U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

GEOTHERMAL TECHNOLOGIES OFFICE

2013 Peer Review Report

U.S. Department of Energy
Office of Energy Efficiency and Renewable Energy
Geothermal Technologies Office
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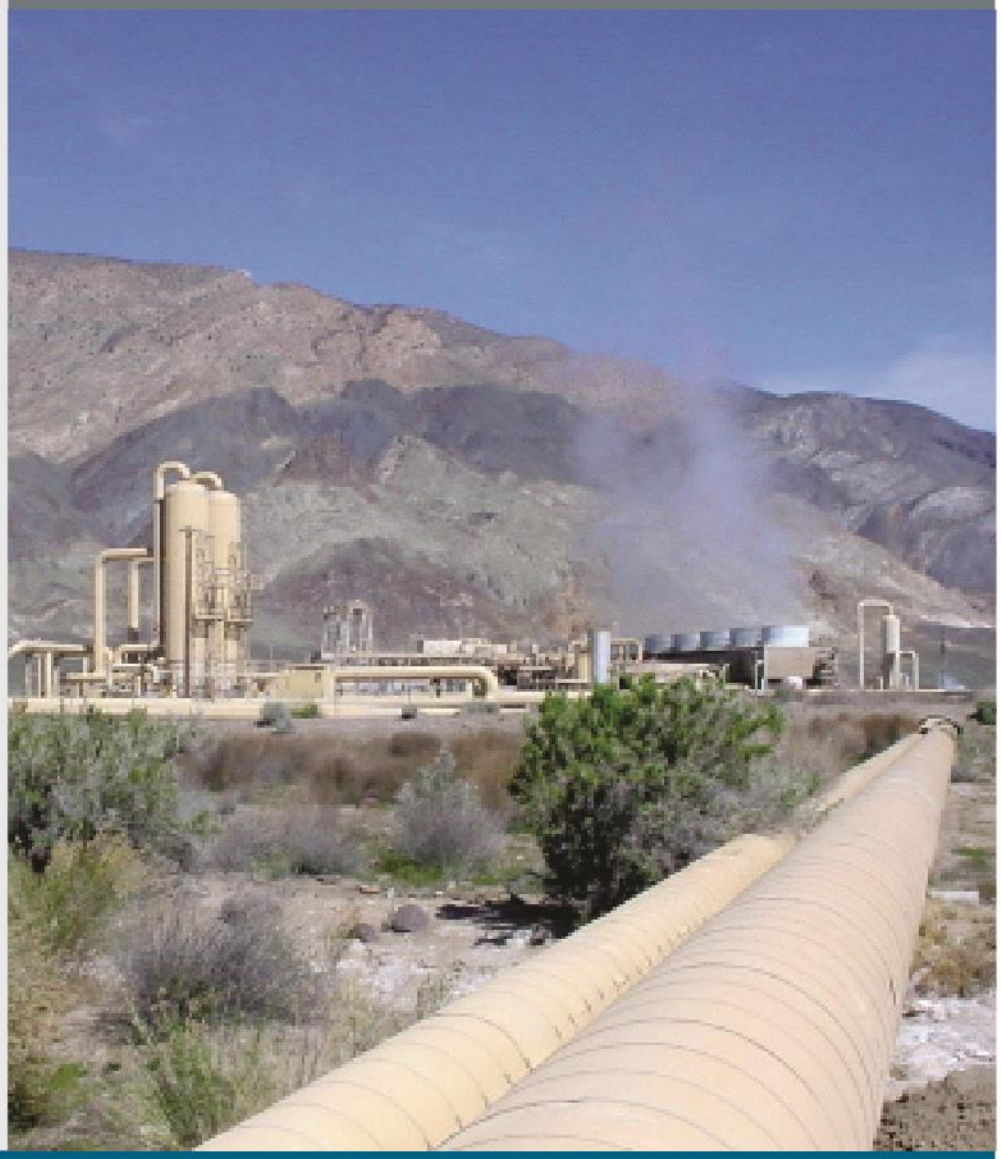
February 2014



The photo on the cover page is of the Dixie Valley, Nevada plant. Photo courtesy of the Geothermal Resources Council.

Geothermal Technologies Office

2013 Peer Review Report
February 2014

U.S. Department of Energy
Office of Energy Efficiency and Renewable Energy
Geothermal Technologies Office
2013 Peer Review Meeting
April 2013

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2013 Geothermal Technologies Peer Review Panel

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Executive Summary

Meeting Logistics

On April 22–25, 2013, the Geothermal Technologies Office (GTO, or the Office) within the Office of Energy Efficiency and Renewable Energy (EERE), U.S. Department of Energy (DOE), conducted its annual program peer review in Denver, Colorado. In accordance with the EERE Peer Review Guide,[1] the review provided an independent, expert evaluation of the technical progress and merit of GTO-funded projects. Further, the review was a forum for feedback and recommendations on future GTO strategic planning. During the course of the peer review, DOE-funded projects were evaluated for (1) their contribution to the mission and goals of the GTO and (2) their progress against stated project objectives. Principal Investigators (PIs) came together in sessions organized by topic "tracks" to disseminate information, progress, and results to a panel of independent experts as well as attendees. Dr. Kate Baker served as the overall chairperson, with responsibility for overseeing the entire peer review process and providing guidance to reviewers to ensure consistency, transparency, and independence throughout the review process.

The 2013 GTO Peer Review Meeting was organized into the following tracks, with associated sessions:

- Track 1 – Co-Produced; Low Temperature; Supercritical Carbon Dioxide; Working Fluids; Innovative Exploration Techniques; Geophysics; and Geochemistry
- Track 2 – Enhanced Geothermal Systems Demonstrations; Fluid Imaging; Characterizing Fractures; Induced Seismicity; High Temperature Tools; Drilling Systems; Materials; Zonal Isolation; and Innovative Methods of Heat Recovery
- Track 3 – Systems Analysis; Data System Development and Population; Tracers; and Modeling.

Evaluation and Scoring Methodology

The following decision criteria were used by GTO to determine whether or not a project should be peer reviewed at the 2013 meeting: (1) project funding levels, (2) whether or not the project was presented the previous year, (3) its project management status, and (4) how the project performed based on reviewer feedback from the previous peer review. GTO also decided how the projects should be presented and evaluated at the peer review meeting. Projects could either be presented via oral presentation, which is subject to evaluation from expert reviewers; or they could be presented during a poster session, which is not subject to expert review and evaluation. At the 2013 Peer Review Meeting, 97 out of 112 projects were orally presented and reviewed by at least three expert reviewers, who provided both numeric evaluations and written comments. The remaining 15 projects were presented as posters at the review.

Reviewers provided comments and numeric scores in four areas: (1) relevance/impact of research, (2) scientific/technical approach, (3) accomplishments, results and progress, and (4) project management/coordination. Numeric scores were based on a ten-point scale, with qualitative descriptors given for the numerical scoring index. The table below illustrates the weighting of each criterion for each of the 12 geothermal technology areas. Scoring weight varies by technology area due to an effort by the Office to emphasize an alignment of areas of importance with the nature of the work performed. A more detailed explanation of the scoring rubric can be found in Section 2.1.

[1] *Peer Review Guide*, Office of Energy Efficiency and Renewable Energy (EERE), August 2004

Weighting of scoring criteria or metrics

Technology Area	Relevance /Impact of Research	Scientific /Technical Approach	Accomplishments, Results, and Progress	Project Management /Coordination
1. Co-Produced and Low Temperature	20%	30%	40%	10%
2. Data System Development and Population	15%	30%	30%	25%
3. Enhanced Geothermal Systems Demonstrations	20%	25%	40%	15%
4. Fluid Imaging, Characterizing Fractures, and Induced Seismicity	20%	30%	40%	10%
5. Geophysics and Geochemistry	20%	30%	40%	10%
6. High Temperature Tools and Drilling Systems	20%	30%	40%	10%
7. Innovative Exploration Techniques	20%	25%	40%	15%
8. Materials, Zonal Isolation, and Innovative Methods of Heat Recovery	20%	30%	40%	10%
9. Modeling	20%	30%	40%	10%
10. Supercritical Carbon Dioxide and Working Fluids	20%	30%	40%	10%
11. System Analysis	20%	30%	25%	25%
12. Tracers	20%	30%	40%	10%

For each project, a **weighted average score** was calculated (from the combined scores of individual reviewers) for each of the four aforementioned criteria. The following formula, where x = score and y = weight, was used to calculate the weighted average score:

Example Calculation:

$\{(x_1*y_1) + (x_2*y_2) + (x_3*y_3) + (x_4*y_4)\}$= total
{(10*.20) + (7*.40) + (9*.15) + (9*.25)} = total
{(2) + (2.8) + (1.5) + (2.25)} = 8.6 weighted average score

Additionally, reviewers were asked to provide qualitative feedback on the strengths, weaknesses, and suggested improvements for the projects they evaluated.

For the purposes of the 2013 Peer Review, GTO project portfolios were organized into four program areas: (1) Enhanced Geothermal Systems Demonstrations, (2) Hydrothermal Resource Confirmation, (3) Research and Development, and (4) Systems Analysis. Expert reviewers evaluated the overall performance of those program areas by providing qualitative feedback on three metrics: (1) Goals—how well the program area goals aligned to industry needs, (2) Projects— how well a program area formed an effectively balanced portfolio of projects that will contribute to achieving its goals and objectives, and (3) Communication and Collaboration—the degree and impact that program area interaction has on industry, universities, federal agencies, as well as comparable international actors and other stakeholders. Additionally, reviewers provided qualitative responses on program area strengths, weaknesses, and any recommendations for improvement.

Scores and comments were submitted by reviewers into an online database called the Peer Review Management Information System (P2RMIS), which allows real-time tracking of the review process. P2RMIS interfaces with external electronic application systems, facilities online meeting planning and logistics, and supports evaluations, reviews, and scoring.

Summary of Scoring Results and Analysis

The table below provides an overview of the weighted average scores of all of the projects based on technology area. The table includes the number of projects, the average number of reviewers to evaluate those projects, and the weighted average scores of all of the projects combined (average, maximum, and minimum) per technology area.

Summary scoring of projects by technology area

Technology Area	Number of Projects Reviewed	Average Number of Reviewers per Project	Average Weighted Average Score	Weighted Maximum Score	Weighted Minimum Score
Above Average Scoring Technology Areas/Panels					
Data Systems Development and Population	4	4	7.8	8.7	7.0
Modeling	12	3.9	7.6	8.4	6.6
Fluid Imaging, Characterizing Fractures and Induced Seismicity	10	4	7.5	8.7	6.6
Enhanced Geothermal Systems Demonstrations	5	4	7.5	8.4	6.3
Average Scoring Technology Areas/Panels					
Geophysics and Geochemistry	16	4	7.2	8.4	5.5
Tracers	3	4	7.0	7.8	6.0
Systems Analysis	6	3.8	7.0	8.6	5.6
High Temperature Tools and Drilling Systems	13	4	6.9	8.6	1.0
Innovative Exploration Techniques	9	3.4	6.8	8.6	4.4
Below Average Scoring Technology Areas/Panels					
Co-Produced and Low Temperature	10	4	6.1	8.4	3.2
Materials; Zonal Isolation; Innovative Methods of Heat Recovery	6	3.5	5.7	7.8	1.0
Supercritical CO2 and Working Fluids	3	4	5.6	6.5	5.0

For individual projects, a comprehensive list of reviewer comments, PI responses, and individual project scoring evaluations can be found in Appendix A.

Common Themes of the Analysis and Results

Common themes of projects with below average scores in accomplishments include:

(1) Hypotheses that were not confirmed by data
(2) An errant initial approach
(3) Causations that were assumed based on flawed correlations
(4) Slow progress
(5) A lack of investigations into novel findings
(6) Reviewer disagreement with the engineering or scientific methodology
(7) Issues with project management
(8) Little consideration for the feasibility of scaling up bench scale experiments
(9) A disconnect or a lack of experimental, field-tested, and/or real-world data
(10) A lack of novel methodology, approach, or accomplishments
(11) Questionable or lacking field testing, data validation/documentation, and/or site selection,
(12) A project scope that is inappropriate or has expanded detrimentally
(13) Insufficient project funding.

Reviewers in 2013 seemed to focus their comments on quality, comprehensive data reporting, and awareness of where projects fit in the current geothermal knowledge base. It should be noted that some projects received low scores in Accomplishments that, despite being on schedule, were not at a point where results were available. Other projects with positive results received low scores due to vague results where poor presentation or proprietary concerns impeded clear dissemination of data. Through this analysis, GTO observed that low scores by themselves do not always indicate low-performing projects. The comments must be examined to determine whether scores are low due to substantial structural issues in the project or if the scores are a function of surmountable barriers to project success identified by reviewers.

Common themes of projects scoring highly in accomplishments include

(1) Good collection, consolidation, correlation, and/or visualization of large data sets
(2) Sufficient review of existing literature, tools, methodology, and/or data
(3) Clear technology transfer efforts or capability
(4) Application of industry or project lessons learned
(5) Strong project management and/or technical team
(6) Strong project comprehensiveness or experiment methodology
(7) Accomplishments that obviously further the industry
(8) Ability to overcome barriers
(9) Novel project component
(10) Successful proof of concept development
(11) Systematic and iterative processes for coordination and methodology
(12) Focus on data validation
(13) Actively avoiding redundancy with other work.

The elements of the list above with the highest frequency are (5) a strong project management and/or technical team and (7) accomplishments that further the industry. This is congruent with the most common themes of low scoring projects where the usefulness of the results and the creativity of the project teams in solving problems were key attributes in reviewer scoring. Many of the high-scoring projects will provide results immediately useful to furthering the industry, whereas low-scoring project results were not as mature. is the Office anticipates that as the low-scoring projects' results progress toward maturity, their scores will improve. The utility of this analysis is to highlight attributes of both low- and high-scoring projects so that lessons learned can be applied by the Office to continually improve all projects in GTO's portfolio and to avoid common pitfalls.

Progress Noted by the Peer Review Panelists

GTO staff have demonstrated an intense dedication to the Office and its goals, and Project Officer (project manager) engagement with the PIs and other partners appears to be instrumental in the high level of progress made on issues vital to national and GTO goals.

The comments below, expressed by the 2013 GTO Peer Review Panelists, summarize the current state of and progress made by the various technology areas within the Office:

- GTO has made excellent progress in making its mission, goals, and progress known to stakeholders at all levels, both nationally and internationally.
- GTO leadership seems to present a united front.
- The Research and Development (R&D) portfolio is an excellent addition to the larger GTO portfolio.
- The Geophysics portfolio is making notable progress in a number of high-impact spaces. Highlights include innovative regional-to-prospect-scale exploration methods that take measures to quantify uncertainty and value of information, and preliminary efforts to develop comprehensive methodologies and models for reservoir development and operations.

- The projects assigned within the Systems Analysis portfolio offer a diverse collection of topics, both technical and non-technical. Each project has attributes that allow it to be distinguished within the greater goals of the GTO.
- Of the Systems Analysis projects reviewed, two have made excellent strides in reaching out to geothermal stakeholders: Geothermal Electricity Technology Evaluation Model and regulatory roadmaps.
- The construction of a national database is a useful goal towards improving widespread use of geothermal [energy]. Several geothermal databases have been developed that directly address the needs of industry, researchers, and the public.
- Targeting fundamental research in geothermal exploration is a strength of the program.

Potential Issues Identified by the Peer Review Panelists

The Peer Review Panel identified the following issues that they feel are worthy of discussion or consideration by the Office:

- The 400 MW of new power by 2014 is an unrealistic goal.
- Funding delays associated with GTO have been too frequent. Changes of course during a project (for a variety reasons) take too long to obtain DOE approval and the process is too cumbersome.

Specific Recommendations of the Peer Review Panelists

The Peer Review Panel believes that addressing the comments and recommendations below could add significant value to GTO and help achieve future successes:

- GTO should rebalance the EGS Demonstrations portfolio with a focus on engaging new Oil and Gas (O&G) industry experts. The R&D portfolio should also be rebalanced and refocused. More demonstration projects and engaging the O&G industry expertise is strongly encouraged.
- GTO should consider funding additional projects that measure fundamental thermodynamic data and phase relations needed for quantitative assessment of a geothermal system. The R&D program is strong, particularly in the area of simulation and modeling.
- Fluid-mineral interactions are key to understanding geothermal systems, and while not “new,” these data are integral to success.
- Characterization of the materials that make up the reservoir is key to predicting the lifetime of the system, identifying the flow zones, and predicting the impact on the engineered systems.
- The Innovative Exploration Technologies portfolio should focus on the technical requirements to drill a 5,000-foot horizontal well with multiple stimulations.
- More comprehensive studies in Systems Analysis should be adopted, perhaps using the growing National Geothermal Data System database.
- GTO should call on more international expertise, in particular from countries with substantial geothermal power production, like Iceland, New Zealand, Indonesia, and Central American countries.
- GTO should press forward with plans for a comprehensive field experiment laboratory for conducting high-risk experiments that offer the opportunity to leapfrog current technology and reduce the levelized cost of energy.
- GTO is encouraged to work with other federal agencies to disseminate reliable resource data and to reduce technical, timeline, and financing uncertainties.
- Data resources should be presented at oil and gas conferences so that the data efforts can gain a more widespread audience.