

TECHNICAL REVIEWERS' RATING SUMMARY

R003-B

Fischer-Tropsch Fuels Development

Submitted by Energy & Environmental Research Center

Principal Investigator: Bruce Folkedahl

Request for \$189,034; Total Project Costs \$899,820

<u>Rating Category</u>	<u>Weighting Factor</u>	<u>Technical Reviewer</u>			<u>Average Weighted Score</u>
		<u>3D</u>	<u>3E</u>	<u>3F</u>	
Objectives	9	3	3	4	30.00
Achievability	9	2	3	3	24.00
Methodology	7	3	4	3	23.33
Contribution	7	4	3	3	23.33
Awareness	5	5	4	2	18.33
Background	5	3	4	4	18.33
Project Management	2	7	3	5	10.00
Equipment Purchase	2	5	4	3	8.00
Facilities	2	4	5	5	9.33
Budget	2	5	4	4	8.67
Average Weighted Score		176	175	169	173.33
Maximum Weighted Score					250.00

OVERALL RECOMMENDATION

FUND	x
FUNDING MAY BE CONSIDERED	x
DO NOT FUND	x

R003-B
Promoting Fischer-Tropsch Fuels Development
Submitted by Energy & Environmental Research Center
Principal Investigators: Bruce Folkendahl
Request for \$189,034; Total Project Costs \$899,820

- 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 3D (Rating: 3)

The proposed project will utilize gasification technology to convert waste and biomass derived syngas for conversion to liquids such as transportation fuels. The proposed project is consistent with NDIC goals and purposes. A successful project would establish a new technology and products, producing jobs and taxes that would be of merit to the ND agricultural community.

Reviewer 3E (Rating: 3)

The objectives of this proposed project are to prepare pilot-scale equipment and to test Fischer-Tropsch (F-T) biomass-to-liquid (BTL) production. Specific objectives are: 1) Integrate the EERC continuous fluid-bed reactor (CFBR) to F-T system, 2) Shakedown and test the CFBR/F-T BTL system, 3) Produce and test iron-based F-T catalyst, 4) Develop an Aspen simulation model, and 5) Develop lab-scale upgrading and refining capability of the F-T liquids. The 12-month program includes 2 ½ months for system shakedown and testing. The budget includes 120 hours for operation of the CFBR during shakedown and testing. The concept is consistent with NDIC/REC goals and objectives.

Reviewer 3F (Rating: 4)

There was a limited discussion of the project impact but seems understandable given the scope of the proposal. FTL processing of biomass-derived syngas would certainly meet Council goals.

There are multiple ways to use biomass for renewable energy and it would be valuable to see some discussion of the proposed benefits of FTL processing over other conversion systems.

- 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 3D (Rating: 2)

The proposed project schedule is of one year duration. The effort includes purchase of equipment, modifications of an EERC reactor system, incorporating ductwork, and other control and reactor systems that appear to be a complex integration of equipment purchase and construction that must be completed before and significant research can be conducted. The project schedule appear be optimistic. It is suggested that a Gantt chart be defined showing milestones, thus providing more visibility to the NDIC PI, industrial participants and to other non-EERC participants. In addition, \$23,059 will be expended for travel that will require some manpower time loss that could impact the timely completion of the project.

Reviewer 3E (Rating: 3)

The objectives are likely achievable given the available approach, time and budget. EERC has a record of developing and testing continuous process units similar to the proposed BTL CFBR/FT system. If the project slips, then the BTL shakedown and operation phase is jeopardized.

Reviewer 3F (Rating: 3)

Details given are not sufficient to make a good judgment but the personnel and organizational experience with such systems make it seem likely.

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 3D (Rating: 3)

The EERC personnel are experienced engineers to design, construction and have some experience using small-scale F-T reactors. However, little information was provided on the selection of biomass, the biomass providers, or the test parameters. The PI indicated that commercial FT catalysts are available although expensive; hence, a FT catalyst will be developed by researchers at Brigham Young University which is funded via a separately funded EERC project. Considering the potential positive impact of a biomass-liquids production, the team should consider existing FT catalysts.

Reviewer 3E (Rating: 4)

The quality of the methodology is above average. EERC displays a high quality of methodology in drafting proposals.

Reviewer 3F (Rating: 3)

Described methodologies were very broad.

System testing description makes it seem as if this work is already being done – “evaluation of syngas cleanup devices being tested under separately funded projects.” How is this evaluation different than the current testing? What is being tested? Is it only sulfur levels?

“A range of test conditions will be determined” – it would help to discuss which parameters would likely be tested, why they are important, and how biomass-based syngas might be different than coal-based syngas.

“Catalyst Development” is listed as a goal but appears to be complete already. Production scale-up is all that was discussed. There was no detail given about how the catalyst production scale-up might occur.

Methodology section overall reads like somewhat expanded goals rather than a description of what would specifically be done to achieve those goals. Process simulation section had some more detail and was stronger.

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 3D (Rating: 4)

A commercial biomass-liquids production facility would provide another source of premium liquids that could provide an additional market for ND farmers. In addition, it could provide new jobs, taxes and additional economic development within ND. Environmental concerns would be of minimum concern with regard to air emissions, and carbon dioxide emissions would be minimal.

Reviewer 3E (Rating: 3)

The capability to evaluate North Dakota biomass feedstock in a BTL system will likely be beneficial and the information generated will likely be significant.

Reviewer 3F (Rating: 3)

Integrated system testing is valuable and necessary for process scale-up.

Catalyst production is also valuable but it is not at all clear how this catalyst is different than other commercial catalysts for FTL processing – other than the fact that other catalysts are expensive due to high royalty fees. There is no reason to believe that any catalysts developed here would not command the same royalty fees. It is therefore not clear how this piece benefits ND.

Development of a system model that allows the prediction of gas quality and processing needs based on feedstock input and rates would be highly valuable. It is not clear how distillation and hydrocracking of biomass-based FTL would be any different than what is done for coal-based FTL.

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 3D (Rating: 3)

The PI's resume indicated over 40 publications comprised of technical contract and symposium and journal articles. No references to external biomass-to-liquids or other professional published or journal articles.

Reviewer 3E (Rating: 4)

The principal investigator's (PI's) awareness of current and published literature is not evident in the proposal. However, the scientific and technical awareness of the PI and other key personnel are known to this technical reviewer to be better than average to exceptional.

Reviewer 3F (Rating: 2)

I would assume the PI and project team have extensive knowledge of current research activity but they showed little evidence of it in this proposal. There were no references cited and only vague acknowledgement of the extensive body of work already done on FTL processing. Indeed it would be difficult or impossible to summarize this in a short proposal but there was no indication how this work builds on previous work at EERC or elsewhere. It would be helpful to know what challenges might be expected with biomass-based systems and how they would differ from conventional coal-based FTL processing.

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 3D (Rating: 3)

Dr. Folkedahl has professional and industrial experience. He is also a PI for a \$1.6 MM Department of Defense contract to develop modular gasification systems.

Reviewer 3E (Rating: 4)

The backgrounds of the investigators are better than average to exceptional as related to this proposed work.

Reviewer 3F (Rating: 4)

Lists of publications would help to document expertise and experience.

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 3D (Rating: 2)

No management structure was presented. Management approach would be on a day-to-day basis to ensure individual activities meet project timely goals within budget. Suggest that a Gantt chart be prepared for each activity and provide the information on a quarter basis to the NDIC Project Manager and to the industrial participants. Strongly suggest that quarterly presentation be provided to the NDIC Project Manager and industrial participants.

Reviewer 3E (Rating: 3)

The project management plan is adequate. Additional project management tools are probably available. The proposal could be improved by including a statement of work, task summaries and milestone and project organization charts.

Reviewer 3F (Rating: 5)

Very well organized.

- 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 3D (Rating: 5)

No equipment would be purchased with NDIC funds.

Reviewer 3E (Rating: 4)

The proposed purchase of equipment is well justified.

Reviewer 3F (Rating: 3)

In some ways this is not applicable as 90% of the direct costs are for salaries and only \$4,000 is for supplies (none for “Equipment” specifically). All of the \$220,000 of equipment referenced in the proposal is paid for out of DOE project 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 3D (Rating: 4)

The EERC research facilities are known to be state of the art.

Reviewer 3E (Rating: 5)

The facilities and equipment at EERC are exceptional.

Reviewer 3F (Rating: 5)

Excellent record with gasification systems. Equipment and facilities appear to be very good.

- 10. The proposed budget “value” 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 3D (Rating: 5)

The proposed project is \$899,820. The DOE is providing \$710,786. The NDIC would be providing \$189,030 or roughly 25% of the total project cost.

EERC states that potential industrial partners include ICM Inc. (an ethanol production facility engineering company), Rentech Inc., (a catalyst develop), Great River Energy, and Falkirk Mining Company.

The potential industrial participants have not yet provided a financial commitment.

Reviewer 3E (Rating: 4)

The DOE share gives the proposed budget a high value. A higher value could be given if the application included private industry investment.

Reviewer 3F (Rating: 4)

There is a high value of the project outcome compared to the proposal cost. The only concern is that most of the costs for this portion of the project are salary and overhead. It seems that all of this work will be done anyway even if this portion of the project is not funded. Was the DOE project (funding match) not fully funded or has extra salary been added to that project? If so, what is the justification for it?

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 3D (Fund)

The Department of Energy is providing 75% of the total project cost and meets the “other source” program guidelines.

The proposed project will be employing existing technology (gasification, hot or warm gas cleanup) using biomass as a feedstock converted to syngas for production of liquid fuels. The successful project could be a tremendous benefit ND agriculture with reduced emissions such as carbon dioxide emissions and the more traditional air emissions.

The travel budget, at \$23,059 (NDIC providing \$4,612) seems excessive for a one year project. Considering that project is scheduled to be completed in one year, the proposed travel would lose roughly 30 man-days.

It is recommended that at least two oral progress updates, in addition to a final oral report, be provided to the NDIC Project Manager and interested industries at the ND Office of Renewable Energy & Energy Efficiency in Bismarck.

Reviewer 3E (Do Not Fund)

The proposal title, “Fischer-Tropsch Fuels Development” is very descriptive of the proposed project and the proposal's primary objective. The proposal describes a program to build a F-T reactor system and to integrate the system with the EERC CFBR. The renewable energy element, to use biomass-derived syngas during testing, appears as a secondary objective included as a means to meet NDIC/REC funding criteria.

This review has a number of questions concerning biomass, gasification, feedstock and the catalyst aspects of this project:

1. What North Dakota biomass feedstock has been identified for testing?
2. What ND biomass feedstock has been tested in the CFBR and what were the results?

3. What gasification BTL systems have been evaluated and tested?
4. Are there any commitments from ND biomass producers to provide feedstock or funding?
5. Does the candidate ND biomass require preparation prior to input into the CFBR system?
6. What are the chemical and physical properties of the biomass feedstock?
7. Will a computer aided economic/engineering model include biomass specific considerations?
8. Will the CFBR be air or O₂ fed, and what impact does this option have on downstream processing options and costs?
9. Does the EERC have water gas shift reactor (WGSR) capability with the CFBR?
10. Has catalyst processing criteria; such as activity, catalyst/oil ratio, conversion, efficiency, recycles, selectivity, space velocity or costs been established?
11. Have syngas and WGSR gas composition goals been established?

Franz Fischer and Hans Tropsch, working at the Kaiser Wilhelm Institute in the 1920s are the inventors of the Fischer-Tropsch process. Fischer and Tropsch filed a number of patents; including US patent no. 1,746,464, applied for in 1926 and issued in 1930.

This BTL concept merits consideration by NDIC/REC. However, specific ND biomass feedstock and biomass gasification issues should be resolved before an F-T catalyst evaluation and development program initiated.

Reviewer 3F (Funding May Be Considered)

The EERC obviously has a strong record working with gasification systems. If one did not know that, it would be more difficult to judge the actual merits of this proposal given the lack of technical detail in the background and methodologies sections. This is likely due to the limitations on proposal length but some discussion about potential differences between using coal and biomass for gasification and FT processing would have been very appropriate, especially given the references to integrating biomass with coal in ND gasifiers. The goals of the project are worthy but the baseline knowledge and/or gaps in knowledge were not adequately identified.

The only other concern is an apparent lack of transparency with the DOE funding. It would appear that the DOE project was funded and that they are now looking for additional dollars for the work that they are already doing. If the DOE project was not fully funded, it would be very valuable to know that. If it was fully funded, there should be justification for the need for additional personnel costs. This may be standard practice but is not clear to this reviewer.