



Single-well Low Temperature CO₂-based Engineered Geothermal System

Project Officer: Tim Reinhardt

Total Project Funding: \$2 million

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Principal Investigator: Alan D. Eastman

Presenter Name: Mark P. Muir

Organization: GreenFire Energy

Track Name: Low Temperature Track

Objective

Demonstrate the feasibility of utilizing supercritical CO₂ as a geothermal fluid

Statement of Principal Objectives Phase I

- ✓ Summary report on “State of the Art” - complete
- ✓ Preliminary engineering design and cost estimate – 25% complete
- ✓ Sensitivity test on design and cost estimate – 0% complete
- ✓ Passive seismic network – 5-station network installed in August 2011, interim reports available
- ✓ Choose MOHC – In progress, nearly complete
- ✓ Permitting – some complete, others in preparation

Additional Knowledge Gaps To be Addressed, as Possible

- ✓ Frictional losses in 2-phase flow in production wells
- ✓ Losses to the formation
- ✓ Chemical impact on formation
- ✓ Power generation with turbines adapted for use with CO₂
- ✓ Viability of the thermosiphon concept
- ✓ Injection pressure required
- ✓ Economics

Impact on Geothermal Industry

- ✓ Reduction in capital costs per MW for EGS by as much as 2/3rds
- ✓ Greater revenue from non-energy projects
 - High-value uses
 - Single-pass uses
 - Smaller, more fundable projects
 - Avoid transmission costs and delays
- ✓ Reductions in cost of carbon capture
- ✓ Status of direct air-capture projects

Relationship to GTP Goals

- ✓ Create hydrosheared reservoir
- ✓ Reduce generating costs to \$0.06 per kWh or less
- ✓ Demonstrate baseload power generation from an EGS project

High-Value, Single-Pass Uses

- ✓ Manufacture of industrial commodity chemicals
- ✓ Extractions
 - Bitumen from oil sands
 - Keragen from oil shale
 - Rare Earth elements from ore or waste
- ✓ Processing of nuclear waste
- ✓ Status of direct air-capture projects

Two Technical Tasks to Date

- **Passive Seismic Network**
 - Chose site in 2011 based on temperatures in existing wells
 - Designed network with input from Foulger Consulting
 - Installed network in August 2011
 - Three interim reports to date
- **Select MOHC – PNNL responsibility**

Completion of Phase I

- Most immediate need – raise \$2 million in additional funds
 - We expect this to take at least six months
 - Keep the company going
 - Restart permitting process
 - Restart and expand passive seismic network
- UIC permit will take 18 months. Other permits will take less time.

Milestone or Go/No-Go	Status & Expected Completion Date
Raise \$2 million in additional funds	In process, October 2013
Complete permitting	In process, March 2015

Completion of Phase II

- Raise \$6 million in additional funds
- Commence fieldwork upon completion of permits
 - Install CO₂ supply wells
 - Install EGS well
 - Log
 - Hydroshear with CO₂
 - Begin testing
- Testing will take 18 months.

Milestone or Go/No-Go	Status & Expected Completion Date
Raise \$6 million in additional funds	Phased investment with previous funding
Commence fieldwork	9 months, December 2015
Test well	18 months, June 2017

- ✓ We are seeking additional funding to complete Phase I (permitting and other tasks)
- ✓ Need to augment Phase II funding to complete the project (drilling, hydroshearing and testing)
- ✓ Our project has implications for a wide range of technologies beyond geothermal
 - Chemical manufacture
 - Energy storage
 - Mining
- ✓ Economics may be far superior to water-based EGS
 - Much lower capital costs per MW
 - Possible much greater revenue leading to use of anthropogenic CO₂

Timeline:

Planned Start Date	Planned End Date	Actual Start Date	Current End Date
9/30/10	9/30/14	9/30/10	9/30/15

Budget:

Federal Share	Cost Share	Planned Expenses to Date	Actual Expenses to Date	Value of Work Completed to Date	Funding needed to Complete Work
\$2,000,000	\$2,530,000	\$460,000	\$339,000	\$325,000	\$83,000

- Management Activities:
 - Working with PNNL on project for Bonneville Power Administration on large-scale energy storage project
 - Working with Brian McPherson at EGI on CO₂-EGS modeling project – data from our project will be used for model verification
 - Possible joint projects with NRAP
- Project behind schedule due to inadequate funding.