work with Seattle City Light, Vulcan Power and Northwest Geothermal relative to the purchase of up to 100 MWe of geothermal power. We also

assisted Seattle City Light to identify and begin to evaluate other potential geothermal power generation sites throughout Oregon and California, as well as providing them with reports that had previously been completed on geothermal resources at Mount Baker, Washington.

We organized geothermal sessions for USDOE Green Power Summits that were held in San Diego and Seattle in the fall of 2000 and in addition to organizing the sessions we made presentations at both.

We have worked on the preparations of RFPs for geothermal projects issued by NREL and served on proposal review committees for both power and direct use projects.

We have actively worked with USDOE headquarters and the Seattle Regional Office in jump-starting the GeoPowering the West effort and have attended a number of organizational meetings and made presentations at a number of GeoPowering the West meetings.

We have also prepared and presented papers at a number of international educational training sessions on geothermal district energy, geothermal heat pumps, and computer software for geothermal analysis and geothermal project framing.

In summary, I feel this has been a very productive program that has met all objectives and has made a significant contribution to accelerating the growth of the geothermal industry.

If you have questions please feel free to contact me at (360) 956-2016 or via email at bloomquistr@energy.wsu.edu.

R. Gordon Bloomquist, Ph.D.
Principal Investigator