TECHNICAL REVIEWERS' COMMENTS

LRC-LXXI(71)-B: "Water Recovery from Lignite Drying"
Submitted by: Energy & Environmental Reserach Center;
Request for: $266,520; Total Project Costs: $897,335;
Project Manager: Joshua J. Ziman;
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 11-04 (Rating: 4)

The two overall goals of this proposal are: 1) to demonstrate that water produced during the drying of ND lignite can be economically recovered, and 2) to develop baseline data that will provide new marketing strategies for ND lignite. Six specific project objectives are :1) to design, fabricate and install an SPX water recovery module at the Coal Creek Station, 2) to conduct validation tests including operational variables and water quality, 3) to develop an assessment of economic potential, and 4) to develop baseline data for new marketing strategies. These goals and objectives are consistent with the ND/LRC statutory goals and objectives.

The proposal does not project goals to NDIC/LRC program goals. However, the proposal is clearly consistent with NDIC/LRC goals.

Reviewer 11-05 (Rating: 4)

The stated primary and secondary goals are consistent with those of the Lignite Council to make the use of North Dakota lignite more attractive to potential users. My concern, as will be expanded upon in other sections, is that I am not persuaded that the achievement of the technical goal (30% recovery, satisfactory operation, etc.) will lead to achievement of the primary goal (an attractive combination of fuel and water for power plants in water-short areas.)

Reviewer 11-06 (Rating: 3)

The researchers are clear in their statements that they believe the technology they propose to evaluate could lead to increased lignite utilization, which is one of NDIC/LRC's objectives. However, it is not clear that the technology will actually lead to increased lignite utilization. The recovery and use of moisture from the lignite is a very good idea but the economics would have to be extraordinary for it to lead to shipping lignite many hundreds of miles to arid regions of the country. Therefore, while water issues pertaining to power plants are of great interest/concern, tying the research to increased lignite utilization appears to be a stretch. If this is the case (i.e., good research topic but not one that will lead to increased lignite utilization), then it is not clear if the proposal meets the criteria set forth in the documents provided to the reviewers

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 11-04 (Rating: 5)

With the approach suggested, the objectives are certainly achievable. The proposal ties the objectives with specific work tasks providing a good roadmap to achieve the project goals.

Reviewer 11-05 (Rating: 3)

The time and budget appear more than adequate to achieve the technical goals of demonstrating the quantity and quality of water recovered and assessing the operability and maintainability of technology. However, the time and budget spent to successfully achieve the technical goals may not lead to achieving the larger programmatic goals.

Reviewer 11-06 (Rating: 4)

The budget appears quite generous at ≈$900,000 and 3 man-years of labor for an 18-month project. With the exception of some travel and analytical services, there are fans to be purchased and installation to be contracted (≈25% of the budget), which leaves most of the budget for salaries. This appears high so the objectives should be met with the generous budget.

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 11-04 (Rating: 4)

The quality of the methodology displayed in this proposal is well above average. The proposal is well written, the work statement well defined and project management identified.

Reviewer 11-05 (Rating: 4)

The quality of the approach is difficult to evaluate based on the proposal. I have no doubt that a high quality experimental rig can be built, instrumented properly and operated in a way to obtain good data. However, it is unclear to me why the project is structured as it is. Why is it necessary to test at small scale a technology which has already been demonstrated at much larger scale on an operating power plant (Unit 4 at Public Service of New Mexico's San Juan Generating Station?) There may be good and sufficient reasons (such as differences in the temperature, water content, gas steam quality, contaminants specific to lignite dryers), but they are not mentioned. If they are the motivating factors, it would seem that the issues might be resolved using a different, less elaborate and less costly experimental approach.

Reviewer 11-06 (Rating: 2)

The proposal presents and briefly discusses the various tasks; however, there is very little detail provided, e.g., what are some of the details on the system design, will data be recorded on site and periodically provided to EERC or will it be remotely accessible, how will the techno-economic evaluation be performed, what is the sampling and compositing schedule, etc.? A large (page number wise) proposal was submitted but much of it is boilerplate.

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 11-04 (Rating: 4)

The scientific and technical contribution of the proposed work to address specific NDIC/LRC goals will likely be very significant. Drying of lignite has been identified as an approach to increase the market for ND lignite. The addition of water recovery to the drying approach presents a potential added incentive. During the past two decades, the NDIC/LRC has funded numerous projects assessing technologies, markets and uses for upgraded lignite. The incentive for lignite drying still exists. Does the GRE fluidized bed with SPX water recovery provide the required economic incentive for upgraded lignite?

Reviewer 11-05 (Rating: 2)

The proposal emphasizes the end goal of making North Dakota lignite attractive to power plants in water-short areas with concept that the purchase of the lignite fuel will bring with it enough water to make a significant contribution to the water requirements of a wet or hybrid cooling system. I do not believe this to be true. The amount of lignite necessary to fuel a plant will bring with it recoverable water of less than 5% of the plant's needs. Given the need to operate a coal-drying facility at the plant, I don't think that this amount of additional water will be an attractive option to many (or any) power plants. The amount of water that they would obtain is just too little to be interesting.

Reviewer 11-06 (Rating: 2)

Many of the comments here are the same as in Item #1. Water recovery/re-use is a very good idea and techniques to do so should be explored. However, I am not sure it addresses NDIC/LEC's goals though in that it is questionable it will lead to increased lignite usage. There were some facts not presented in the proposal such as how much water per year can be recovered if 30% of the moisture that is driven off from the coal when drying it by 10 percentage points? Is this significant at GRE's plant? These values were not presented. Similarly, if the drying and water recovery technologies were to be installed on other lignite-fired power plants, what are some estimates of total water generation that could be realized? While this may not lead to increased lignite utilization, it could lead to other water markets (as pointed out by the proposers) along with improving unit efficiencies and reducing pollutants.

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 11-04 (Rating: 4)

The PI's awareness of current research activity is better than average. However, a great deal of work has been done in this area with only limited reference to previous activity. EERC and GRE are well aware of previous work in this and related areas.

Reviewer 11-05 (Rating: 2)

Based only on the list of references in the proposal, it seems that the group is not aware of the state of the SPX Air-to-Air technology. Results of their demonstration study (funded, I believe, by DOE) are well known and would seem to greatly reduce the need for this study unless it will concentrate on specific issues related to the humid air stream exiting a lignite dryer. See my remarks in #3 above.

Reviewer 11-06 (Rating: 3)

There was no discussion of current research activity in this area but the principal investigator must be aware of it in order to prepare the proposal. There was limited background literature referenced or discussed.

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 11-04 (Rating: 4)

The background of the investigators as related to the proposed work is better than average. EERC and GRE have staff with knowledge and experience in this and related. SPX provides unique expertise in water recovery.

Reviewer 11-05 (Rating: 4)

The backgrounds, particularly of Cowan and Leroux, seem well suited to the study.

Reviewer 11-06 (Rating: 3)

The research team is adequate.

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 11-04 (Rating: 4)

Most aspects of this proposal are outstanding. The proposal relates goals and objectives to tasks and work activities. The statement of work is carefully defined and well structured. Also, the proposal contains well-defined milestone charts and financial plan. The inclusion of an organization chart would improve the proposal and project communication.

Reviewer 11-05 (Rating: 4)

The study plan appears to be well thought out and suitable for successfully conducting the study.

Reviewer 11-06 (Rating: 2)

There is a milestone chart and schedule but no project management plan is presented. There is no financial plan and no plan for communicating among the researchers and subcontractor. There is a significant subcontract on the project with no associated plan to communicate with them.

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 11-04 (Rating: 5)

NOTE: Reviewer 11-04 provided no comments.

Reviewer 11-05 (Rating: 4)

There is no information in the proposal from which I can determine the size of the experiment (exhaust gas flow, recovered water flow, dimensions of the heat exchanger, etc.) Therefore, I can't judge whether the amount and cost of the purchased equipment is reasonable. However, SPX is thoroughly familiar with the testing requirements for their device so I assume the test facility will be appropriately sized and equipped.

Reviewer 11-06 (Rating: 3)

Equipment (2 fans) is identified for introducing the ambient air into the heat exchanger and for handling the slipstream.

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 11-04 (Rating: 5)

The facilities available at EERC, GRE and SPX are exceptionally good.

Reviewer 11-05 (Rating: 3)

The facilities at the Coal Creek Station should be adequate. See also my remarks in #8 above.

Reviewer 11-06 (Rating: 4)

Facilities and equipment that are available for the project are very good for the research – GRE's LFE dryers and the SPX's heat exchanger.

10. **BUDGET**

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

Reviewer 11-04 (Rating: 5)

This proposal has a very high budget value. The request to the NDIC/LRC is for 28.7% of the total project cost. Additional requests are to EPRI, GRE, SPX, and DOE through the EERC Northern Great Plains Water consortium.

Reviewer 11-05 (Rating: 2)

Consistent with my remarks in #3 above, I think that approximately $900,000 is a lot of money for a small-scale study of a technology which has already been demonstrated at much larger scale. If a study of this magnitude is required to address the "process-specific" issues related to coal dryers, then the contributions of over $630,000 from other sources is of great value to NDIC.

Reviewer 11-06 (Rating: 4)

The budget value to NDIC is high as <50% cost share (i.e., ≈30%) is requested from NDIC, although the budget appears high for the scope of work.

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.

[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 11-04 (Rating: FUND)

This proposal is exceptionally well structured and organized. The goals and objectives are consistent with NDIC/LRC goals and objectives. Upgraded lignite has been an area of interest since inception of the NDIC/LRC program. This proposal adds to past effort with a technology of water recovery. If this marketing strategy can be successfully developed, then this project could be significant for the industry.

However, two areas are potential flaws. First the organization chart and communication lines could be improved. Additional charts and details can correct this flaw.

The second potential flaw, related to the marketing of upgraded lignite, may be more difficult to solve. Technologies to upgrade lignite and the marketing of upgraded lignite have been studied numerous times. The use of upgraded lignite beyond the point of operation has not been clearly demonstrated. The nature of the GRE fluidized bed operation may be site specific and not broadly applicable throughout the industry. Also, partially upgraded lignite, as produced by the GRE technology, may not be amenable to offsite use. A cost advantage must be gained to offset increased cost due to upgrading and transportation. The GRE fluidized bed advantage gained, with a limited reduction in moisture content and increase in heat content, may not be sufficient to offset increased costs. Is the GRE fluidized bed upgraded lignite competitive with other fuel options?

In spite of the potential flaws, this proposal warrants funding.

Reviewer 11-05 (Rating: FUNDING MAY BE CONSIDERED)

My reservations about the merits of the proposed study fall in three categories:

1. Potential value of even a very successful technical result:

I don't think that a power plant can hope to recover enough water from the amount of lignite required to fuel the plant to make a significant difference to their water budget. There is certainly not enough to achieve the objective stated on p. 18 of the proposal which says "reuse of that moisture could result in little or no power plant derating".

Although I know very little about hydraulic fracturing, using the numbers in the proposal (0.5 to 4 million gallons) for a single well, I estimate that at the moisture content (38%) and recovery rates (30%), approximately 80,000 tons of lignite would be required to deliver 2 million gallons. This sounds like a lot to me. The proposers should be asked to resubmit the proposal with specific attention to the relationship of the amount of water available to the corresponding needs of a power plant.

2. Need for the data:

The technology has been demonstrated at much larger scale than is proposed here at a site which replicates much of the same range of climate conditions.

3. Recommendations for funding:

I would fund the proposal <u>only</u> if it is shown to address important "process specific" issues. The proposers should be asked to resubmit and address this issue in detail.

Reviewer 11-06 (Rating: FUNDING MAY BE CONSIDERED)

It is my recommendation that funding may be considered. Overall this is not a very well written/ presented proposal and the budget appears high for what will be delivered. However, the recovery and re-use of water is a very important topic/ issue and the proposal should be considered. I suggest NDIC/LRC request a more detailed accounting of the labor hours to justify them. There are many hours associated with un-named positions with no explanation of their duties. Also, as mentioned earlier, it is not clear if the proposal meets NDIC/ LRC goals. Economics would have to exceptional before lignite will be shipped long distances. I question whether this would ever be feasible. This technology could have a major impact locally but I doubt that it would have a regional or national impact from the standpoint of increased utilization of North Dakota lignite. Therefore, my recommendation is that funding may be considered, which I would change to fund if NDIC thinks this project does meet NDIC/ LRC goals and a better accounting of the budget is provided.