Environment and Natural Resources Trust Fund
2014 Request for Proposals (RFP)

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Project Title:

Biomass Gasification to Produce Electricity for CO2 Reduction

Category: E. Air Quality, Climate Change, and Renewable Energy

Total Project Budget: $ 175,000

Proposed Project Time Period for the Funding Requested: July 2016

Other Non-State Funds: $ 0

Summary:

This project will provide a platform for distributed renewable electrical generation, allow us to rethink energy distribution, use renewable resources to manage carbon, create local bioenergy ecosystems and sustainable communities.

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Sponsoring Organization: U of MN

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Location

Region: Statewide

County Name: Statewide

City / Township:

MP: 0613-2-128-proposa
Budget: 0613-2-128-bud
Qual: 0613-2-128-qualifi
Map: 0613-2-128-map-2
Resolution:
List:

_____ Funding Priorities	_____ Multiple Benefits	_____ Outcomes	_____ Knowledge Base	
_____ Extent of Impact	_____ Innovation	_____ Scientific/Tech Basis	_____ Urgency	
Capacity	Readiness	Leverage	Employment	TOTAL

Environment and Natural Resources Trust Fund (ENRTF)
2014 Main Proposal
Project Title: Biomass Gasification Using Local Fuels of Opportunity to Produce Electricity for CO_2 Reduction

PROJECT TITLE: Biomass Gasification Using Local Fuels of Opportunity to Produce Electricity for CO_2 Reduction

I. PROJECT STATEMENT

This project will provide a platform for distributed renewable electrical generation, allow us to rethink energy distribution, use renewable resources to manage carbon, create local bioenergy ecosystems and sustainable communities. The University of Minnesota has purchased a prototype gasifier/engine/generator platform, the PowerTainer, from ALL Power Labs under a previous project that was funded by the U.S. Department of Energy, National Energy Technology Laboratory. We are proposing to optimize the control of this system, implement low-temperature combustion operation, and then conduct moderate length durability tests of the system performance gasifying several readily available fuels of opportunity such as corn cobs, stover, and dried poultry litter from farming operations, downed trees/limbs and wood from wreckage from disaster areas, or biomass waste streams—wood waste, cardboard, nut shells, etc., from commercial industrial uses.

This project will allow the environmental and performance benefits of operating a diesel engine in a dual fuel mode with producer gas as the primary fuel to be evaluated. Producer gas is an excellent fuel, being a blend of gases rich in carbon monoxide and hydrogen, but is most often used in lower efficiency spark ignition engines. The engine/generator package was supplied by Cummins Engine Company and is a 100 kWe unit powered by a Cummins 6.7L turbo diesel engine. The entire platform is housed in a 20 foot shipping container that also contains a fuel hopper for easy transport and siting. Preliminary emissions testing on producer gas diesel blends and approximately 40 hours of durability have been conducted. These tests showed that it is possible to successfully operate a high efficiency modern diesel engine displacing up to 90% of the diesel fuel by fumigating with producer gas.

Advanced low-temperature combustion modes such as homogenous charge compression ignition (HCCI) have shown the potential to maintain this high efficiency operation while producing very low oxides of nitrogen and particulate matter emissions. These advanced forms of combustion have the potential to offer substantial advantages, but have a number of implementation issues. Dual fuel operation is one method often used to control these combustion modes. By controlling the ratio of the fuels and when each fuel is introduced into the engine, optimized operation can be achieved resulting in the lowest possible CO_2 emissions from a gen-set.

II. DESCRIPTION OF PROJECT ACTIVITIES

Activity 1: Upgrade system to require minimal operator attention during running with additional controls and instrumentation. Test the unit on several biomass fuels at varying loads and producer gas substitution rates to determine optimum system performance. Target twelve 8 – 24 hour tests.

Budget: $100,000

The goals of Activity 1 are to design and implement an optimized control system to minimize operator requirements, diesel fuel consumption and emissions while maintaining steady operation on varying producer gas/diesel ratios. The optimized system will allow the demonstration of advanced combustion modes. Short term testing will be conducted while monitoring system performance and emissions. Concurrently we will develop collaborations with two sites for the subsequent field testing.

Outcome	Completion Date
1. Install the gasifier/generator platform at UMN Center for Diesel Research laboratory. Acquire necessary permits and make electrical connections.	*8/01/2014*

2. Update Controls, add in-cylinder pressure measurement capability and optimize system performance	*4/30/2014*
3. Test the unit on various fuels at several loads and producer gas substitution rates while recording emissions and performance data – target 12 tests of 8-24 hours each.	*5/31/2015*
4. Process and analyze on-site data	*6/30/2015*

Activity 2: Extended operation testing at 2 selected field locations to verify lab results in real world situations. Each location would be able to provide a local different local source of biomass to run in the gasifier. **Budget: $75,000**

The goals of Activity 2 are to locate the unit at two different field sites and conduct extended demonstration tests at each while running on local fuels of opportunity. Performance data will be logged throughout the demonstration while emissions data will be collected several times over the period of the testing.

Outcome	Completion Date
1. Install PowerTainer at field site 1 – determine and acceptable site, resolve any code and or permitting issues, make electrical connections	*7/31/2015*
2. Complete endurance test 1 – target 500 hour endurance run with performance monitoring and intermittent emissions testing.	*11/30/2015*
3. Install PowerTainer at field site 2 – move unit to a second site with a different locally available biomass.	*12/31/2015*
4. Complete endurance test 2 – repeat 500 hour endurance run	*4/30/2016*
5. Process and analyze field data, compile complete data set and prepare final report	*6/30/2016*

III. PROJECT STRATEGY

A. Project Team/Partners

The group led by Darrick Zarling, project director, Scientist, University of Minnesota; includes Prof. David Kittelson Director, Center for Diesel Research and Frank B. Rowley Professorship in Mechanical Engineering, University of Minnesota; James Barbour, Scientist, University of Minnesota Morris (UMM) and Bear Kaufman, Chief Technical Officer, ALL Power Labs, a state of the art gasification company.

B. Timeline Requirements – 2 Years

One year for improving and optimizing the system and laboratory testing and reporting. One year for siting and demonstrating of the unit at two field locations followed by two months for the final data analysis and reporting.

C. Long-Term Strategy and Future Funding Needs

The vision for this project is to provide a platform for distributed renewable generation of electricity. This site specific energy platform would combine gasification with a reciprocating internal combustion engine powered generators and have a significant potential for deployment in industry as well as municipal and other public venues. This concept was expanded to include possible application with many biomass feedstocks that have the potential to allow the use of renewable energy to manage carbon emissions. This gives credence to the ideas of creating local bioenergy ecosystems and sustainable communities. This proposal is continuing the work originally funded by the DOE-NETL.

2014 Detailed Project Budget

Project Title:Using Producer Gas from Fuels of Opportunity for Onsite Electrical Generation in Diesel Gen-Sets

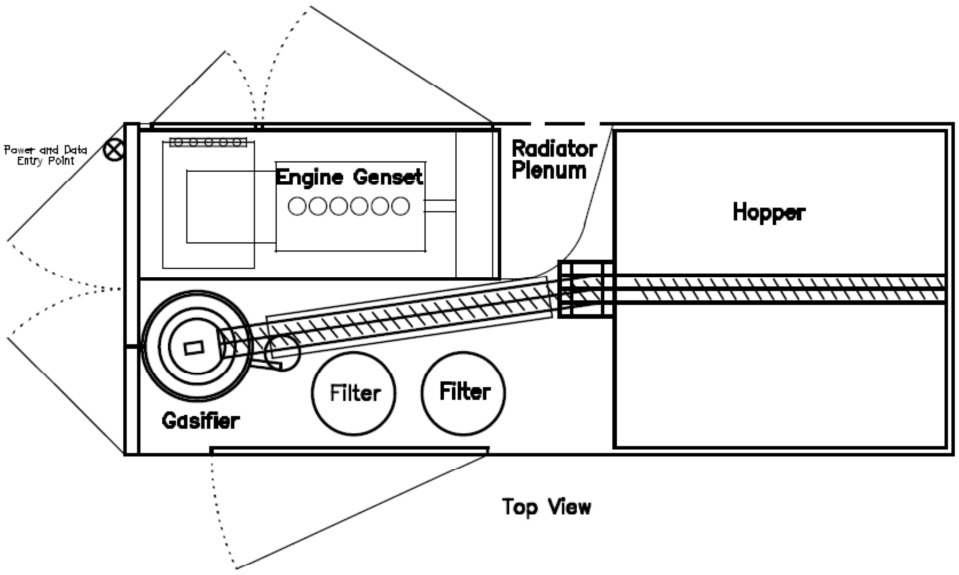
IV. TOTAL ENRTF REQUEST BUDGET [2] years

BUDGET ITEM	AMOUNT
Personnel:	$ 140,000
Scientist: Darrick Zarling, (45% for two years) $57,564 salary / $21,184 fringe	
Scientist: Jim Barbour (45% for two years) $35,009 salary / $12,883 fringe	
Professor David Kittelson: (5% for two years) $10,000 Salary / $3,360 fringe	
Contracts: All Power Labs - developer of prototype gasifier/engine/generator platform for the DOE project. They will provide the necessary technical support required to conver the gasifier to run on different fuels along with assisting in the implementation of any upgrades to the systyem.	$ 10,000
Equipment/Tools/Supplies: National Instruments data acquisition and contol hardware: $5,000, Kistler In-Cylinder Pressure and charge amplifier: $8,000, Mass air flow sensor: $880, Spare parts for gasifier and gen-set: $1,900 Fuel for gen-set and gasifier: 1000 gallons of diesel fuel, corn cobs and wood chips: $5,000	$ 20,780
Travel: Travel to field locations for set up, monitoring and emissions testing: Estimated 20 nights hotel: $2,000, 4000 miles - mileage: $2220	$ 4,220
	$ -
TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND $ REQUEST =	$ 175,000

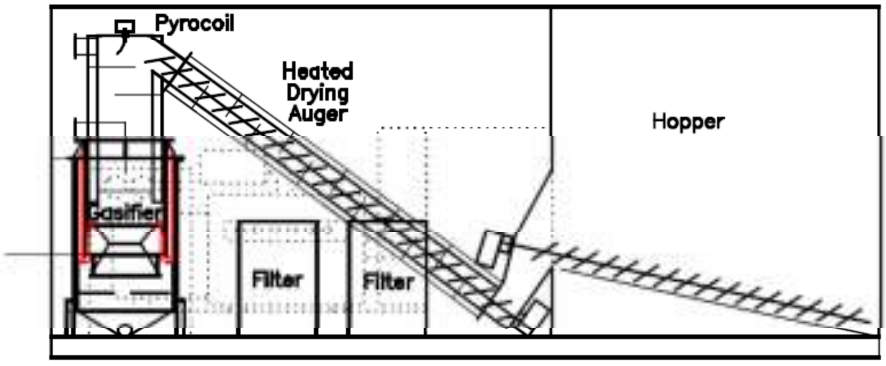
V. OTHER FUNDS

SOURCE OF FUNDS	AMOUNT	Status
Other Non-State $ Being Applied to Project During Project Period:	$0	
Other State $ Being Applied to Project During Project Period:	$0	
In-kind Services During Project Period:	$0	
Remaining $ from Current ENRTF Appropriation (if applicable):	$0	
Funding History: DOE-NETL Project $1,072,792 DOE share, Project total $1,637,278. overal project included the installation and testing of a 400 kW steam turbine that is not realted to this request, however, it is estiamted that 70% of the origianl project funds were directed towrads the development and testing of the prototype gasifier/engine/generator platform.	$1,146,095	

100 kW “PowerTainer” Prototype gasifier/engine/generator platform.



Top View



Side View

“PowerTainer” installed at UM Morris

Project Manager Qualifications

Darrick Zarling
Scientist
Center for Diesel Research
University of Minnesota

Project Manager Background

Mr. Zarling has over 15 years of experience in emissions control and emissions evaluations of diesel engines. He has assisted in the development and application of diesel exhaust filters, diesel oxidation catalysts, exhaust systems for explosive atmospheres and the development of high temperature filtration media. Since returning to the University of Minnesota in 2000 he has been involved in testing the use of biodiesel fuels in diesel engines, exhaust controls for emissions mitigation, and the development of instrumentation for emissions monitoring. He has also been the project manager for several laboratory evaluations of alternative fuels and currently serves on the State of Minnesota's Biodiesel Task Force.

Project Manager Responsibilities

As project manager, Mr. Zarling will be responsible for coordinating all aspects of the project. During each phase, he will communicate closely with Prof. David Kittelson. Prof. Kittelson has conducted an extensive amount of research concerning diesel engine combustion and emissions. Mr. Zarling will be responsible for selecting the field sites and arranging for the installation of the PowerTainer. He will assist in the emissions evaluation and durability test, analyze data and prepare reports. He will be responsible for disseminating the results of this work to state agencies, power companies, oil producers, suppliers of gen-set, and other interested parties.

Organization Description

The **Center for Diesel Research** is an independent research facility within the Mechanical Engineering Department at the University of Minnesota. The Center specializes in the physical and chemical characterization of exhaust emissions, evaluation of emission controls, evaluation and demonstration of alternative fuels, and the evaluation of control technology in the field.