

TECHNICAL REVIEWERS' COMMENTS

LRC-LXXIX-E:

"Pathway to Low-Carbon Lignite Utilization"

Submitted by: Energy & Environmental Research Center (EERC)

Request for: \$1,480,000; Total Project Costs: \$3,180,000

Principal Investigator: Michael Holmes

1. OBJECTIVES

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

Reviewer 16-07 (Rating: 4)

The objective of the proposed work is to continue development of a lignite-based Allam Cycle. Specific goals are to resolve key barriers of the lignite-based system; corrosion, impurity management, gasifier selection, and syngas combustor design. These objectives and goals are very clear and consistent with LRC goals; to promote efficient and clean use of lignite, preserve lignite jobs and create new jobs, and ensure economic stability and future growth in the lignite industry.

Reviewer 16-08 (Rating: 4)

The Allam cycle technology could be the basis for the next generation of lignite-fired power plants in North Dakota. If proven, this technology would significantly increase the efficiency of electrical generation, reduce emissions, and maintain or increase jobs and lignite utilization in the state. The proposed project is the next logical step towards proving the feasibility of a lignite-fired Allam Cycle power plant. As such, the NDIC/LRC goals are very clearly being met.

Reviewer 16-09 (Rating: 5)

The objectives as stated are key to the continued use of lignite for future power generation. This continued use of lignite is a primary goal of the NDIC/LRC.

2. ACHIEVABILITY

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 16-07 (Rating: 4)

The proposal states that the ultimate goal of the project is to conduct a series of laboratory, pilot plant, and modeling activities. Without specific goals in the areas of activity, the objectives will most likely be achievable. Are there specific goals – corrosion rates, syngas composition or \$/MMbtu, other costs?

Reviewer 16-08 (Rating: 5)

The proposal's approach, timetable, and budget all seem to be aligned, making the objectives highly likely to be achievable.

Reviewer 16-09 (Rating: 4)

The experience and expertise of the research team and the targeted objectives they plan to tackle combine to instill confidence that they are very likely to achieve the objectives in the time proposed.

3. **METHODOLOGY**

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 16-07 (Rating: 5)

The methodology displayed in the proposal is well above average. EERC has submitted another excellent proposal and developed a solid project.

Reviewer 16-08 (Rating: 4)

The approach and methodologies described in the proposal are very logical and well thought out.

Reviewer 16-09 (Rating: 4)

The layout of the tasks to meet the goals of this project are very good.

4. **CONTRIBUTION**

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

Reviewer 16-07 (Rating: 5)

Carbon dioxide is the highest priority for the industry. The entire fossil fuel industry is under attack by proposed CO2 emission standards.

Reviewer 16-08 (Rating: 4)

Identification of components and their characteristics that would meet the needs of an Allam Cycle plant and the expected performance and economics, will be a very important technical step towards commercializing the technology in North Dakota. Perhaps as important will be the identification of issues that become apparent as the project proceeds, these issue should be the basis for the “next steps” as stated in the proposal.

Reviewer 16-09 (Rating: 5)

If the barriers to the long term goal of being able to utilize lignite in the future for power generation cannot be overcome, the use of lignite will definitely decline.

5. **AWARENESS**

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 16-07 (Rating: 5)

The PI, key personnel and organization are exceptional as related to this project. Their knowledge of current research is demonstrated by attached information and referenced materials.

Reviewer 16-08 (Rating: 5)

The PI's grasp of research regarding the Allam Cycle appears to be very good and may be as complete as anyone in the world.

Reviewer 16-09 (Rating: 5)

Michael Holmes and the rest of the EERC staff have lots of experience in this area and seem very aware of the other research being conducted related to CO2.

6. **BACKGROUND**

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 16-07 (Rating: 5)

The background of the PI is exceptional.

Reviewer 16-08 (Rating: 5)

The resumes in the proposal indicate that the PI team has broad and detailed experience, covering all aspects of the proposal's various tasks.

Reviewer 16-09 (Rating: 4)

The staff at EERC has the varied background and past experience in very similar research to be able to address the challenges proposed in this project.

7. **PROJECT MANAGEMENT**

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 16-07 (Rating: 5)

The project management plan, proposed schedule, and financial plan are reasonable. According to Section 11, the project management plan is exceptionally good. The proposal structure connects objectives to specific goals to work tasks. The SOW construction easily leads to development of the project management tools (milestone chart, schedule, financial plan and communications).

Reviewer 16-08 (Rating: 3)

The management plan detailed in the proposal would appear to be adequate and should meet the needs for successful project completion.

Reviewer 16-09 (Rating: 4)

The EERC staff is well versed in performing projects of this type and has very good financial support from all the participating parties, especially 8 Rivers.

8. **EQUIPMENT PURCHASE**

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 16-07 (Rating: 5)

No comment.

Reviewer 16-08 (Rating: 2)

According to the proposal's budget, equipment purchases over \$5,000 will total only \$15,000 or 0.47% of the total budget. As such, this is an almost insignificant amount. However, while the budget amount may be minor, the clear listing of equipment to be purchased is lacking. The proposal's budget should include more detail/description of the equipment to be purchased. After all, the budget even has a line item for food totaling \$765.

Reviewer 16-09 (Rating: 5)

They appear to be utilizing existing equipment at EERC and computing faculties at both EER and 8 Rivers.

9. **FACILITIES**

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 16-07 (Rating: 5)

The facilities and equipment available thru EERC, BEPC and ALLETE are exceptionally good.

Reviewer 16-08 (Rating: 5)

The equipment and facilities at EERC identified in the proposal are world class and well suited to meet the research needs.

Reviewer 16-09 (Rating: 5)

EERC has an excellent set of facilities that match up very well to the project tasks described.

10. **BUDGET**

The proposed budget "value"¹ relative to the outlined work and the financial commitment from other sources² is of: 1 - very low value; 2 - low value; 3 - average value; 4 - high value; or 5 - very high value.

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.

² Financial commitment from other sources – A minimum of 50% of the total project must come from other than Industrial Commission sources to meet the program guidelines. Support greater than 50% from Industrial Commission sources should be evaluated as favorable to the application.

Reviewer 16-07 (Rating: 4)

The proposed budget exceeds the minimum matching requirements and provides access to additional knowledge and capability.

Reviewer 16-08 (Rating: 4)

Given the budget and matching funds as listed in the proposal, the state is being asked to contribute 46.5% of the total cost. This is including the in-kind services from 8 Rivers, ALLETE, and Basin. The state is being asked for 56.3% of the total cash in the project. Thus, the proposal is meeting the minimum of 50% requirement, but not by much. However, the proposal shows that 8 Rivers is a subcontractor who is being paid \$480,000. The proposal also lists 8 Rivers as contributing \$500,000 of in-kind services. This recommendation is based on the assumption that the \$480,000 is buying services not included in the \$500,000. Additional information needs to be provided to define and clarify the funds to and from 8 Rivers. If 8 Rivers' \$500,000 in-kind services are being paid for by the \$480,000 fee, then the requested state contribution would be above 50% and would not meet the NDIC guidelines.

Reviewer 16-09 (Rating: 4)

The contributions from other sources, both direct financial and in-kind services look very good related to the likely success of the project goals.

OVERALL COMMENTS AND RECOMMENDATION:

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 16-07 (Rating: FUND)

The proposed project exhibits some flaws and many merits including:

Flaws

- 1. The proposal does not contain specific quantified goals. Specific corrosion rates, syngas characteristics and costs, and overall system efficiency.*
- 2. A potential end user of the CO2 product could enhance the project. Will markets exist for CO2 and at what price?*

The proposed project exhibits many merits including:

- 1. The project includes key organization with unique and complimentary strengths.*
- 2. The proposal is well written, the project solidly organized and key personnel exceptional.*
- 3. The project addresses a significant need for the industry.*
- 4. Supercritical CO2 has unique properties. This project can demonstrate some of those properties.*

Reviewer 16-08 (Rating: FUND)

Overall, the proposal is very good and meets the NDIC's goals and guidelines, with only a few budget details that need additional explanation. The project would move the state's coal industry a step closer to technology that may become its future. As such, my recommendation is to fund the proposal; assuming the noted budget information is provided to the LRC Technical Advisor and is to his satisfaction. A challenge the project may face is what defines the best-fit current market components. It may be relatively easy and objective to select components based solely on technical design performance. However, industry needs the best performance for the money. A component at a much lower cost that would work might be better than an expensive unit that worked better. Perhaps listing the various models of a component that would all work along with a brief pro and con description would solve this issue.

Reviewer 16-09 (Rating: FUND)

The project targets barriers identified from previous research and is critical to the future lignite industry in North Dakota. I recommend to fund.