TECHNICAL REVIEWERS' RATING SUMMARY

R008-H

Renewable Oil Refinery Pilot Plant Construction

Energy & Environmental Research Center
Principal Investigators: Chad Wocken, T.R. Aulich, and B.G. Oster
Request for $500,000; Total Project Costs $6,500,000

Rating Category	Weighting Factor	Technical Reviewer 4A Rating	4B Rating	4C Rating	Average Weighted Score
1. Objectives	9	5	4	4	39.00
2. Achievability	9	4	3	3.5	31.50
3. Methodology	7	3	3	3.5	22.17
4. Contribution	7	4	4	3	25.67
5. Awareness	5	4	4	4.5	20.83
6. Background	5	5	5	5	25.00
7. Project Management	2	3	3	5	7.33
8. Equipment Purchase	2	5	5	5	10.00
9. Facilities	2	5	3	5	8.67
10. Budget	2	5	3	5	8.67
Average Weighted Score		211	185	200.5	**198.83**
Maximum Weighted Score					**250.00**

OVERALL RECOMMENDATION

FUND	x	x	
FUNDING MAY BE CONSIDERED			x
DO NOT FUND			

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1. The objectives or goals of the proposed project with respect to clarity and consistency with North Dakota Industrial Commission/Renewable Energy Council goals are: 1 – very unclear; 2 – unclear; 3 – clear; 4 – very clear; or 5 – exceptionally clear.

Reviewer 4A (Rating: 5)
The objective is to build a small scale (100 barrel/day) oil refinery that uses renewable seed oils (i.e., crambe, camelina, soy, and corn) as its feed stock. Completion of this facility will allow further testing of the design's scalability and validate its economic viability. Overall, successful completion of the proposal will help promote the development of renewable energy sources within the state of North Dakota is it will provide a real (small commercial scale) facility for renewable fuel manufacturing within the state.

Reviewer 4B (Rating: 4)
The objective of the overall project is to construct renewable oil refinery facility at a pilot scale that would allow EERC personnel to further develop their patented biofuel refining technology for potential jet fuel production. The objective is very clear and well justified, and well in line with the NDIC/REC's goals of (1) promoting efficient, economic and environmentally sound development and use of North Dakota's vast renewable energy resources, particularly in the areas of wind energy, biofuels (ethanol & biodiesel), and biomass, and (2) encouraging and promoting the use of new technologies and ideas that will have a positive economic and environmental impact on renewable energy development and production in North Dakota. The specific objective of this proposal, although not clearly provided, is to request financial support for EERC personnel who will be working on this project.

Reviewer 4C (Rating:4)
The overall goal of the project is very clear: to construct a pilot facility based on "front-end engineering design" and patented catalysis technology to produce biobased jet fuels from oleochemical feedstocks produced by North Dakota farmers. A perfect score was not granted because no plans were developed to take advantage of North Dakota agriculture to provide oleochemical feedstocks to the facility for the near-term.

2. With the approach suggested and time and budget available, the objectives are: 1 – not achievable; 2 – possibly achievable; 3 – likely achievable; 4 – most likely achievable; or 5 – certainly achievable.

Reviewer 4A (Rating: 4)
Although the main objective is to build a renewable oil refinery pilot plant, the proposal lacked any detail in the timeline or the budget as to the actual construction process (other than to say it will take 1 year), which makes it hard to determine the achievability of the project.

With respect to the bid process (the part of the proposal to be financially supported by NDIC), the timeline was vague, but achievable. However, the timeline and the proposal did not specify what alternatives would be sought if a compatible general contractor could not be located within the specified timeframe.

As a side note, the proposal seems to indicate that the construction process could experience significant complications (i.e., a moderate portion of the NDIC's financial share is allocated to visiting the job site to insure the construction process is processing as planned). This suggests that the overall timeline could be jeopardized depending on the frequency and severity of the unforeseen construction problems.

Reviewer 4B (Rating: 3)
This is a construction project with an overall budget of $6.5 million. This proposal is part of the overall project and requests mainly salary costs of $500,000 for the EERC personnel working on the project. Without the details of the project construction arrangements with the contractors, it is difficult to see if the overall project to be achieved within the 18-month timeline even with the condition that this proposal is to be funded. However, the specific objective of this proposal, i.e., requesting support for EERC personnel working on this project, is achievable.

Reviewer 4C (Rating: 3.5)
I believe that the budget is reasonable, the expertise exists, and the team has been assembled for the proposed pilot-scale biorefinery facility to be assembled in an 18 month period via a "front-end engineering design." However, as described in the proposal, the funding to enable this $6.5 Million project is contingent upon the applicants receiving a $2.25 Million DOE "Center for Biomass Utilization" proposal and partner Accelergy raising $3.75 Million cost sharing. The latter adds some uncertainty for the overall project to be successfully completed. Moreover, it is not clear if the DOE grant was (or will be) awarded or not.

3. The quality of the methodology displayed in the proposal is: 1 – well below average; 2 – below average; 3 – average; 4 – above average; or 5 – well above average.

Reviewer 4A (Rating: 3)
The methodology to select a general contractor to build the Front-End Engineering Design (FEED) pilot plant seems consistent to other major construction projects. A major portion of the selection process is determining whether the General Contractor (GC) has the necessary skills and technical responsiveness, yet the method for doing so (i.e., how the technical competency of the GC is be evaluated was not provided). In addition, the actual process for selecting the GC cannot start until the completion of the FEED project, which is not scheduled to be completed until the 2nd quarter of 2010.

The proposal lacks contingency plans if an appropriate general contractor cannot be discovered and does not specify how the project will be advertised and/or whether it will be restricted to local/regional advertisement or be national search.

Reviewer 4B (Rating: 3)
The methodology in this proposal is fairly well developed and justified from multiple aspects such as technical, environmental, and economical for the overall project, or the infrastructure construction of an R&D / pre-commercialization facility. However, the methodology presented does not well validate the specific objective of this proposal. This reviewer would anticipate justifications on why this proposal is important to the overall project, and how the support from NDIC/ERC would further help the successful achievement of the overall project.

Reviewer 4C (Rating: 3.5)
The applicants have developed an exciting technological approach to convert oleochemical feedstocks into jet fuel, and have the necessary expertise in-house and with collaborators Accelergy (and their "Alliance") and Tesoro Mandam to scale up this technology. Therefore I feel the applicants will succeed in preparing the pilot facility.

However, the applicants have not demonstrated that their technological approach will work with high-erucic (long, C22,-chain) oleochemical feedstocks such as crambe oil as a sole feedstock source, or as a component thereof, to prepare jet fuels that meet military specifications. The requirements for pre-refining of crambe oil (e.g., degumming, deodorization, etc.) and/or of other feedstocks to accommodate the requirements of the CHI process (e.g., removal of phospholipids and other potentially harmful catalyst "poisons") have not been addressed.

4. The scientific and/or technical contribution of the proposed work to specifically address North Dakota Industrial Commission/Renewable Energy Council goals will likely be: 1 – extremely small; 2 – small; 3 – significant; 4 – very significant; or 5 – extremely significant.

Reviewer 4A (Rating: 4)
The greatest contribution would be the commercially viable, 'proof of concept' aspect. The proposal's objective of building a 100 barrel/day (1.7 million gallons/year), refinery would be on a scale much larger than any laboratory tests. Successful completion should give commercial investors confidence in funding even larger scale plants (up to 100 million gallons/year), in addition to optimizing the CHI-based process for oil production.

Reviewer 4B (Rating: 4)
The project will make very significant contributions to the goals of North Dakota Industrial Commission/ Renewable Energy Council. The overall project of R&D infrastructure construction is an important step towards commercialization of biofuels from locally available renewable resources. It is a project that represents a unique strength of EERC and would put North Dakota in a position of national leader in the technological development of biofuel refinery for advanced aviation fuels.

Reviewer 4C (Rating: 3)
I believe the proposed pilot scale facility will lead to many but not all of the Renewable Energy Council's goals. The preparation of the pilot facility will create employment in the near-term and can potentially lead to a growth of energy- and agriculture- related jobs. I believe the scaling up of a novel technology to produce biobased aircraft fuels is meritorious for the benefit of North Dakota and the USA.

In terms of economic assessment, the proposed facility has some unique advantages due to its location: reduced transportation costs of locally grown feedstock to the refinery and from the refinery to a potentially large local customer, the US military.

However, a major concern for the success of this project that has not been addressed is the supply chain of oleochemical feedstock, particularly crambe. Moreover, my concern is that after 18 months the proposed facility will be ready for operation, but will be sitting idle or will have to operate well below capacity due to an inability to procure a sufficient supply of feedstock.

The applicants state correctly that for their proposed facility to be economically viable, feedstock costs for oleochemical sources must be low relative to petroleum. In order for crambe to be cost-effective, co-product development from the feedstock is very important. The utilization of crambe meal is strongly deterred by the presence of glucosinylates, which are incompatible with its use as animal feed in many instances. This is an important aspect which needs to be considered for the successful implementation of crambe. In addition, the economic viability of crambe is also contingent upon the degree of pre-processing required to prepare the crude oil for the proposed CHI technological process.

The concept "[i]f we build it, they [suppliers of feedstock] will come" works well in the movies, but is not necessarily reliable philosophy for biorefinery planning.

5. The principal investigator's awareness of current research activity and published literature as evidenced by literature referenced and its interpretation and by the reference to unpublished research related to the proposal is: 1 – very limited; 2 – limited; 3 – adequate; 4 – better than average; or 5 – exceptional.

Reviewer 4A (Rating: 4)
A major concern to the long-term success of the project will be whether sufficient quantities of crambe and other low input industrial seed oils can be grown (ideally, near the refinery). The proposal attempts to address these major factors by expanding the scope of the proposal to include typical yield rates for ND, "the US Department of Agriculture estimates that 50 million gallon/year refinery would require 500,000 to 1,000,000 acres of crambe and/or other oil seed crops based on typical ND's yields." This indicates the PI's ability to consider secondary (indirect), aspects of the project to help ensure a success.

Reviewer 4B (Rating: 4)
Although it is not clearly stated/ documented in the proposal, this reviewer believes that PIs are well aware of the current research activities and other published information in this specific area.

This is partially because that EERC is the leader in this country in developing new technologies of biofuel upgrading and refinery for aviation uses. Besides, the nature of this project allows light coverage of the current research activity and published literature to demonstrate the PIs' awareness.

Reviewer 4C (Rating: 4.5)
I believe the core enabling technology to be scaled up at the proposed technology, the "CHI" process to catalytically de-oxygenate vegetable oils for conversion into jet fuels, is state-of-the-art. As a minor concern, it is not clear if the applicants are up to date on the overall economics of crambe utilization relating to an oleochemical biorefinery concept.

6. The background of the investigator(s) as related to the proposed work is: 1 – very limited; 2 – limited; 3 – adequate; 4 – better than average; or 5 – exceptional.

Reviewer 4A (Rating: 5)
The two principle investigators have been in the field of renewable oil refinery for many years, having published several papers, although it is unclear as to why the proposal requires to primary investigators.

Reviewer 4B (Rating: 5)
The PIs are research leaders in this area.

Reviewer 4C (Rating: 5)
The applicants and collaborators have the expertise to implement the "front-end engineering design" –based preparation and construction of the proposed facility.

7. The project management plan, including a well-defined milestone chart, schedule, financial plan, and plan for communications among the investigators and subcontractors, if any, is: 1 – very inadequate; 2 – inadequate; 3 – adequate; 4 – very good; or 5 – exceptionally good.

Reviewer 4A (Rating: 3)
Communication between the PI's and the GC should be very good given the proposed efforts to have a high level of communication between them. Since the project manager and the two PI's work for the same organization, communication between them should also be very strong. The financial project management plans seem sufficiently adequate for the scope of the project, while the schedule and milestone chart are too vague and do not address contingency plans and/or additional buffer time should the project experience delays.

Reviewer 4B (Rating: 3)
The project management plan, milestones /schedule, and financial plan are adequate. Plans for communications between the PIs and contractors are not well documented; arrangements of project activities with construction contractors and corresponding milestones are not documented. However, once again, this proposal is a part of the overall project.

Reviewer 4C (Rating: 5)
The milestone chart, schedule, and financial plan have been well prepared. The plan for communications among the investigators and subcontractors will be developed using technology of collaborator Accelergy; specifically, their "Alliance" partner Raytheon.

8. The proposed purchase of equipment is: 1 – extremely poorly justified; 2 – poorly justified; 3 – justified; 4 – well justified; or 5 – extremely well justified. (Circle 5 if no equipment is to be purchased.)

Reviewer 4A (Rating: 5)
No equipment is to be acquired using the NDIC's contribution to the project.

Reviewer 4B (Rating: 5)
The proposed activities in this proposal do hove have equipment involved, although the overall project does.

Reviewer 4C (Rating: 5)
No major equipment will be purchased with the proposed funds.

9. The facilities and equipment available and to be purchased for the proposed research are: 1 – very inadequate; 2 – inadequate; 3 – adequate; 4 – notably good; or 5 – exceptionally good.

Reviewer 4A (Rating: 5)
No equipment and minimal facilities are necessary for the aspects of the proposal pertaining to NDIC's monetary allocation. In addition, the actual build site is at the Tesoro Mandan petroleum refinery, which with has sufficient experience and capabilities to accommodate the FEED project.

Reviewer 4B (Rating: 3)
This proposal does not involve specific facility/ equipment. This reviewer assumes the facilities and equipment to be developed and installed is adequate for the R&D goals set by EERC.

Reviewer 4C (Rating: 5)
The necessary facilities are available in-house and/or through their collaborators, Accelergy Alliance.

10. The proposed budget "value"[1] relative to the outlined work and the financial commitment from other sources is of: 1 – very low value; 2 – low value; 3 – average value; 4 – high value; or 5 – very high value. (See below)

Reviewer 4A (Rating: 5)
NDIC's contribution is 8% of the total proposal. Given this proposal's main objective is to build a fully functioning renewable oil refinery pilot plant, its successful outcome is not only help provide new jobs and applications for ND's renewable resources (i.e., farmable seed oils), but will provide momentum for building larger scale facilities which will only continue to make North Dakota a leader in renewable energy production.

Reviewer 4B (Rating: 3)
This reviewer has difficulties in judging the significance of this proposal to the overall project due to the inadequate justification of this proposal to the overall construction project. It is assumed that technical details of the EERC technology are to be contracted out for engineering design and construction implementation. The role of EERC personnel may be "consultants" to ensure the accuracy of contractors' understanding of EERC's technology, and answer/discuss questions raised (this stage may be on going or even have passed). However, these are not well discussed in the proposal.

Reviewer 4C (Rating: 5)
The majority of budget is for salary support and travel of the project leaders, who will carry out the proposed work.

[1] "Value" – The value of the projected work and technical outcome for the budgeted amount of the project, based on your estimate of what the work might cost in research settings with which you are familiar.

10a. Financial commitment from other sources – A minimum of 50% of the total project must come from other sources to meet the program guidelines. Higher priority is to be given if the application has private industry investment equal to or at least 50% or more of total cost.

The minimum 50% cash match is demonstrated.

Section C. Overall Comments and Recommendations:

Please comment in a general way about the merits and flaws of the proposed project and make a recommendation whether or not to fund.

*Reviewer 4A **(Fund)***
Overall, the idea of building a pilot plant to refine renewable seed oils for fuel is a very exciting project. It is important to make sure laboratory "test stand," experiments can actually be scaled up to commercial scale sizes and to address any unforeseen problems while the size of the project is still manageable.

My main concerns/questions with the proposal are:

1) There currently isn't enough crambe or camelina being grown in the state to support a full scale operation and while NDSU is currently expanding its seed stock it's unclear as the time needed to achieve the 500,000 to 1,000,000 acres needed to support the 100 million gallon/year commercial scale refinery.

2) The authors seem to indicate that the refinery cannot currently compete against petroleum based refining methods, but that it may become a financially competitive option in the future. This raises the question as to who will support the plant operations while other facilities are more cost effective.

3) The proposal failed to indicate the expected lifetime of the plant and who would take possession of it once construction was finished.

4) The money requested from the NDIC was to be used to secure a general contractor for the actual construction process and ensure that the construction process followed the specified plans. While NDIC's contribution is ~8% of the budget, the amount of money being spent to facilitate the GC selection process seems high.

5) What will happen if EECR can't locate a suitable general contractor?

6) Why does the PI need to be on-sight 2-4 days/week during the build? Since the proposal wants to keep a PI at the build site, perhaps it would be better to keep the PI there 5 days/wk (bi-weekly trips) to reduce travel costs.

7) Another aspect was to take pictures of specific installations. Why can't that be picture taking process be part of the responsibilities of the GC? The FEED should include detailed schematics for installation. The GC should be able to follow those schematics and verify proper installation with digital pictures.

8) Since the PI's main responsibility seems to focus on technical support during the construction process, the need for two PI's seems inappropriate. This is further justified since the project also has a project manager to handle coordination with the GC and ensure milestones and timelines are adequately followed.

Reviewer 4B ***(Fund)***
This proposal is fairly well written. The overall project is based on PIs' patented work, the objective of the overall project is clear, and, with the funds from other partners in place, achievable. PIs have the expertise to conduct the work. It is this reviewer's discretion that the technology developed by the EERC leads the country in this area in the technology innovation and advancement. Successful accomplishment of the project will provide EERC the capability for engineering research and development of commercialization; will also put North Dakota in the nation's leading position in using locally available resources for advanced biofuel production and utilization. Thus, this reviewer recommends the project be funded.

Reviewer 4C ***(Funding May Be Considered)***
The objective of this proposal fits within a major project: to construct a pilot facility that can utilize oleochemical feedstocks, with crambe, a potential new US crop of relevance to North Dakota, being a key feedstock, for the manufacture of biobased jet fuels (and other co-products) at a scale of 1.7 million gallon per year, using patented ("CHI") technology developed by the applicant's organization that employs catalysis to remove oxygen atoms from the oleochemicals. The specific objective of this proposal is to enable the design and construction of the facility within 18 months via a "front-end engineering design" (developed in-house with collaborators WorleyParsons) by supporting the salary and travel expenses of the applicants who will oversee the bidding and construction process.

Strengths of the Proposal:

- The applicants have developed novel technology ("CHI") based on heterogeneous catalysis to convert oleochemical feedstocks into jet fuels via removal of the molecules' O atoms. The proposal involves the scale up of this process and its extension to crambe and other oils grown or obtained in North Dakota.
- The idea and ability to utilize an existent refinery (Teresoto Corp., Mandan, ND, facility) as source of utilities, process inputs (e.g., steam and hydrogen gas), and refinery expertise is strength of the project and an excellent source of savings for the project. (However, it is unclear why a letter of support from Teresoto was not included.) The integration of biorefineries with existent power plants or refineries is an excellent approach.
- The applicants have the necessary expertise to complete the project proposed to the Renewable Energy Council, the development of a pilot scale refinery facility based on "front-end engineering design" (with the assistance of collaborators WorleyParsons.
- The collaborator, Accelergy Corporation (and their "Alliance" of corporate partners and universities) provide the necessary expertise.
- The co-location of the pilot facility, the agricultural cultivation of the feedstock, and potential customers (i.e., the US military) in North Dakota will lead to reduced transportation costs.

Weaknesses of the Proposal:

- It is not clear if the applicants have secured an established supply of oleochemical feedstocks to meet significant biobased jet fuel production by the proposed facility.
- It is not clear (based on the information provided in the proposal) if the applicant's CHI technology will be effective in producing jet fuels that meet US Military requirements from the long-chain (C22) fatty acid source erucic acid, the major fatty acyl component of crambe oil. The information given in Appendix A involves "CHI"-based conversion of feedstocks enriched in C18 fatty acyl chains.
- It is not clear to what extent pretreatment of crambe oil (e.g., degumming and /or deodorization), or of other feedstocks, will be required to enable the successful CHI-induced conversion to occur, and to what extent the pretreatment will affect the overall process economics.
- The need to develop co-products from crambe (or other feedstocks) to improve the overall economics forthe process was not addressed. The presence of glucosinylates in crambe meal is a major hurdle in its utilization as animal feed (co-product).

- The overall project's ability to be initiated hinges upon the acceptance of a DOE "Center for Biomass Utilization" proposal.
- No letters of support were provided by WorleyParsons or Tesoro.