Grant Opportunity: AEA Emerging Energy Technology Grant Application AEA-2014-007

Project Title: Using SuperCritical Water Extraction and Refining (SCWER) to convert coal to oil for rural power generation

Applicant: Heavy Oil Solutions, LLC

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Applicant Contact Information: Mr. Gerald Myers, Heavy Oil Solutions, LLC, 3680 Lathrop St. Fairbanks, AK 99701 email: geraldmyers@heavyoilsolutions.net, Tel: 907-457-2354 Cell: 907-750-5452

Partners: University of Alaska, Fairbanks, AK 99701

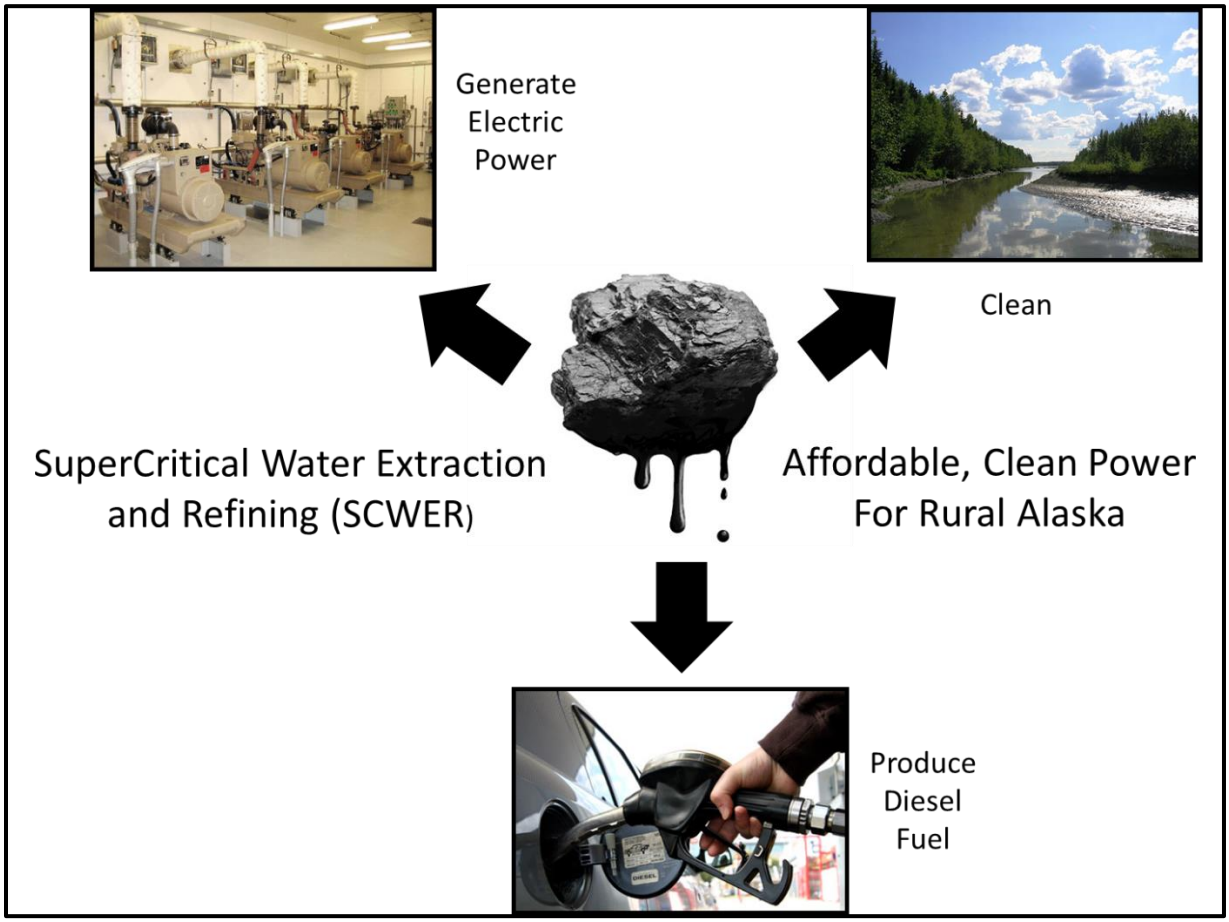
Total Project Cost: $848,783

Grant Funds Requested: $749,818 grant + $98,965 in-kind labor and equipment in-use match committed

Previous Grants: None

Applicant Eligibility: Heavy Oil Solutions, LLC is a business based in Fairbanks, AK

Project Eligibility: This project will test emerging energy technology that can be commercialized within 5 years



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Project description: Alaska's rural communities pay some of the highest prices for energy in the United States, despite their relative proximity to substantial resources in fields such as Point Thomson and Prudhoe Bay. Electricity costs for diesel generation average from $0.35 to more than $1.00 per kilowatt hour. One major factor contributing to high costs is a lack of state-wide energy supply infrastructure systems, such as an electrical grid or gas pipeline network. But building those systems would entail huge costs, due in part to the state's size. Therefore, smaller, efficient distributed power generating systems would have a tremendous positive benefit for rural Alaska.

Alaska has over 5760 billion metric tons (MT) of very low sulfur (<0.3%) coal that is a potential resource for generating power either directly as electricity or providing diesel for existing generating plants. Heavy Oil Solutions, LLC has demonstrated that supercritical water is an efficient solvent for extracting a high-grade crude oil from coal. It is particularly attractive for coals with high moisture contents, such as those found in Alaska. If oil can be extracted with high efficiency, then it is possible to burn the oil 'in-situ' to generate electricity without the complex, costly additional off-gas handling equipment associated with conventional coal-fired plants. In addition, supercritical water cycles are much higher efficiency, up to 35 to 40% compared to 25 to 29% for conventional power plants. In addition, the oil can be refined to provide diesel if that is more economical given location or infrastructure requirements.

This project will develop the basic concept by optimizing the parameters for efficient coal to liquids conversion using supercritical water and maximizing the conversion to either electricity or diesel fuel.

Technology readiness: Currently, small-scale work at a Technology Readiness Level 3 (TRL 3) is complete demonstrating the concept and providing estimates of potential reaction conditions. At this point, the main issues that remain are optimizing extraction conditions and validating the optimum design and operating conditions. This will be achieved by integrating the basic technological components with reasonably realistic supporting elements so it can be tested in a simulated environment at Technical Readiness Level 4/5. The "high fidelity" laboratory integration of components will be conducted at the University of Alaska Coal to Liquids laboratory at the 1000 g/hour scale. It is intended for the project to provide data to move the technology to TRL Level 6-7 in 18 to 24 months.

Preliminary Results: Initial testing with coal samples from Usibelli Coal Co. in Alaska have shown that >90% of the carbon can be removed in a single batch contact. This translates to roughly 2.5 bbl of oil per ton of coal extracted.

The higher efficiency of the SCW process uses essentially the same amount of coal but with much simpler off-gas and handling requirements. This translates into less capital and operating cost with similar coal costs. This will produce cheaper electricity with an environmentally benign process.

Project Innovation: The technical trait that separates our approach from the conventional is the high solvent capacity and reaction potential of supercritical water. The water is recycled after the less-viscous oil is separated.

The basic concept is illustrated below:

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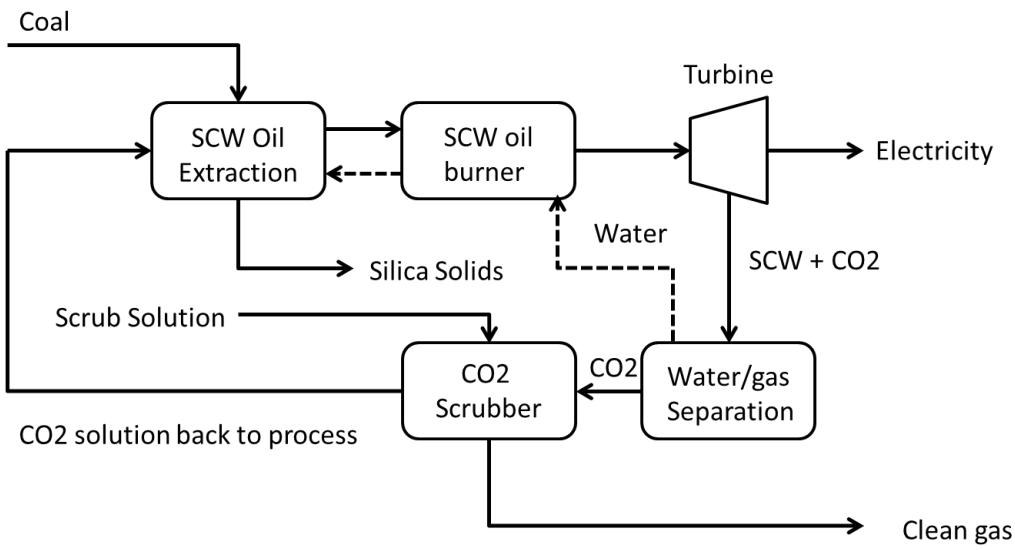

Supercritical water (SCW) has been demonstrated as an excellent solvent for high molecular weight organic compounds due to its high dielectric constant. Therefore, coal is contacted with the SCW to remove the oil and leave the mainly silica solids for disposal or reuse as building or road material. The oil, dissolved in the SCW is oxidized and the resulting high-temperature, high-pressure stream is sent to a turbine to produce electricity. SCW oxidation processes are very efficient, essentially 100%, so the gas is mainly nitrogen and carbon dioxide. The water stream is flashed to separate the water and gas and the water is sent to the SCW oil burner to be heated for return to the SCW oil extractor. The gas is sent to a CO_2 scrubber to remove CO_2 and return it along with chemicals needed for extraction to the SCW oil extractor. The clean cooled gas is vented to the atmosphere. This approach is much simpler and potentially less costly, both in capital and operating costs than a typical coal-fired plant.

Project Site and Demonstration Environment: It is planned to start with an extraction unit for 100 g/hour then scale up to 1000 g/hour coal unit. Testing will be located at the University of Alaska Coal to Liquids laboratory.

The SCWER Pilot Project does not require any special electrical, water or sewer utilities. It is designed to be a modular unit that needs minimal resources, mainly water, coal and some common environmentally benign commercially available chemicals. Given the approach of deployment in rural Alaska, the site requirements are designed to be a minimal as possible. The entire pilot project can be housed in the laboratory.

Project Priority:

- Mr. Gerald Myers is a long-time Alaska resident and HOS,LLC is an Alaskan business
- This project has negotiated a partnership with the University of Alaska (Dr. Shiva Hullavarad) and will be conducting the work at the U of AK coal to liquids laboratory
- This project is supported by matching funds
- This project is intended to provide affordable, clean energy for rural Alaska.
- The technology is capable of delivering electricity and heat or diesel. The process uses the combustion energy from oil to generate temperatures up to 800° F

Technology Validation and Data Collection: We propose to build and operate initially a 100 g/hour extraction unit that we will scale to 1000 g/hour as a demonstration for extracting oil from coal and converting it to electricity or diesel. The University of Alaska will provide all chemical and physical property analysis along with data review and verification. The University will provide peer review of experimental plans.

We will develop the design and fabrication drawings, contracts, procurements, document control and data acquisition in accordance with ASME-NQA-1 latest revision quality standards. Also, we will develop appropriate experimental plans that meet the facility's safety and site requirements and provide appropriate material for student interaction and training. The data will be logged using standard industrial process control and data logging equipment. Laboratory notebooks will be maintained according to ASME-NQA-1. Every six months throughout the project, there will be independent reviews of data and progress by selected experts from the University of Alaska.

Project Objectives and Deliverables:

1. Demonstrate "green" technology that can efficiently extract oil from Alaskan coal
2. Demonstrate technology that can use the oil to produce useable heat and electricity in compact distributed units that can provide cost-effective electricity and heat for rural Alaska
3. Demonstrate that SCWER is environmentally friendly. SCWER only uses chemicals that are currently approved for use in the petroleum and steam boiler industry and does not use hazardous chemicals or generate wastes that are not environmentally benign**Project Team Capabilities:**

Gerald Myers Project Manager: Mr. Myers has an extensive background managing construction projects and is a long-time successful business man in Alaska. Mr. Myers will be the project manager for the term of the project.

Steve Yarbro Technical Lead: Dr. Yarbro is a licensed engineer in the State of New Mexico and has a Ph.D in Chemical Engineering from New Mexico State University. Dr. Yarbro is the inventor of the technology and will be providing the technical management of the project.

Shiva Hullavard University of Alaska: Dr. Hullavard is an Adjunct Professor at U of AK and has extensive experience in hydrocarbon analysis and manufacture of advanced materials. Dr. Hullavard will be providing additional technical leadership and peer review.

UAF Graduate Students: Selected students will work on this for the fulfillment of their Master's or Doctoral thesis requirements

Regan Hallford: Mr. Hallford is the Contracts Manager at the San Juan Generating Station for Public Service Co. (PNM) of New Mexico and has extensive experience with power generation and coal use and will be assisting with the contract management and negotiation for the project.

Ralph Ahn: Mr. Ahn, CFA, is a principal with Aventur Partners and has extensive experience with financial modeling, business plans and developing commercialization plans to successfully bring new technology to market.

Commercialization of Funded Project: Alaska has 150 stand-alone electrical grids serving remote villages and 40 have identified coal opportunities nearby. Upon completion of the technology development effort, the technical team will develop a business and commercialization plan, three years pro forma financial statements assist with further design and regulatory testing and permitting requirements, conduct a partner search for investors and fabricators, and negotiate with viable partners who are motivated to distribute the product to rural Alaska.

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Project Budget and Schedule:

Milestone or Task	Anticipated Completion Date	EET Fund Grant Funds	Grantee Matching Funds	Source of Matching Funds	Totals
Phase 1					
Project scoping and equipment	Q1	$56,205	$0	N/A	$56,205
procurement					
Site construction	Q1	$11,241	$0	N/A	$11,241
Permitting completed	Q1	$22,482	$0	N/A	$22,482
Extraction testing completed	Q3-Decision Point	$110,244	$31,265	in-kind labor	$141,509
Project control plan complete	Q1	$11,241	$1,500	in-kind labor	$12,741
Technology validation and	Q1	$6,745	$1,500	in-kind labor	$8,245
research plan finalized					
Preliminary Commercialization plan complete	Q3-Decision Point Documentation	$4,496	$1,500	in-kind labor	$5,996
Phase 1 Totals		$222,653	$35,765	in-kind labor	$258,418
Phase 2					
Phase 2 equipment procurement	Q3	$85,000	$0	N/A	$63,391
Data validation and	on-going	$31,696	$0	N/A	$31,696
project control					
Project Control Plan updated	Q4	$5,000	$1,500	in-kind labor	$9,424
Commercialization Plan	Q4	$7,924	$1,500	in-kind labor	$9,424
updated with current project					
costs and performance					
Scale-up and flowsheet development completed	Q4 - Decision Point	$224,818	$15,000	in-kind labor	$205,173
Permit updates	Q3	$15,848			$15,848
Phase 2 Totals		$370,285	$18,000		$334,955
Phase 3					
Commercialization Plan complete	Q8 - Decision Point Documentation	$8,000	$1,500	in-kind labor	$9,493
Permit summary	Q7	$5,000		N/A	$7,993
Complete performance data	Q7	$15,987	$1,700	in-kind labor	$17,687
monitoring and collection					
Final testing and demonstration complete	Q7	$95,920	$15,000	in-kind labor	$110,920
Final performance report complete	Q8 - Decision Point	$12,789	$2,000	in-kind labor	$14,789
Site clean up and closure	Q8	$19,184		N/A	$19,184
Phase 3 Totals		$156,880	$20,200		$180,067
Project Sub Total		**$749,818**	**$73,965**	**in-kind labor**	**$823,783**
Budget Categories					
Direct Labor & Benefits		$249,990	$73,965	in-kind labor	$114,313
Univeristy of Alaska contract		$180,000	$0	N/A	
Travel & Per Diem		$18,500	$0	N/A	$12,130
Equipment		$125,000	$25,000	equipment in-use	$117,144
Materials & Supplies		$70,912	$0	N/A	$70,912
Contractural Services		$74,991	$0	N/A	$35,456
Construction Services		$30,425	$0	N/A	$0
Other		$0	$0	N/A	$0
Project Total with Matching		**$749,818**	**$98,965**	**in-kind labor/equipment**	**$848,783**

Signed Applicant Certification: