



High-potential Working Fluids for Next Generation Binary Cycle Geothermal Power Plants

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Specialized Materials and Fluids and Power Plants

Project Overview

- **ENERGY** Energy Efficiency & Renewable Energy
- <u>3-Phase, 3-Year Effort</u> \$3.75M total, including 20% cost share by GE
 - Timeline
 - Project start date January 29th, 2010
 - Project end date February 28, 2013
 - Percent complete 3%
 - Budget
 - Total project funding = \$3.75M, DOE share = \$3.0M, Awardee share = \$0.75M, Funding for FY10 = \$0.69M (\$0.55M DOE)
 - Barriers N: Energy Conversion at Low Temperature
 - Partners AltaRock Energy, Inc.





- EGS wells deeper more costly
- Invest more into energy conversion unit to lower overall cost
- Evaluate combinations of high-potential working fluids / advanced cycles
- Find cost optimum for drilling vs. power conversion cost

Overall Objective: Find optimized working fluid/advanced cycle combination for EGS applications

Three-phase Approach:

- <u>1</u>: Identify high-potential working fluids. Develop thermo physical model predicting net power output for high-potential working fluids. Document impact of key fluid properties. Milestone - GO/NO GO March 2011
- <u>2</u>: Identify technology gaps. Determine required fluid property accuracy for reliable component design. Develop integrated thermo economic cost model and predict cost for different fluids/cycles including drilling cost. Milestone - GO/NO GO March 2012
- <u>3</u>: Down select working fluid / cycle for potential EGS site. Improve fluid knowledge if necessary. Build and design pilot scale rig for validation Milestone - Complete February 2013
- Whenever possible use existing GE expertise and technology.

Accomplishments, Expected Outcomes and Progress

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- Assembling Fluid Database
- Field Trip / Kick-off with AltaRock



Project Management/Coordination

U.S. DEPARTMENT OF Energy Efficiency & **Renewable Energy**

- 3 Phases followed by go/no go decisions
- January 1st, 2010 February 28th, 2013
- \$3.75M total including 20% cost share by GE
- Each of the subtasks has a set of deliverables and risks associated with it

	51.	\$1,117,992	51 12 11011015									
	DOE			COST S	SHARE	VARIANCE						
	Phase	Plan	Actual	Plan	Actual	DOE	Cost Share					
Apr-10	Phase I	\$111,759		\$27,939		\$111,759	\$27,939					
May-10	Phase I	\$107,719		\$26,930		\$107,719	\$26,930					
Jun-10	Phase I	\$112,160		\$28,040		\$112,160	\$28,040					
Jul-10	Phase I	\$107,890		\$26,973		\$107,890	\$26,973					
Aug-10	Phase I	\$56,057		\$14,014		\$56,057	\$14,014					
Sep-10	Phase I	\$55,942		\$13,986		\$55,942	\$13,986					
Oct-10	Phase I	\$53,986		\$13,496		\$53,986	\$13,496					
Nov-10	Phase I	\$50,563		\$12,640		\$50,563	\$12,640					
Dec-10	Phase I	\$48,951		\$12,238		\$48,951	\$12,238					
Jan-11	Phase I	\$51,080		\$12,770		\$51,080	\$12,770					
Feb-11	Phase I	\$65,994		\$16,499		\$65,994	\$16,499					
Mar-11	Phase I	\$72,293		\$18,073		\$72,293	\$18,073					
		\$894,394	\$0	\$223,598	\$0	\$894,394	\$223,598					

ask Name		1st Quarter			3rd Quarter			1st Quarter			3rd Quarter			1st Quarter			3rd Quarter			1st Quarter		
	Nov	Jan	i Ma	ar May	/ Jul	I S	ep Nov	Jan	Mar	May	Jul	Sep	Nov	Jan	Mar	May	Jul	Sep	Nov	Jan	Mar	May
Working Fluid																					- ₹	
🖃 Phase 1: Screen for High Potential Working Fluids and Develop Performance Model			5	,				-														
Task 1: Identify high-potential working fluids for advanced cycles			1																			
Task 2: Evaluate cycle performance for high-potential working fluids																						
Task 3: Identify key fluid parameters that impact cycle performance																						
Task 4: Project management and reporting					:			:														
Milestone: Go/No Go decision to continue with Phase 2									•													
$ar{}$ Phase 2: Determine required accuracy of fluid property data and build plant economic model																						
Task 5: Identify impact of uncertainty in fluid property data on design of componentry																						
Task 6: Develop economic model for next generation geothermal plants											:			:								
Task 7: Project Management and Reporting																						
Milestone: Go/No Go decision to continue with Phase 3															•							
😑 Phase 3: Downselect hihg-potential working fluid, determine fluid properties, and build pilot rig																					- 🖓	
Task 8: Downselect high-potential working fluid/advanced cycle combination for performance validation																						
Task 9: Determine fluid properties																						
Task 10: Build pilot rig to validate performance predictions of chosen working fluid and advanced cycle design																						
Task 11: Project Management and Reporting																						
Milestone																					•	

	Geotherma	al Technology Pr	ogram-Working	
Project Title:	FI	uids for Binary S	ystems	
Awardee:		GE Global Rese	arch	
Award #:		DE-EE000276	69	
Total DOE Obliga	ation:	\$894,394		Plan numbers should not be updated retroactively
Recipient Cost S	hare:	\$223,598		Plan numbers for future months may be updated.
Total Project Cos	st:	\$1,117,992	1st 12 months	

Find optimized working fluid/advanced cycle combination for EGS applications and demonstrate predicted performance in pilot-scale rig by February 2013.

Planned activities in remainder of FY 2010 and 2011

- Complete Phase 1:
 - Identify high-potential fluids
 - Test high-potential fluids in thermo physical models for advanced cycles
 - Milestone GO/NO GO March 2011
- Begin Phase 2:
 - Identify technology gaps.
 - Determine required fluid property accuracy for reliable component design.
 - Develop integrated thermo economic cost model





- <u>Objective</u>: Find optimized working fluid/advanced cycle combination for EGS applications
- 3-year, \$3.75M effort
- Project commenced on April 1st, 2010
- Phase 1 to be completed March 31st, 2011
 - Identify high-potential working fluids
 - Develop thermo physical model predicting net power output for highpotential working fluids
 - Document impact of key fluid properties

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