

## TECHNICAL REVIEWERS' COMMENTS

### LRC-LXIX(69)-B: "Partnership for CO<sub>2</sub> Capture – Phase II"

Submitted by: Energy & Environmental Research Center

Request for: \$150,000; Total Project Costs: \$1,860,000

Project Manager: Brandon M. Pavlish

Project Duration: 18 Months

#### 1. OBJECTIVES

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

##### **Reviewer 10-4 (Rating: 4)**

The overall objective is to further develop promising CO<sub>2</sub> capture technologies toward demonstration and commercialization. In addition, several specific objectives and four tasks are very clearly stated. These objectives are consistent with the NDIC/LRC goals.

##### **Reviewer 10-5 (Rating: 4)**

Carbon management from lignite-fired power plants will be a critical issue if regulations limiting CO<sub>2</sub> emissions are passed. Hence, technically viable and economic carbon management from lignite-fired power plants is crucial. Lignite is the major fuel source for power generation in North Dakota and is a key to North Dakota's economy. Therefore, the overall goal of the proposed research is consistent with the NDIC/LRC goals of sustaining lignite's economic viability.

##### **Reviewer 10-6 (Rating: 3)**

The objectives of the project are general and not specific. The goals are to test promising technologies identified in Phase I. However, specific examples were not included on what technologies will likely be evaluated. The Phase I program should have identified specific examples of technologies to move forward to Phase II. The proposal did not provide sufficient information on specific accomplishment in order to demonstrate the success of Phase I.

#### 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 10-4 (Rating: 3)**

These objectives are likely achievable given the time, budget and approach given. However, additional funding will be required for demonstration and commercialization of the promising technologies.

##### **Reviewer 10-5 (Rating: 2)**

The objectives are possibly achievable; however, the proposal is lacking in details to make this assessment. See Section C for more comments.

##### **Reviewer 10-6 (Rating: 3)**

The approach suggested involves the creation of a working group consisting of experts from the stakeholders to identify the optimum technologies for further modeling and demonstration testing. Without knowing the specific types of testing to be conducted and more information on the specific accomplishments of Phase I for the funding spent in Phase I the achievability is difficult to evaluate.

### 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 10-4 (Rating: 4)**

The quality of the proposal is above average. The proposal relates the overall objective, specific objectives and tasks to work activities and develops a reasonable statement of work.

#### **Reviewer 10-5 (Rating: 2)**

The methodology is lacking in details, especially for a \$1.9 million project. See Section C for more comments.

#### **Reviewer 10-6 (Rating: 3)**

The methodology is average, no specific examples of testing that could be performed based on Phase I results were included. Developing a working group of experts seems to be part of management and communication process of the project as a whole. A combined modeling and testing effort is a very good approach. More detail is needed in the proposal.

### 4. CONTRIBUTION

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

#### **Reviewer 10-4 (Rating: 5)**

The scientific and technical contribution of the proposed work could be extremely significant to address NDIC/LRC goals and needs. This is an area of critical need for the lignite industry in North Dakota.

#### **Reviewer 10-5 (Rating: 4)**

The results from this project, specifically those related to CO<sub>2</sub> capture when firing lignite, are very significant in addressing NDIC/LRC goals of sustaining the use of lignite in North Dakota.

#### **Reviewer 10-6 (Rating: 5)**

This project has the potential to provide extremely significant information the applications of CO<sub>2</sub> separation and capture technologies for lignite fired power plants. It is an extremely important program. The proposed effort appears to be aimed at addressing these issues and can make significant contributions.

### 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 10-4 (Rating: 5)**

The PIs do an exceptional job describing research, providing references and establishing an understanding of current activities.

**Reviewer 10-5 (Rating: 3)**

The project manager/principle investigator's awareness of current research activity and published literature is adequate.

**Reviewer 10-6 (Rating: 3)**

The principal investigator is aware of the current research activities. The proposal did not include any of the unpublished results of Phase I. Information is likely available on testing in Phase I but was not used to justify the research conducted in Phase II.

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 10-4 (Rating: 5)**

The background of the PIs as related to the proposed work is exceptional. The researchers have been involved in much of the work in this area.

**Reviewer 10-5 (Rating: 3)**

The background of the investigators is adequate. From the resumes, many of the investigators appear relatively inexperienced (i.e., young) with respect to CO<sub>2</sub> technologies; however, they have pilot-scale and other emissions experience and, according to the proposal, many/most of them were involved in Phase I of the 'Partnership for CO<sub>2</sub> Capture'.

**Reviewer 10-6 (Rating: 4)**

The principal investigator has several years of experience in a wide range of CO<sub>2</sub> separation and capture technologies.

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 10-4 (Rating: 4)**

The project management plan is very good. However, additional milestone graphs and charts could be provided and probably are available.

**Reviewer 10-5 (Rating: 2)**

With the exception of a figure showing those who are responsible for the various tasks, there is no project management plan. In addition, there is no milestone chart, schedule, and financial plan. The proposal is woefully lacking in any details, especially for a project \$1.9 million in size. See Section C for more details.

**Reviewer 10-6 (Rating: 3)**

The management plan is adequate for the project. Based on the nature of the project clear milestones cannot be developed.

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 10-4 (Rating: 3)**

The purchase of equipment is not detailed but the level and amount shown is justified and consistent with the level of funding.

**Reviewer 10-5 (Rating: 2)**

The proposal does not contain any justification for the purchase of equipment. The proposal does, however, provide a detailed list of the items to be purchased, which appear consistent with pilot-scale testing.

**Reviewer 10-6 (Rating: 3)**

There is \$50,000 of equipment listed in the budget for CO2 sequestration system. The specific equipment to be fabricated is not clear. The proposal indicates that equipment developed in Phase I would be used in Phase II.

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 10-4 (Rating: 5)**

The facilities and equipment available at EERC are exceptional.

**Reviewer 10-5 (Rating: 4)**

The test facility at EERC appears to be very good.

**Reviewer 10-6 (Rating: 4)**

EERC has excellent facilities.

10. **BUDGET**

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

**Reviewer 10-4 (Rating: 5)**

The budget for the proposed work is of very high value because of the matching DOE and industry funds.

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<sup>1</sup> "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.

<sup>2</sup> 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 10-5 (Rating: 2)**

NDIC's requirement that a minimum of 50% of the total cost come from other than Industrial Commission sources is met with approximately 92% of the total coming from non-Industrial Commission sources. However, it is difficult to gauge the reasonableness of the budget because there are no details to justify the overall budget.

### **Reviewer 10-6 (Rating: 5)**

The project has very high value based on funding from other sources. Only one letter of support was provided for the project.

### **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 10-4 (Rating: FUND)**

The strengths of this proposal include; the organization, PIs, proposal quality, past work (Phase I), and the critical need that exist for the industry and state.

The weakness of the proposed work is a lack of specific target performance objectives, which are necessary for evaluating promising technologies. Specific performance goals for the promising technologies should include energy needs (parasitic load) and costs (COE/Avoided costs). Criteria for existing and new facilities are appropriate. All this information is probably known but should be stated to facilitate evaluation of technologies, the work product and industry options. Also, since lignite funds are requested, than lignite should continue as a part of the test matrix and criteria specific for lignite identified. What options exists for additional lignite production and use? The CO<sub>2</sub> capture technologies are energy intensive, which could create a new market for lignite. Since much of the knowledge, expertise and equipment for the use and handling of lignite exists at the facilities, than the option for additional lignite to meet the increased energy needs should be encourage and the technologies requirements adapted to include this option.

### **Reviewer 10- 5 (Rating: FUNDING MAY BE CONSIDERED)**

My initial recommendation is **do not fund** based on the proposal, which in my opinion is not well written as it is confusing in some areas and is lacking in details that are needed to make a funding decision, especially for a project that is ≈\$1.9 million in size. However, since this is a Phase II effort, I will recommend that **funding be considered** if the project sponsors (and I assume NDIC is one of them) are satisfied with the Phase I performance. Following are specific comments/concerns/issues about the proposal.

On page 1, there is reference that the CO<sub>2</sub> capture from lignite, subbituminous coal, bituminous coal, natural gas, petroleum coke, and biomass were studied in Phase I. Then later in the proposal, it is stated that the fuels to be evaluated in Phase II included coals of various rank and biomass. Two questions. If the objective is to study CO<sub>2</sub> capture technologies in general and lignite generated CO<sub>2</sub> specifically, then what is the justification for all of the different fuel types? Secondly, how did the results from Phase I direct the overall program to focus on coals of various rank and biomass for the second phase and what was the rationale to drop natural gas and petroleum coke from Phase II (later discussions do not mention natural gas or pet coke)? How were technology type, coal type (or was it supposed to be fuel type?), and plant configurations factored into the Phase II work?

On page 5, first paragraph under project description – there is a statement on ...technologies to be tested in ...EERC 'may' include solvent scrubbing ... How can the word may be used? How can a proposal and budget be prepared but the test matrix, details, and scheduled not be worked out? Testing configurations should already be identified and discussed in the proposal, especially with a project of this magnitude.

Same page, last sentence in project description – If Phase I is done, then the technologies chosen for evaluation under this project (which I am assuming is Phase II) should already be known and discussed in the proposal.

On page 6, the various bullets are too vague for a \$1.9 million dollar project: What are the promising technologies? What are the challenges that must be overcome? What are examples of strategies to be developed and implemented? What are some of the approaches that will be evaluated? What are the evolving or known strategies? Etc. There is too much ‘hand waving’ in the proposal. EERC has a history of writing proposals to DOE and other agencies. If DOE is providing nearly \$1.5 million in funding, it surely had to receive more detail than NDIC is receiving in this proposal or the project would not have been funded. If the Phase I proposal was this vague, I do not see how it could possibly have been funded.

Same page, last bullet – I am assuming the reference to demonstration scale testing is for testing outside of Phase II. If so, the reference to demonstration scale testing in the last paragraph of the approach section is confusing. On page 7, does demonstration testing refer the pilot-scale testing in Phase II? If not, where does demonstration-scale testing fit in so Aspen Plus modeling can be performed? This is confusing.

Also on page 7, second paragraph of the approach – If the working group has not been identified and will be identified later and the working group is to identify the technologies for testing, how can a cost estimate for testing be prepared at this stage? If there are assumptions in testing, then they should be discussed for the reviewers to assess the proposal.

Overall the proposal is poorly written. There are few details. The tie between Phase I and Phase II is not presented clearly.

**Reviewer 10-6 (Rating: FUNDING MAY BE CONSIDERED)**

This is extremely important work that is needed by the lignite industry and this project has the potential to make a significant contribution. This is the Phase II of the PCOC program. The outlined scope of work is a logical next steps to be taken in the PCOC program. The major flaw of the proposal is that it does not provide sufficient detail background information related to the accomplishments of Phase I to justify the Phase II effort. The Phase I tasks have been completed results of testing are likely available and examples of the results should have been included in the proposal.

I can only indicate that this project be considered for funding since it lacked sufficient background information on the accomplishments of Phase I. If sufficient background can be provided I would recommend the project be funded.