Northwest Pennsylvania Biodiesel Fuel Adoption Project

Promoting the economic feasibility and adoption of available technology used to convert waste vegetable oil into a practical, economical, clean burning, and environmentally friendly fuel suitable for many purposes

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Pennsylvania Energy Harvest Grant Funds Requested $66,480

Executive Summary

In the year 2000, biodiesel became the only alternative fuel in the country to have successfully completed the EPA-required Tier I and Tier II health effects testing under the Clean Air Act. These independent tests conclusively demonstrated biodiesel's significant reduction of virtually all regulated emissions without posing a threat to human health. Increasing utilization of renewable biofuels would not only result in significant economic benefits to both urban and rural sectors, it also would reduce carbon dioxide emissions by up to 78.5% when compared with burning petroleum diesel. Biodiesel is a renewable energy resource since it can be produced readily, cheaply, and safely by the average person utilizing used vegetable oil which is commonly generated and disposed of as a waste product by thousands of restaurants and institutions. Conversion of this waste vegetable oil to biodiesel fuel has the potential to save money to both the businesses generating the oil and the farmers who could utilize the biodiesel fuel in reducing their overhead expense of producing our food supply. This project will promote the economic benefits and feasibility of that process, increase public awareness of the suitability of biodiesel as an alternative fuel, and stimulate pursuit of this technology by entrepreneurs generating economic benefits and producing energy.

Goals and Objectives

The goals of this project are:

1. Promote available technology to process waste vegetable oil into biodiesel fuel.
2. Evaluate and promote satisfactory performance of alternative renewable fuels in agricultural production and transportation as opposed to burning non-renewable fossil fuels to provide power for machinery.
3. Encourage private entrepreneurial efforts to adopt this technology to create economic benefits by creating production jobs or by reducing overhead costs of businesses in Pennsylvania.
4. Reduce quantity of waste vegetable oil to be disposed of and the associated costs of disposal paid by the businesses that generate the waste vegetable oil.
5. Reduce carbon dioxide emissions to the atmosphere by substituting the use of clean burning biodiesel fuel for conventional diesel fuel.
6. Reduce Sulfur Dioxide emissions to the atmosphere by substituting use of clean burning biodiesel fuel for conventional diesel fuel.
7. Reduce unburned Hydrocarbon emissions to the atmosphere by substituting use of clean burning biodiesel fuel for conventional diesel fuel.
8. Reduce carbon monoxide emissions to the atmosphere by substituting use of clean burning biodiesel fuel for conventional diesel fuel.
9. Reduce Particulate Matter emissions to the atmosphere by substituting use of clean burning biodiesel fuel for conventional diesel fuel.
10. Provide education to residents of eight counties in northwestern Pennsylvania to improve public awareness of air quality and energy policy issues.

The goals in this project will be attained by achieving the following objectives:

A. Secure funding resources to provide eight biodiesel production kits and make them available to host locations and real farmers that will actually produce biodiesel fuel to be used in real life working and production business situations, lowering energy costs and producing environmental benefits.

B. Contract with a technical service provider to supply host location personnel the applicable on the job training in the technical operation and safety procedures of the biodiesel production kits, and serve as process mentor and troubleshooter for the grant period.

C. Contract with eight host site locations, organizations, or individuals to demonstrate for public educational purposes the process of conversion of waste vegetable oil to biodiesel fuel suitable for use in any conventional diesel engine; to actually collect waste vegetable oil and produce biodiesel; and to utilize biodiesel fuel onsite or distribute biodiesel to real life work applications where successful use of the fuel may be documented to increase public acceptance of biofuels.

D. The eight demonstration sites at host locations in the member counties of the Penn Soil Resource Conservation and Development (RC&D) Area will collectively produce a minimum of 30,000 gallons of biodiesel fuel to be used for practical purposes during the grant period to gain consumer acceptance.

E. Publicize and report experience with this project to local media and information outlets. Promote the successful production operation and use of the biodiesel fuel at local events, county fairs, and other public events to encourage adoption of this alternative fuel and create demand for the fuel. Develop and distribute Biodiesel fact sheets for public events.

Statement of Need and Justification of Funding

Our system of transportation and most forms of horsepower utilized today in agricultural and industrial production are heavily dependent on the use of fossil fuels such as gasoline and diesel fuel. Fossil fuels are largely considered a non-renewable resource and are all too often imported from other countries creating a dangerous situation in which we must rely on foreign countries for oil that we depend on for our transportation, agricultural, and industrial needs. This shortsighted and dangerous energy strategy is not only unnecessary, but it prevents the efficient development of a more sustainable energy program which would not only reduce our risk, but create much needed economic benefits to the industrial, commercial, and agricultural sectors. In addition, the production of more sustainable alternative fuels, such as Biodiesel, benefits all citizens by reducing air and water pollution.

Northwest Pennsylvania Biodiesel Fuel Adoption Project

Biodiesel is a recognized and registered alternative fuel that shows great promise and improvements in air quality by utilization in place of the more common petroleum diesel fuel. Biodiesel is registered as a fuel and a fuel additive with the EPA and meets clean diesel standards established by the California Air Resources Board (CARB). The U.S. Energy Department and the U.S. Department of Transportation have designated B100 (100% biodiesel) as an alternative fuel. The American Society of Testing and Materials (ASTM) established the D6751 standard and specifications for Biodiesel in 2001, and the National Biodiesel Board now provides oversight and issues a "Certified Biodiesel Marketer" seal which will provide added assurance to customers and manufacturers that the biodiesel marketed under this seal meets fuel quality standards and the supplier will stand behind its products.

A 1998 biodiesel lifecycle study, jointly sponsored by the US Department of Energy and the US Department of Agriculture, concluded biodiesel reduces net CO^2 emissions by 78 percent compared to petroleum diesel. This is due to biodiesel's closed carbon cycle. The CO^2 released into the atmosphere when biodiesel is burned is recycled by growing plants, which are later processed into fuel. Is biodiesel safer than petroleum diesel? Scientific research confirms that biodiesel exhaust has a less harmful impact on human health than petroleum diesel fuel. Biodiesel emissions have decreased levels of polycyclic aromatic hydrocarbons (PAH) and nitrited PAH compounds that have been identified as potential cancer causing compounds. Test results indicate PAH compounds were reduced by 75 to 85 percent, with the exception of benzo(a)anthracene, which was reduced by roughly 50 percent. Targeted nPAH compounds were also reduced dramatically with biodiesel fuel, with 2-nitrofluorene and 1-nitropyrene reduced by 90 percent, and the rest of the nPAH compounds reduced to only trace levels.

With all these designations, one might wonder what the holdup is in bringing this technology to the front burner and promoting widespread production and use. For the most part, the limitations of its use are only effected by the lack of awareness of the general public and those in industry that just don't know enough about the process or the product to trust it in their particular application. This project will address this issue by successfully demonstrating the conversion of waste vegetable oil commonly used and disposed of by many local restaurants and kitchens across the country to a useful biodiesel fuel that can be used in any diesel powered engine. With agricultural commodity prices near record lows and petroleum prices near record highs, the timing appears right to generate a great deal of interest in this process from all sectors.

The process of conversion of waste vegetable oil to biodiesel fuel will be accomplished by using the process of transesterification. Basically the process involves removing the fatty acids from organic oil by setting up a chemical reaction utilizing methanol and lye as the reagents. The fatty acids are separated from glycerine which can be utilized in soap making, and is easily separated from the pure biodiesel fuel at the completion of the reaction process.

The process is reasonably simple, economical, and safe, as long as proper procedures are followed and safe equipment and components are used. The process has been randomly

demonstrated by various individuals or organizations across the country, however, this project will endeavor to successfully demonstrate the available technology and its application in a concentrated, closely supervised regional approach that will generate much public awareness of the economics and feasibility of the process. This approach will foster increased adoption of the technology and multiply the benefits to the environment and the air quality in northwestern Pennsylvania.

To carry out the project as described above, it is essential to involve the expertise and support of someone who has successfully used and directly managed this process. It is anticipated that this role would be filled by a college, private individual or business that would assist in selecting quality components for the production kits, provide proper safety and production training at the host location, and serve as process consultant, mentor, and troubleshooter for the host locations during the contract period.

Partnerships

Partnerships in this project will be crucial. Several Conservation Districts have already expressed their interest and commitment to the project by offering to serve as one of the host locations for the biodiesel demonstrations. Two agricultural producers have already volunteered to host a production unit at their farm or participate in the project by using the fuel produced at another location. Letters of support are included in the grant application package.

The eight host locations will be providing matching dollars or in kind services to the project. The requirements placed on the host location will be to provide staff time and labor to arrange for the collection of waste vegetable oil from local sources, conduct or oversee the actual transesterification process, furnish a diesel engine to actively promote the practical use of the biodiesel fuel produced, and to keep production records of fuel produced and used. In addition, each host location will be required to host a minimum of six public field days or promote the process at a minimum of six public events hosted by other organizations. This could include public field days, organized group events, tours, and meetings on site to explain and demonstrate the process. It could also include transporting the unit to a public event such as a county fair and providing live demonstration, utilizing a prepared photo exhibit, or a combination display.

Sufficient quantity of the necessary reagents will be supplied at the startup of the project to provide for the training and learning the operation of the production kit. This is expected to produce about 250 gallons of biodiesel fuel for use in the demonstration. The host will then provide the reagents and waste vegetable oil to make the biodiesel fuel for the life of the project, once the initial supplies are exhausted. Collectively, the eight locations will produce a minimum of 30,000 gallons of biodiesel fuel for practical application purposes during the grant period.

Work Plan with Schedule

Once funds are secured for the project, a contract will be developed for the project oversight within 60 days. Preliminary discussions have been held with Matt Steiman, Program Manager of the Richard Alsina Fulton Center for Sustainable Living at Wilson College, Thomas Reynolds, Director of the Robert A. Macoskey Center for Sustainable Systems Education and Research at Slippery Rock University, Joseph Perez, Senior Scientist in the Chemical Engineering Department at the Pennsylvania State University, and Gregory Boulos, MS in Sustainable Systems and Director of Education and Programming for Steel City Biofuels.

All have indicated that they would be willing to provide limited support to the project. Matt Steiman has five years experience producing biodiesel fuel using the transesterification process, and has agreed to serve as overall project consultant and provide training and serve as a resource to other contractors participating in the project. Gregory Boulus has indicated an interest in serving as the primary contractor for working with the eight host locations to setup and deliver the biodiesel production units. Due to privacy concerns, Federal Employer Identification Numbers will be provided upon a successful grant award and prior to entering into the contract. All contracts will be subject to DEP approval before award.

Acquisition of biodiesel production kits will commence within 90 days from the time a contract is awarded with all eight units to be delivered to the host locations within one year from the award of the contract. Host locations will carry out the program at a minimum for the remaining grant period, but hopefully beyond the grant period for extended educational, environmental, and economic benefits.

The tentative schedule for the proposed project stages would look something like this:

Receive grant award	November, 2006 to January, 2007
Develop acquisition & oversight contracts	January to March, 2007
Select eight host locations for biodiesel units	March to May, 2007
Deliver kits; provide training & reagents to hosts	March 2007 to March, 2008
Host continues production and education program, Hosts field days, generate public awareness	January 2007 to January 2009

Proposed Project Summary Statistics

Biodiesel contains no sulfur or aromatics, and use of biodiesel in a conventional diesel engine results in a substantial reduction of unburned hydrocarbons, carbon monoxide, and particulate matter. A U.S. Department of Energy study showed that the production and use of biodiesel, compared to regular petroleum diesel, resulted in a 78.5% reduction in carbon dioxide emissions. In addition, the production of biodiesel fuel results in a net energy gain of 3.24 units of energy, whereas, petroleum diesel production results in an

overall net energy loss. For every unit of energy used to produce a gallon of petroleum diesel fuel, only 0.7 units of energy are returned.

It is difficult in a demonstration such as this to quantify the exact amount of pollutants reduced by switching from one fuel such as No. 2 Diesel to another blended or alternate fuel such as biodiesel because of variable engine size in horsepower, different dates of manufacture, operating workload, engine use on highway or off road conditions, and the time period the engine runs.

Diesel engines are rated by grams of emissions per brake horsepower per hour units. For example, a new, clean burning, diesel engine designed for bus usage, would certify at 0.1 grams per HP per hour. A typical bus engine runs about 300 horsepower. So, in one hour of city driving, a 300 HP diesel bus engine will emit, on average, 30 grams of hydrocarbon. Since one pound equals 453.6 grams, it would take that bus 15 hours and seven minutes operating time to emit one pound of hydrocarbons to the atmosphere.

One unit of horsepower is defined as the force necessary to move 550 pounds in one second or 33,000 foot-pounds of work every minute. So, imagine a horse raising coal out of a coal mine. A horse exerting 1 horsepower can raise 330 pounds of coal 100 feet in a minute or 33 pounds of coal 1,000 feet in one minute, or 1,000 pounds 33 feet in one minute. You can make up whatever combination of feet and pounds you like. As long as the product is 33,000 foot-pounds in one minute, you have one horsepower unit.

The standard emissions for number two diesel fuel according to EPA studies are: Hydrocarbons 0.1 g/bhp-hr; Carbon Monoxide 2.6 g/bhp/hr; Nitrogen Oxides 4.8 g/bhp/hr; Particulate 0.2 g/bhp/hr; and Carbon Dioxide 564 g/bhp/hr

To make any kind of comparison of fuel emissions produced, or pollutants reduced, some assumptions need to be made concerning the equipment used. For this example, it is assumed that the diesel engine is a 50 horsepower tractor engine. Therefore, burning number two diesel fuel, the tractor exhaust would contain about 5 grams of HC, 130 grams of CO, 240 grams NOx, 10 grams Particulate, and 28,200 grams carbon dioxide per hour of engine running time. Assuming 10 hours running time per day, seven days per week, and converting the pollutants to pounds, in one year, the pollutants released into the atmosphere would be approximately 40 pounds Hydrocarbons, 1043 pounds of Carbon Monoxide, 1925 pounds of Nitrogen Oxides, 80 pounds of Particulate, and 226,296 pounds of Carbon Dioxide.

If the same tractor were burning B100 (100% biodiesel fuel) for the entire year, the comparative emissions would be: 13.2 pounds unburned Hydrocarbons, 542 pounds of Carbon Monoxide, 2117 pounds of Nitrogen Oxides, 42 pounds of Particulate, and 48,653 pounds of Carbon Dioxide. As you can see, the real potential in reducing air pollution is getting more individual operators to switch from number two diesel to B100 or even a blended fuel such as B20 or B40 biodiesel based on the results of our project.

This project is structured to produce a minimum of 30,000 gallons of B100 biodiesel, however, it is likely that this minimum production estimate will be far exceeded once the project is operating successfully and the host sponsor will most likely continue the project long after the completion of the grant contract period. The minimum energy value of the fuel produced during the grant contract period is estimated to be 223,968.6 brake-horsepower-hours, or 570,000,000 BTU. Utilizing the EPA emission standards for Number two diesel fuel we can conclude that if we were burning 100% number 2 diesel fuel, emissions would be produced in the following amounts: Unburned Hydrocarbons 49.35 pounds, Carbon Monoxide 1283.7 pounds, Nitrogen Oxides 2370 pounds, Particulate Matter 98.7 pounds, and Carbon Dioxide 278,479.5 pounds.

Substituting the use of B100 biodiesel fuel for the number two diesel fuel, we would achieve reductions of 67% in unburned Hydrocarbons, 48% in Carbon Monoxide, 47% in Particulate Matter, and 78.5% of Carbon Dioxide. A slight increase up to 10% in Nitrogen Oxides would result, however, Sulfate emissions would be virtually eliminated and this would allow the use of Nitrogen Oxide control technologies that can not be used with conventional diesel. The reduction of these pollutants being released into the atmosphere not only provides air quality benefits and slows global warming, but also means that these pollutants are not available in the atmosphere to come back to earth and enter our water table as acid rain. This means that additional benefits will accrue to water quality of our lakes, rivers, streams, and groundwater.

Measurable Environmental and Economic Results and Benefits from the project that will be tracked

Number of gallons of waste vegetable oil converted to useful biodiesel fuel, rather than disposed of in a landfill as a waste product
Number of gallons of biodiesel fuel produced for adoption purposes
Number of gallons conventional petroleum diesel fuel saved
Dollars saved by use of biodiesel instead of purchased petroleum diesel
Dollars generated by sale of biodiesel fuel
Energy units gained by biodiesel production compared to petroleum diesel production
Carbon Monoxide emissions reduced
Carbon Dioxide emissions reduced
Particulate Matter emissions reduced
Unburned Hydrocarbon emissions reduced
Number of consumers evaluating Biodiesel Fuel
Number of satisfied consumers adopting Biodiesel Fuel

Equipment Disposition

There will be no equipment to dispose of at the end of the grant period. All items purchased are considered supplies and component materials necessary for the biodiesel conversion process. Penn Soil RC&D has established a threshold value of $5000 for any purchases to be considered as equipment. The biodiesel production kits will remain property of Penn Soil RC&D throughout the grant period so that management of the kits may be transferred to another host if the requirements of the host contract are not being fulfilled to meet the grant objectives. The production kits may become the property of the host location at the conclusion of the grant period by mutual agreement with Penn Soil RC&D and the host.

Budget

Energy Harvest funds in the amount of $66,480.00 are being requested for the project. The bulk of the funding requested will be used for purchase of component materials and assembly of the eight production kits and for the support contract for training and oversight of the host locations. The following budget summary is provided here for general information.

Pennsylvania Energy Harvest Funds Requested	
Assembly & Delivery of 8 Biodiesel Production Units @ $5450 each	$43,600.00
Staff Salary, Administration & Travel	$ 2,780.00
Portability trailer kit for Education, Field Days, Meetings	$ 1,700.00
Equipment & Supplies	$ 5,600.00
Contractual. Assistance for Technical Training ($1,600 per unit estimated)	$ 12,800.00
	$ 66,480.00
Matching Funds	
Expected 100% Match from eight Host Locations and Cooperators	$ 69,000.00
Total Project Cost	$135,480.00

The Penn Soil RC&D Council serves eight northwestern Pennsylvania counties. The project is structured to establish eight production units to promote the adoption of the Biodiesel fuel throughout the eight counties. We are planning on allotting one stationary unit per county and have asked for the funding to create a mobile unit which can better be utilized at county fairs and other public events to achieve benefits in all eight of the counties we work with. Our project team feels that this is the most efficient scope of the project to work with; however, if grant funding were an issue, we would be willing to consider scaling the project back to a lesser number of units. For this reason, we have provided unit prices in our budget wherever feasible.