EERC
Energy & Environmental Research Center

UNIVERSITY OF NORTH DAKOTA
15 North 23rd Street — Stop 9018 / Grand Forks, ND 58202-9018 / Phone: (701) 777-5000 Fax: 777-5181
Web Site: www.undeerc.org

October 31, 2008

Ms. Karlene Fine
Executive Director
North Dakota Industrial Commission
ATTN: Renewable Energy Development Program
600 East Boulevard Avenue
State Capitol – Fourteenth Floor
Bismarck, ND 58505

Dear Ms. Fine:

Subject: EERC Proposal No. 2009-0086

Enclosed please find an original and one copy of the proposal entitled "Mobile Biodiesel Production Facility." Also enclosed is the $100 application fee.

The Energy & Environmental Research Center (EERC) of the University of North Dakota is pleased to submit the subject proposal. The EERC is committed to completing the project as described in this proposal if the Commission makes the requested grant.

If you have any questions regarding this proposal, please contact me by phone at (701) 777-5149 or by e-mail at ddunham@undeerc.org.

Sincerely,

David J. Dunham
Research Engineer

Approved by:

Dr. Barry I. Milavetz, Associate VP for Research
Research Development and Compliance

DJD/sah
Enclosures

c/enc: Jeff Burgess, NDIC

MOBILE BIODIESEL PRODUCTION FACILITY

EERC Proposal 2009-0086

Submitted to:

Karlene Fine

North Dakota Industrial Commission
ATTN: Renewable Energy Development Program
600 East Boulevard Avenue
State Capitol – Fourteenth Floor
Bismarck, ND 58505

Amount Requested: $75,000

Submitted by:

David J. Dunham
Nathan J. Fiala

Energy & Environmental Research Center
University of North Dakota
15 North 23rd Street, Stop 9018
Grand Forks, ND 58202-9018

10/31/08

David J. Dunham, Project Manager

Dr. Barry I. Milavetz, Associate VP for Research
Research Development and Compliance

October 2008

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ABSTRACT

The objective of this Energy & Environmental Research Center (EERC) project is to develop a mobile biodiesel production facility that could bring biodiesel production to where feedstocks are grown. The proposed system will be capable of crushing feedstock seeds to obtain oil, combining that oil with alcohol and a base catalyst to form methyl esters and, finally, separating and washing the finished biodiesel in a continuous in-line processing system. The mobile facility will allow farmers to operate their equipment using crops they have grown as fuel. By eliminating seed and oil transportation costs, as well as refining costs, the fuel could be produced and sold cheaper than conventionally processed biodiesel.

In order to produce smaller quantities of biodiesel on a mobile platform, a new processing technology utilizing ultrasonic catalysis is proposed to reduce the time needed for transesterification. Testing the ultrasonic equipment is the primary focus of this proposal. Subsequent work will endeavor to integrate crushing, transesterification, and washing as a portable demonstration.

This proposal seeks to fund work from September 2009 to August 2010. The goal of this project is to make biodiesel from vegetable oil in a continuous-flow, bench-scale system with a capacity of up to 4 L/min. The biodiesel produced will be tested according to ASTM International standards. Funding of $75,000 provided by the North Dakota Renewable Energy Council (NDREC) will be matched the U.S. Department of Energy-sponsored EERC Center for Biomass Utilization® Program in the amount of $75,000 for a total project budget of $150,000.

PROJECT DESCRIPTION

Hypothesis/Background

Commercially available biodiesel is produced today in large batch reactors in factories with capacities up to 288,000 gallons per day (1). Biodiesel production economics have been studied, and the profit margin for this market is slim (2). Because harvested biomass feedstocks have to be transported to these facilities and refined biodiesel transported again to end user facilities, some of which may be the original farms, developing a mobile biodiesel factory capable of making biodiesel at a location where it is used has the potential to significantly reduce the cost of such fuels.

The primary problem with producing smaller amounts of biodiesel, as would be required in a mobile biodiesel factory, is the time currently required for the transesterification process. This time-consuming process limits biodiesel production to large batches, requiring big mixing tanks and reaction times on the order of several hours. New technology utilizing ultrasonic mixing is currently becoming available, and manufacturers of this equipment claim it can reduce reaction time from hours to seconds, allowing biodiesel to be produced in continuous inline processing systems, yielding fuel that is 99% pure (3). The literature confirms these claims (4, 5), but no information on pilot-scale or portable demonstration project results could be found. Multiple resources are available touting the advantages of using ultrasonic energy in the conversion of bio-oils to biodiesel in laboratory batch production (4–6). In contrast to this, minimal research has been undertaken in the area of continuous in-line flow ultrasonic biodiesel production. One study that was found indicated that an ultrasonic reactor system showed promise for continuous-

flow, industrial-scale biodiesel production but additional system design work would be required (7).

Commercialization

Bringing biodiesel production to where feedstocks are grown is not a new idea; however, the idea of an all-inclusive truck-mounted design that would travel to farms and produce fuel for on-site consumption is novel. Specifically envisioned here is a unit capable of crushing feedstock seeds to obtain oil, combining that oil with alcohol and a base catalyst to form methyl esters and, finally, separating and washing the finished biodiesel in a continuous in-line processing system. Several companies (Imerjent, Crystal Biofuels, Orbitek Inc.) currently offer small-scale, semiportable biodiesel production plants. Although these systems are portable, they are not designed for daily travel and do not have seed-crushing capabilities as the proposed project envisions.

Economics

B20 biodiesel (80–20 blend of conventional and biodiesel) is currently in highest demand amongst biodiesel users because it increases lubricity while still retaining the antigelling characteristics of petroleum-based fuels. One biodiesel-refining company reported that it was paying $2.70 a gallon for soybean oil, with $0.25 of that going to transportation of the oil (8). Since this fee does not include transportation of the finished product back to end users, it is conceivable that making biodiesel where feedstocks are grown could save up to $0.50 per gallon. This is approximately 11% of the current retail price of B20, which is $4.66 per gallon (9). Since farming is energy-intensive, an 11% reduction in fuel costs would offer significant financial benefits to farmers. In all actuality, a greater savings could be achievable as the farmer is only sacrificing the value that a seed crushing plant would pay him for his product. In adition, the

elimination of transportation costs to and from a separate crushing facility before refining would further decrease the bottom line.

Although fuel transport will be eliminated, there will be transportation costs associated with a mobile fuel system. The system will have fuel and upkeep costs associated with traveling between farms. Methanol and base catalyst will have to be shipped/transported to where biodiesel production is taking place. Depending on how much biodiesel a client orders, this could require a separate tanker truck. As system design is refined, the feasibility of having a complete system mounted on one truck will have to be evaluated. A mobile biodiesel system could be privately owned and operated or perhaps owned by a group of farmers as a cooperative venture. Additionally, with this technology, farms that do not otherwise grow oil crops and would not sell to large biorefineries could meet some of their own fuel needs by only growing enough oil crops to be self-sufficient.

Scope of Work

The design of a system to convert biomass to biodiesel in a completely portable continuous in-line biodiesel production facility will require the integration of three primary processes. The first process is the mechanical crushing of feedstock seeds to generate vegetable oil. The second process is the transesterification of oil with methanol under the influence of ultrasonic catalysis. The final process is the separation of the refined biodiesel from the glycerine by-product. Each of these processes will require further development before system integration can take place. Proof of transesterification using ultrasonic catalysis is the primary goal of this funding application. Specifically envisioned is the continuous-flow in-line production of biodiesel that meets ASTM D International 6751 standards at rates of up to 4 L/min.

Secondary work will focus on system integration and design feasibility. Specific questions that will be answered are as follows:

- Can all of the system components be loaded onto a single trailer?
- What are the consumable requirements (water, catalyst, methanol…)?
- How will the power requirements of a portable biodiesel factory be met?
- Can the crushing process be scaled down as this idea requires?
- How will the waste products be handled?
- How will the 80–20 blend be produced on-site?
- What is an optimum production rate?
- Will the system need to operate 24/7?

STANDARDS OF SUCCESS

Goals

The goal of this research project is to test the capabilities of ultrasonic processing in the production of biodiesel. In addition the project will investigate the economics of biodiesel production by a mobile unit and seeks to develop a system design based on the results of ultrasonic catalysis testing.

Funding will be used to evaluate the ultrasonic transesterification step by operating a bench-scale biodiesel production system with the hope of obtaining the following:

- Equipment
  - A 1000-watt, 20-kHz ultrasonic processor and controlling equipment with capacity of 0.25–4 L/min.
  - Fuel-handling equipment including pumps, tubing, heaters, valves, and tanks.
- Experiment goals

- Bench-scale biodiesel production.
- Continuous in-line flow production of biodiesel from precrushed vegetable oil.
- 98% or greater biodiesel purity.
- Biodiesel production in the range of 0.25 L/min for proof of concept.
- Proof of system reliability in continuous testing.
- Any biodiesel-related intellectual property.
- Experimental data confirming benefits of ultrasonic catalysis for biodiesel production prior to complete system demonstration.
- Finalize system size, design, and integration before pilot-scale testing of a 2-gallon/min (1000-gallon/8 hr) demonstration.

If the above goals can be reached, the first stage of research will be deemed successful. The next step in the development of a complete system would then be to develop the seed-crushing capability and method. This would be one of the goals set forth for a second year of developmental research and would be the topic of later funding opportunities along with the demonstration. The end product and objective of this research is to commercialize a mobile biodiesel facility and use it to produce more affordable fuel for North Dakota and world farmers. Decreasing fuel costs for farmers will stimulate our agriculture economy, keeping jobs in-state for our residents. Furthermore, development of a completely new biodiesel production system would be good exposure for our state in the race to obtain energy independence through renewable and alternative fuels.

Continuing Research

Research is needed to evaluate individual components of a portable biodiesel system as well as integration and demonstration of the overall system. Specifically, and perhaps of highest

importance is the testing and demonstration of the ultrasonic catalysis for the transesterification process. In addition, the following areas offer continuing research possibilities as the process is streamlined:

- Eliminating wash water from the system by means of an ion exchange filter or centrifuge to separate biodiesel from glycerine.
- Finding a source or use for the glycerine by-product.
- Seed-crushing systems.
- Gasification of waste biomass from the seed-crushing process in the hopes of providing power to the facility via a syngas/generator system.
- Gasification of waste biomass from the seed-crushing process in the hopes of synthesizing the methanol necessary for the process.
- Economics of selling the unused meal and screenings on feed markets.
- An alcohol-recycling system.
- Using ethanol as a reactant instead of methanol because of its availability, safer handling characteristics, and renewability.
- Using pyrolysis instead of a mechanical seed crusher, with products being the condensed vegetable oils and syngas.

Another intriguing spin-off to mobile biodiesel production would be to produce regular diesel on a mobile system using biomass feedstocks. Although this process is more complicated and many production-scale issues arise, the economic potential is much greater than the production of biodiesel. This concept is being evaluated and is a possibility for future proposals.

BACKGROUND/QUALIFICATIONS

Facilities/Fuel Research Experience

All research work will be performed at the Energy & Environmental Research Center (EERC) in Grand Forks, North Dakota. One of the EERC centers of excellence is the National Alternative Fuels Laboratory (NAFL). Past and ongoing NAFL research has covered the areas of renewable ethanol, urea production, and aviation-grade ethanol and JP-8 fuels. The experience gained through development of these processes as well as the many other EERC fuel-related projects will be helpful in development of a mobile biodiesel production facility. The center also has laboratory space set aside for fuel-related research as well laboratory and testing equipment to verify the quality of the biodiesel that is produced.

As was discussed in the hypothesis/background section, some research has been done in the area of ultrasonic biodiesel processing. A full review of this work has been completed, and the results are being used to narrow the focus of this project. Because no data could be found that prove that ultrasonic processing will work in a pilot-scale continuous-flow biodiesel production system, the project team will focus on this objective for Year 1 development.

Project Team

With a background in chemistry and mechanical engineering and work experience including bench-scale system design and operation, the principal investigator is suited to direct this project. The project team also includes investigators with backgrounds in mechanical, chemical, and electrical engineering. They will be called upon to provide expertise in the design, control, chemical process, and testing of the system. The project team is given below along with their respective backgrounds:

- Principal Investigator: David Dunham, B.S. Chemistry, B.S. Mechanical Engineering

- Senior Research Manager: Stanley Miller, M.S, B.S. Mechanical Engineering, B.S. Physics
- Research Manager: Grant Dunham, M.S. B.S. Mechanical Engineering
- Research Engineer: Chris Martin, PhD. Mechanical Engineering
- Research Engineer: Steve Wilmoth, B.S. Electical Engineering
- Research Engineer: Nathan Fiala, M.S., B.S. Mechanical Engineering
- Research Engineer: Ben Oster, B.S. Chemical Engineering

TIMETABLE AND MANAGEMENT

Twelve months of work has been budgeted to complete the goals of this project. Funding disbursement from the U.S. Department of Energy (DOE) through the EERC's Center for Biomass Utilization Program is expected in September 2009. It is anticipated that research will begin in September 2009, with work to be ongoing throughout the year. The final report will be submitted to DOE and the North Dakota Renewable Energy Council (NDREC) in August 2010. The work is expected to be carried out in the following time increments:

- September 09 – System Design and component ordering.
- November 09 – Component integration and system assembly.
- January 09 – Initial system testing and troubleshooting.
- February 10 – System testing and product analysis.
- July 10 – Final report preparation and submission.

Status update reports are planned after each month of work and will be submitted to the NDREC quarterly. Team meetings will be held to assure the project stays on schedule.

BUDGET

Because of the biomass renewable energy nature of this project and its potential to stimulate agriculture in the state of North Dakota, funding is sought from NDREC, as well as DOE for the first stage of system development. Research 1 research will focus on proving the effectiveness of ultrasonic catalysis mixing, with the end result being in-line continuous biodiesel production. Future research funds and cost share will be sought from interested investors and private industry beyond this scope of work. Interest from these parties is expected once the continuous in-line processing technology has been demonstrated. Financial backing is anticipated from the private sector including companies listed in previous sections of this proposal, biodiesel production equipment providers, and state biodiesel producers and users. Contacts have been made within the Northwood Mills LLLP vegetable oil production company in Northwood, North Dakota, in hopes of generating interest in the concept. Discussion has also been ongoing with Brandon Wall Farms in Northwood as a provider of feedstock and a possible site for a demonstration run.

This proposal seeks total funding of $150,000 for completion of proposed activities. The NDREC is asked to commit $75,000. The EERC Center for Biomass Utilization Program will supply the required 50% match of $75,000 (commitment letter enclosed in Appendix A).

A detailed budget and budget notes is included in Appendix B.

TAX LIABILITY

The EERC is part of the University of North Dakota, a tax-exempt entity.

CONFIDENTIAL INFORMATION

There is no confidential information contained in this proposal.

REFERENCES

1. Tremain, S., Ed. Commercial Biodiesel Production Plants. *Biodiesel,* Sept 29, 2008; National Biodiesel Board. www.biodiesel.org/buyingbiodiesel/producers_marketers/producers%20map-existing091708.pdf> (accessed Oct 2008).
2. Myint, L.L.; El-Halwagi, M.M. Process Analysis and Optimization of Biodiesel Production from Soybean Oil. *Science Direct,* Oct 9, 2008.
3. Hielscher. Ultrasound Technology, Oct 2, 2008 www.hielscher.com/ultrasonics/biodiesel_transesterification_01.htm> (accessed Oct 2008).
4. Singh, A.K.; Fernando, S.D.; Hernandez, R. Base-Catalyzed Fast Transesterification of Soybean Oil Using Ultrasonication. *Energy Fuels* **2007**, *21*, 1161–163.
5. Ji, J.; Wang, J.; Yu, Y.; Xu, Z. Preparation of Biodiesel with the Help of Ultrasonic and Hydrodynamic Cavitation. *Science Direct,* Oct 2, 2008.
6. Hanh, H.D.; Dong, N.T.; Okitsu, K.; Nishimura, R.; Maeda, Y. Biodiesel Production Through Transesterification of Triolein with Various Alcohols in an Ultrasonic Field. *Science Direct*, Oct 13, 2008.
7. Stavarache, C.M.; Maeda, V.Y.; Bandow, H. Ultrasonically Driven Continuous Process for Vegetable Oil Transesterification. *Ultrasonics Sonochemistry* **2007**, *14,* 413–17.
8. Timmerman, L. Can Biodiesel Compete on Price?" *The Seattle Times,* Feb 14, 2007. <http://seattletimes.nwsource.com/html/businesstechnology/2003470213_biodiesel10.html>.

9. Laughlin, M.D. *Clean Cities Alternative Fuel Price Report*; Alternative Fuels & Advanced Vehicles Data Center, July 2008. U.S. Department of Energy. www.afdc.energy.gov/afdc/pdfs/afpr_july_08.pdf> (accessed Oct 2008).

APPENDIX A

LETTER OF COMMITMENT

EERC
Energy & Environmental Research Center

UNIVERSITY OF NORTH DAKOTA
15 North 23rd Street — Stop 9018 / Grand Forks, ND 58202-9018 / Phone: (701) 777-5000 Fax: 777-5181
Web Site: www.undeerc.org

October 31, 2008

Ms. Karlene Fine
Executive Director
North Dakota Industrial Commission
600 East Boulevard Avenue
State Capitol – Fourteenth Floor
Bismarck, ND 58505

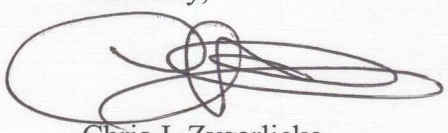
Dear Ms. Fine:

Subject: North Dakota Renewable Energy Council Application

This letter is in regard to the cost share provided by the Energy & Environmental Research Center (EERC) for "Mobile Biodiesel Production Facility", as proposed to the North Dakota Renewable Energy Council. The EERC will provide a 50% match of $75,000, contingent on award from the 2009 U.S. Department of Energy (DOE)-sponsored Center for Biomass Utilization® (CBU®). Availability of CBU funding is expected in early 2009 with awards sent Fall 2009; likelihood of funding is very strong, as the EERC has been receiving CBU program awards from DOE for 9 consecutive years.

If you have any further questions, please contact me by phone at (701) 777-5123 or by e-mail at czygarlicke@undeerc.org.

Sincerely,



Chris J. Zygarlicke
Deputy Associate Director for Research

CJZ/kal

APPENDIX B

BUDGET AND BUDGET NOTES

MOBILE BIODIESEL PRODUCTION FACILITY
NDIC RENEWABLE ENERGY DEVELOPMENT PROGRAM
PROPOSED PROJECT START DATE: 9/1/09
EERC PROPOSAL #2009-0086

BUDGET

CATEGORY			TOTAL		NDIC REDP SHARE		BIOMASS SHARE	
LABOR		Rate	Hrs	Cost	Hrs	Cost	Hrs	Cost
Dunham, D.	Project Manager	$ 26.00	766	$ 19,916	392	$ 10,192	374	$ 9,724
Fiala, N.	Principal Investigator	$ 26.78	150	$ 4,017	80	$ 2,142	70	$ 1,875
----------	Senior Management	$ 65.65	42	$ 2,757	-	$ -	42	$ 2,757
----------	Research Scientist/Engineer	$ 36.27	176	$ 6,384	88	$ 3,192	88	$ 3,192
----------	Research Technician	$ 23.45	59	$ 1,384	32	$ 750	27	$ 634
----------	Technology Dev. Mech.	$ 28.55	40	$ 1,142	-	$ -	40	$ 1,142
----------	Technical Support Services	$ 19.31	12	$ 232	-	$ -	12	$ 232
				$ 35,832		$ 16,276		$ 19,556
Escalation Above Base		6%		$ 2,150		$ 977		$ 1,173
TOTAL DIRECT HRS/SALARIES			1,245	$ 37,982	592	$ 17,253	653	$ 20,729
Fringe Benefits - % of Direct Labor - Staff		53.3%		$ 20,244		$ 9,196		$ 11,048
TOTAL FRINGE BENEFITS				$ 20,244		$ 9,196		$ 11,048
TOTAL LABOR				$ 58,226		$ 26,449		$ 31,777
OTHER DIRECT COSTS								
TRAVEL				$ 4,822		$ -		$ 4,822
EQUIPMENT > $5000				$ 17,000		$ -		$ 17,000
SUPPLIES				$ 20,000		$ 20,000		$ -
COMMUNICATION - PHONES & POSTAGE				$ 60		$ 41		$ 19
PRINTING & DUPLICATING				$ 50		$ 23		$ 27
OPERATING FEES & SVCS								
Process Chem. & Dev. Lab.				$ 1,960		$ -		$ 1,960
Graphics Support				$ 369		$ 362		$ 7
Shop & Operations Support				$ 54		$ -		$ 54
TOTAL DIRECT COST				$ 102,541		$ 46,875		$ 55,666
FACILITIES & ADMIN. RATE - % OF MTDC		VAR		$ 47,459	60%	$ 28,125	50%	$ 19,334
TOTAL PROJECT COST				$ 150,000		$ 75,000		$ 75,000

Due to limitations within the University's accounting system, bolded budget line items represent how the University proposes, reports and accounts for expenses. Supplementary budget information, if provided, is for proposal evaluation.

MOBILE BIODIESEL PRODUCTION FACILITY
EERC PROPOSAL #2009-0086

BUDGET - TRAVEL

RATES USED TO CALCULATE ESTIMATED TRAVEL EXPENSES

DESTINATION	AIRFARE	LODGING	PER DIEM	CAR RENTAL	REGIST.
Unspecified Destination (USA)	$ 950	$ 150	$ 64	$ 75	$ 525

PURPOSE/DESTINATION	NUMBER OF TRIPS	NUMBER OF PEOPLE	NUMBER OF DAYS	AIRFARE	LODGING	PER DIEM	CAR RENTAL	MISC.	REGIST.	TOTAL
Conference/Unspecified Dest. (USA)	1	2	4	$ 1,900	$ 900	$ 512	$ 300	$ 160	$ 1,050	$ 4,822
TOTAL ESTIMATED TRAVEL										$ 4,822

MOBILE BIODIESEL PRODUCTION FACILITY
EERC PROPOSAL #2009-0086

DETAILED BUDGET - EQUIPMENT

Ultrasonic processing unit	$ 17,000
Total Equipment	$ 17,000

MOBILE BIODIESEL PRODUCTION FACILITY
EERC PROPOSAL #2009-0086

DETAILED BUDGET - EERC RECHARGE CENTERS

			TOTAL
Process Chemistry. & Dev. Lab.	Rate	#	$Cost
GC (Hourly)	$43	43	$ 1,849
Subtotal			$ 1,849
Escalation		6%	$ 111
Total Process Chemistry & Dev. Lab.			$ 1,960
Graphics Support	Rate	#	$Cost
Graphics (hourly)	$58	6	$ 348
Subtotal			$ 348
Escalation		6%	$ 21
Total Graphics Support			$ 369
Shop & Operations Support	Rate	#	$Cost
Technical Development Hours	$1.28	40	$ 51
Subtotal			$ 51
Escalation		6%	$ 3
Total Shop & Operations Support			$ 54

BUDGET NOTES

ENERGY & ENVIRONMENTAL RESEARCH CENTER (EERC)

BACKGROUND

The EERC is an independently organized multidisciplinary research center within the University of North Dakota (UND). The EERC receives no appropriated funding from the state of North Dakota and is funded through federal and nonfederal grants, contracts, and other agreements. Although the EERC is not affiliated with any one academic department, university faculty may participate in a project, depending on the scope of work and expertise required to perform the project.

INTELLECTUAL PROPERTY

If federal funding is proposed as part of this project, the applicable federal intellectual property (IP) regulations may govern any resulting research agreement. In addition, in the event that IP with the potential to generate revenue to which the EERC is entitled is developed under this agreement, such IP, including rights, title, interest, and obligations, may be transferred to the EERC Foundation, a separate legal entity.

BUDGET INFORMATION

The proposed work will be done on a cost-reimbursable basis. The distribution of costs between budget categories (labor, travel, supplies, equipment, etc.) is for planning purposes only. The project manager may, as dictated by the needs of the work, incur costs in accordance with Office of Management and Budget (OMB) Circular A-21 found at www.whitehouse.gov/omb/circulars. If the Scope of Work (by task, if applicable) encompasses research activities which may be funded by one or more sponsors, then allowable project costs may be allocated at the Scope of Work or task level, as appropriate, to any or all of the funding sources. Financial reporting will be at the total-agreement level.

Escalation of labor and EERC recharge center rates is incorporated into the budget when a project's duration extends beyond the current fiscal year. Escalation is calculated by prorating an average annual increase over the anticipated life of the project.

The cost of this project is based on a specific start date indicated at the top of the EERC budget. Any delay in the start of this project may result in a budget increase. Budget category descriptions presented below are for informational purposes; some categories may not appear in the budget.

Salaries: The EERC employs administrative staff to provide required services for various direct and indirect support functions. Salary estimates are based on the scope of work and prior experience on projects of similar scope. The labor rate used for specifically identified personnel is the current hourly rate for that individual. The labor category rate is the current average rate of a personnel group with a similar job description. Salary costs incurred are based on direct hourly effort on the project. Faculty who work on this project will be paid an amount over their normal base salary, creating an overload which is subject to limitation in accordance with university policy. Costs for general support services such as contracts and intellectual property, accounting, human resources, purchasing, shipping/receiving, and clerical support of these functions are included in the EERC facilities and administrative cost rate.

Fringe Benefits: Fringe benefits consist of two components which are budgeted as a percentage of direct labor. The first component is a fixed percentage approved annually by the UND cognizant audit agency, the Department of Health and Human Services, and covers vacation, holiday, and sick leave (VSL). This percentage is applied to direct labor for permanent staff eligible for VSL benefits. The second component is estimated on the basis of historical data and is charged as actual expenses for items such as health, life, and unemployment insurance; social security; worker's compensation; and UND retirement contributions.

Travel: Travel is estimated on the basis of UND travel policies which can be found at www.und.edu/dept/accounts/policiesandprocedures.html. Estimates include General Services Administration (GSA) daily meal rates. Travel may include site visits, field work, meetings, and conference participation as indicated by the scope of work and/or budget.

Equipment: If equipment is budgeted, it is discussed in the text of the proposal and/or identified more specifically in the accompanying budget detail.

Supplies – Professional, Information Technology, and Miscellaneous: Supply and material estimates are based on prior experience and may include chemicals, gases, glassware, nuts, bolts, and piping. Computer supplies may include data storage, paper, memory, software, and toner cartridges. Maps, sample containers, minor equipment, signage, and safety supplies may be necessary as well as other organizational materials such as subscriptions, books, and reference materials. General purpose office supplies (pencils, pens, paper clips, staples, Post-it notes, etc.) are included in the facilities and administrative cost.

Subcontracts/Subrecipients: Not applicable.

Professional Fees/Services (consultants): Not applicable.

Other Direct Costs

Communications and Postage: Telephone, cell phone, and fax line charges are generally included in the facilities and administrative cost. Direct project costs may include line charges at remote locations, long-distance telephone, postage, and other data or document transportation costs.

Printing and Duplicating: Photocopy estimates are based on prior experience with similar projects. Page rates for various photocopiers are established annually by the university's duplicating center.

Food: Food expenditures for project meetings, workshops, and conferences where the primary purpose is dissemination of technical information may include costs of food, some of which may exceed the institutional limit.

Professional Development: Fees are for memberships in technical areas directly related to work on this project. Technical journals and newsletters received as a result of a membership are used throughout development and execution of the project by the research team.

Fees and Services – EERC Recharge Centers, Outside Labs, Freight: EERC recharge center rates for laboratory, analytical, graphics, and shop/operation fees are anticipated to be approved for use beginning July 1, 2008. Only the actual approved rates will be charged to the project.

Laboratory and analytical fees are charged on a per sample, hourly, or daily rate, depending on the analytical services performed. Additionally, laboratory analyses may be performed outside the university when necessary.

Graphics fees are based on an established per hour rate for production of such items as report figures, posters, and/or PowerPoint images for presentations, maps, schematics, Web site design, professional brochures, and photographs.

Shop and operation fees are for expenses directly associated with the operation of the pilot plant facility. These fees cover such items as training, personal safety (protective eyeglasses, boots, gloves), and physicals for pilot plant and shop personnel.

Freight expenditures generally occur for outgoing items and field sample shipments.

Facilities and Administrative Cost: Facilities and administrative cost is calculated on modified total direct costs (MTDC). MTDC is defined as total direct costs less individual items of equipment in excess of $5000 and subawards in excess of the first $25,000 for each award. The EERC Facilities and Administrative rate for commercial entities as proposed in this budget is 60%. The components are as follows: the approved federal rate is 50%; added to the federal rate is an increment of 10%. This increment represents calculated costs that exceed the allowable 26% federal cap on Administrative costs as well as depreciation/use allowance on buildings and equipment purchased with federal dollars.