4.2.2 Electrical Power Generation Using Geothermal Fluid Co-produced from Oil & Gas

Presentation Number: 012
Investigator: Karl, Bernie (Chena Hot Springs Resort)
Objectives: To validate and realize the potential for the production of low-temperature resource geothermal production on oil and gas sites; to test and document the reliability of this new technology; to gain a better understanding of operational costs associated with this equipment; and to help realize that a more distributed power generation network is attainable and an effective solution to energy problems.
Average Overall Score: 2.8/4.0

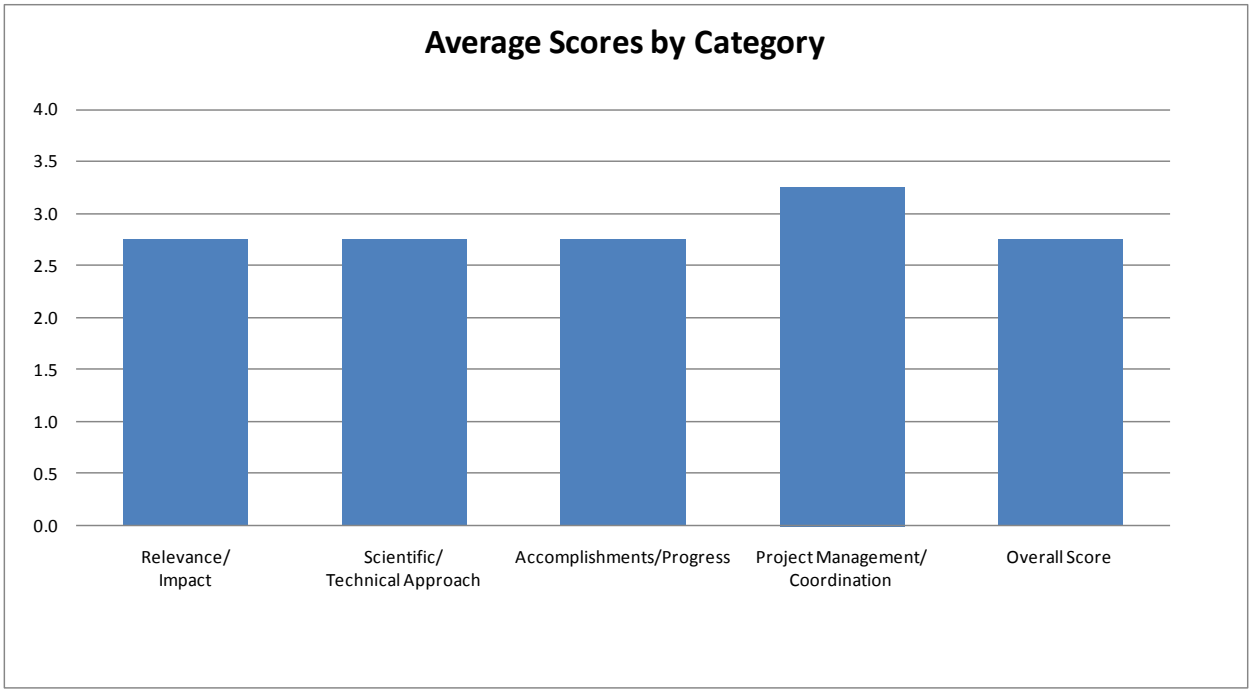

Figure 12: Electrical Power Generation Using Geothermal Fluid Co-produced from Oil & Gas

4.2.2.1 Relevance/Impact of the Research

Ratings of Four-member Peer Review Panel: Good (3), Good (3), Fair (2), Good (3)

Supporting comments:

- The industry can benefit by having a proven, small, mobile unit for generating electricity from geothermal sources. This system can be used on EGS, co-produced/geopressured, or conventional resources, so this project has real benefit. A drawback is that a primary beneficiary is the provider of the power equipment, UTC (now Pratt-Whitney), but there is still good value to this program.

- The primary objective of this project is to demonstrate an economical, distributed generation, geothermal energy co-production technology from oil and gas fields.

  This project does not fit directly into the broader context of conducting research, development

or demonstration of EGS.

The project is innovative and addresses known and some unknown technical barriers. Demonstrating proven ORC technology to exploit geothermal resources addresses a technical barrier of moderate proportions. This is a viable technological application for the geothermal industry in colder climates. The project has successfully established the feasibility of energy production from low-temperature geothermal resources at Chena Hot Springs. The payback of the ORC system is greatly improved by oil and gas recovery.

The project attempts to address the market barriers. However, the question of whether this co-production technology will overcome significant market barriers in warmer climates and other markets with more stringent waste discharge, noise, and air emissions requirements is unknown. This project advances the science and technology but more work is required in addressing whether this technology will work in other low-temperature geothermal co-production fields with different water chemistry and compositions of oil and gas mass fractions. This is dependent not only on the geothermal resource's water chemistry but also on well-head temperatures and pressures, ambient conditions, cost of equipment, engineering costs, site mitigation costs, permitting costs, available infrastructure, and utility power rates.

The project has successfully established the development of a transportable 100 to 200 kWe net power plant (No oil and gas equipment at the Reno location.) The project has successfully provided a foundation for remote distributed power systems.

The project broadens the potential for geothermal co-production in some locations and provides the following additional positive benefits:

- improves the competitiveness of geothermal co-production
- increases resource/electricity availability, flexibility and reliability of geothermal power
- provides a reasonable alternative to fossil fuel in relation to environmental concerns including greenhouse gases, health and safety benefits and mitigating adverse impacts
- reduces capital costs or operation and maintenance costs
- provides a platform for the development of a renewable technology
- includes technology transfer activities as part of the project

Weaknesses:

There was very little discussion on geothermal fluid content and discussion on recovery of oil and gas products. What was the cut ratio at Chena Hot Springs? No discussion was provided to ascertain what happens to the off-spec gas or what quantities of oil and gas are produced and how they factor into the economics of the project.

Questions:

1. How will this project take this technology a step forward towards commercialization?

2. What is the Grantee's own match contribution and what was the match contribution of the subcontractors, if any?

3. What is the likelihood of an oil company incorporating this technology into their operations?

4. Are there any air, land use or water discharge permits required for this project?

- There have been delays due to negotiating with oil companies and so progress has been very slow. I have therefore rated this as fair.

- Water produced in oil and gas fields can be a large resource for geothermal energy production in a large number of states. The goal of utilizing that resource is inhibited by lack of demonstrated experience using that technology. This project contributes to the goal of utilizing that resource by providing a demonstration of the feasibility of using a particular power plant built by a particular company, and has provided stimulus for that company to improve its power plant hardware. I cannot assess how applicable this experience will be to the broader industry.

4.2.2.2 Scientific/Technical Approach

Ratings of Four-member Peer Review Panel: Good (3), Good (3), Fair (2), Good (3)

Supporting comments:

- There has been a lot of outstanding work in this program, but a critical aspect is missing. One of the biggest risks of power production from co-produced fluids is degradation of heat transfer due to fouling of exchanger surfaces from scale and/or oil buildup. The value of this program would be significantly enhanced if fouling factors and pressure drop in the heat exchangers were carefully tracked and reported.

- The Grantee utilized the appropriate scientific/technical methods, procedures to achieve project objectives with the available funding and personnel.

  The design and technical approaches are based on sound engineering principles and are incorporated into the deployment of the project. Project deployment appears to be well grounded and focused on site-specific characteristics and it addresses engineering design and manufacturing specifications for efficient operations at the Chena Hot Springs Resort.

  The presentation and quarterly status report did not provide an adequate analysis on the effects from build-up of oil, other hydrocarbon and scaling on the heat exchanger and equipment. In addition, no discussion was provided on the frequency and cost of equipment maintenance.

  The presentation did not provide separate discussions on mass, energy balances and a thermodynamic analysis from the project sites. (Chena Hot Spring and Reno, Nevada) Also, the presentation did not provide a discussion on power-plant thermal efficiencies or a description

of power-plant performance at both locations. In addition, no noise data, water, or air emissions data were provided in the presentation or supplemental material for review.

- The lack of progress in this project doesn't allow me to rate this as anything but fair.

- The project is focused on demonstrating the feasibility of utilizing this technology and reducing the "uncertainty risk" for oil-field operators who might want to use it. Through negotiations with possible field sites, the team is improving the product to deal with concerns of the potential users. Until the system is deployed at a site, I cannot assess how well they are managing the experiment and how useful the data will be in encouraging broader utilization. Will we learn enough to reduce concerns about regulatory and operational issues for a variety of locations and power plant designs? I am not sure.

4.2.2.3 Accomplishments, Expected Outcomes and Progress

Ratings of Four-member Peer Review Panel: Good (3), Good (3), Fair (2), Good (3)

Supporting comments:

- No comments.

- The overall quality and qualifications of the research team, equipment and facilities are superior. The project has an excellent chance of successful completion given the support by UTRC, PWPS, Aurora Energy, The Peppermill Resort and Casino, The Geothermal Resources Council, Quantum Resources, and Southern Methodist University.

  The Chena Hot Springs Resort is an excellent location to demonstrate UTRC/PWS's low-temperature ORC technology. How well this technology translates to another location is another matter. While this technology was demonstrated on a skid mounted platform at Reno, Nevada, no discussions on mass, energy balances and thermodynamic analysis from the Reno project site was provided.

  Productivity:

  The level of work productivity underway is timely and on schedule with respect to the budget. The accomplishments thus far against planned goals and objectives, technical targets, and awards seem to be on schedule and responsive to the original timelines, goals and objectives. While, there is no doubt the technology did work, what were the costs? There was no discussion on project levelized costs of electricity or payback calculations.

  Quality:

  The project team is well qualified to conduct this research. UTRC, PWPS, Aurora Energy, Quantum Resources, and Southern Methodist University have successfully demonstrated and provided technical expertise necessary for the completion of this project.

  The Chena Hot Springs Resort, through the project management of Mr. Karl and subcontractors has been awarded numerous awards, and has received national and international recognition.

- No information was provided on the resources and facilities involved beyond the successful mobilization of a mobile binary unit to a site. I acknowledge that a portable unit may have benefits in terms of fewer permitting requirements. However, based on data presented I have rated this as fair.

- The power plant designers obviously know what they are doing. The PI's energy and dedication (both personal and financial) are an important resource for this project. The results to date have been limited by the difficulties in negotiating a site for the tests. I cannot assess how well the project has performed in the effort to resolve these difficulties.

4.2.2.4 Project Management/Coordination

Ratings of Four-member Peer Review Panel: Outstanding (4), Good (3), Good (3), Good (3)

Supporting comments:

- Bernie's persistence and perseverance have contributed greatly to the success of this program.

- Budget:

  The project has an excellent chance of successful completion given the support by UTRC, PWPS, Aurora Energy, The Peppermill Resort and Casino, Quantum Resources, and Southern Methodist University.

  The budget is reasonable. The cost share provided by the Grantee or the subcontractors was not made clear in detail, but there is an indication of willingness by the Grantee to take a financial risk to make this project a success. The budget seems appropriate for the scope and complexity of the project. This is a workable project given the budget, technical difficulty and qualifications of the Grantee, subcontractors and project participants. The DOE cost share on this project is $724,000 with matching contributions of $724,000.

  The project appears to be compatible with the work statement, budget and Grantee's qualifications. It appears that the technical, policy, business, and spending plans for the project have been carried out successfully. The work presented was clear and the project was executed in a logical manner. The scope of the project is reasonable but there are some minor issues that will require more clarification.

  Weaknesses:

  The presentation and related material did not include an economic analysis or data to substantiate a favorable return on investment. The rate of return on the investment is unknown. Discussion concerning lowering the cost of extracting energy from resources of progressively lower temperature resources would have been useful. Also, no information or data were provided that discussed operation and maintenance costs of production wells and power plants.

  A clear schedule or Gantt chart describing project trajectory and critical decision points, and, beginning and ending dates for each project task were not provided. Information on due dates

and deliverables would have been useful. There was no indication of go/no-go reviews or when they should have taken place.

A scant summary of the budget is provided, but detailed break-down of expenses was not included.

- It is too early in the project to make an assessment of the management of the project but the presenter appears to have made every effort to obtain agreements to locate his unit at an appropriate site. I have therefore rated this as good.

- The management approach has been flexible and reactive, which is probably a good approach for this project. Finding a good site for this test has been a significant challenge, and the PI is reacting effectively to concerns raised by potential partners. The project appears to be based on the assumption that "if we do it, then that will encourage others". That assumption is true to some extent, but the project might have a greater value if there was an assessment of what are the specific barriers to utilization and what data could eliminate these barriers.

4.2.2.5 Overall

Ratings of Four-member Peer Review Panel: Good (3), Good (3), Fair (2), Good (3)

Supporting comments:

- A good program that DOE and Bernie can be proud of.

- Overall the Chena Hot Springs project has met all technical and operational expectations given its unique location and excellent qualifications of the technical and administrative teams.

  Commentary:

  However, not all states in the Union are as lax in their environmental regulatory authority. For example, the State of California, which has the largest geothermal production and significant untapped geothermal potential from hydrothermal resources, and underdetermined geothermal potential from its vast oil and gas production fields, has very stringent environmental requirements that could prevent energy producers from considering doing business in California.

  In attempting to address the technology transfer aspect of this project and other geothermal power generation technologies that could be adapted to California, energy developers must consider many other aspects to their environmental project plans. This applies to power plant operations larger than 50 MW, however, smaller power generators are required to conduct similar assessments. Below is a list of environmental considerations that must be addressed in the planning stages:

  1. Air Quality
  2. Public Health
  3. Transmission Line and Safety
  4. Hazardous Materials

5. Waste Management
6. Land Use
7. Traffic and Transportation
8. Noise
9. Visual Resources
10. Cultural Resources
11. Socioeconomics
12. Biological Resources
13. Soil and Agricultural Resources
14. Water Resources
15. Geological Resources
16. Paleontologic Resources
17. Facility Design
18. Energy Facility Reliability
19. Generating Efficiency
20. Transmission System

In reviewing this project and from what was presented, the Chena Hot Springs project has successfully addressed some of the abovementioned criteria but would not meet the State of California's environmental regulatory requirements.

- Because the project is at such an early stage it is not possible to assess if this project is weak or good. Right now however, I have to rate the project as only fair.

- My only concern is about the generalizability of the experience resulting from this funding.

4.2.2.6 PI Response

No response.