

TECHNICAL REVIEWERS' COMMENTS

LRC-LXXVII(77)-B:

“Enhanced High Capacity Sorbent and Process for CO₂ Capture Using Hybrid Sorption (E-CACHYSTM)”

Submitted by: Envergenx LLC

Request for: \$50,000; Total Project Costs: \$99,967;

Principal Investigator: Srivats Srinivasachar, Sc.D., President

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 14-04 (Rating: 3)

The objectives and goals are concisely stated.

Reviewer 14-05 (Rating: 4)

No comment.

Reviewer 14-06 (Rating: 4)

The overall objective of this proposal is the Phase II development of the E-CACHYSTM hybrid sorbent technology for the capture of CO₂. Objectives during this Phase II program include the development of improved sorbent manufacturing methods and development of new operational philosophy to reduce sorbent attrition thus reducing sorbent replacement costs. Development of a cost-effective CO₂ capture and separation technology will facilitate the use of NDL for power generation minimizing greenhouse gas emission. The objectives of this proposal are consistent with the goals and objectives 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 14-04 (Rating: 4)

Assuming positive outcomes with each of the defined tasks, the objectives should be achievable in the given time and budget. The uncertainty is what is normally expected in a research project.

Reviewer 14-05 (Rating: 4)

No comment.

Reviewer 14-06 (Rating: 3)

The standard of success of the project, “to make progress in decreasing the cost of CO₂ capture” is very modest and arbitrary. The objectives are likely achievable.

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 14-04 (Rating: 4)

The proposed methodology is well defined and is making use of a suite of equipment and facilities that are not available to many. The level of instrumentation should allow for rapid and complete evaluation of different formulas and processes.

Reviewer 14-05 (Rating: 4)

No comment.

Reviewer 14-06 (Rating: 5)

The quality of the methodology displayed in the proposal is well above average. Proposals prepared by Michael Mann, PhD and Steve Benson, PhD are of the highest quality.

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 14-04 (Rating: 4)

With EPA's current regulatory push on CO₂, the proposed work could be very important to North Dakota's lignite industry. The continued operation of the State's existing lignite-fired power plants and mines, as well as the potential for new facilities, will likely depend on the success of projects such as this one.

Reviewer 14-05 (Rating: 4)

No comment.

Reviewer 14-06 (Rating: 4)

The scientific and technical contribution of the proposed work to specifically address NDIC/LRC goals will likely be very significant.

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 14-04 (Rating: 3)

As written, the proposal does not contain an extensive reference list. CO2 capture research is an exploding field of investigation with far more information available than indicated in the proposal. However, knowing the members of the research group, I do know that they are aware of all the other work and will use this knowledge to help further the project. To include a significant number of the recently published references would be prohibitive.

Reviewer 14-05 (Rating: 3)

No comment.

Reviewer 14-06 (Rating: 5)

The three principal investigators, Michael Mann, PhD, Steve Benson, PhD and Srivats Srinivasachar, Sc.D have published extensively in this and related areas. Their current awareness in the field is evident in the referenced literature references and resumes.

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 14-04 (Rating: 3)

The investigators have good backgrounds for the proposed work and they should complement each other well.

Reviewer 14-05 (Rating: 4)

No comment.

Reviewer 14-06 (Rating: 5)

The backgrounds of the investigators are exceptional.

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 14-04 (Rating: 3)

The management plan appears adequate.

Reviewer 14-05 (Rating: 4)

No comment.

Reviewer 14-06 (Rating: 4)

The project management plan with the inclusion of the Gantt chart is very good. Other project management tools are most likely available on request.

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 14-04 (Rating: 4)

The project is making good use of existing equipment and facilities at UND. The new equipment being purchased for the project is well justified and could be valuable additions for future work at UND.

Reviewer 14-05 (Rating: 5)

No comment.

Reviewer 14-06 (Rating: 5)

The purchase of proposed equipment is extremely well justified.

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 14-04 (Rating: 4)

The newly purchased and already available equipment for this project will all be required for a successful outcome.

Reviewer 14-05 (Rating: 4)

No comment.

Reviewer 14-06 (Rating: 5)

The facilities available thru UND are exceptionally good.

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.

Reviewer 14-04 (Rating: 4)

The project has a high industry matching contribution, along with monies from DOE. For the NDIC's contribution, it should be a relatively low cost – high value investment.

Reviewer 14-05 (Rating: 4)

No comment.

Reviewer 14-06 (Rating: 5)

The proposed budget is of very high value. Industry match by ALLETE and SaskPower match the funding requested from NDIC/LRC. The Federal funds make the overall project of 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.

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 14-04 (Rating: FUND)

Finding a low-cost, high efficiency CO₂ capture sorbent is the current “holy grail”. While the proposed project may or may not find it, it should add to the overall knowledge of capturing CO₂. This is the type of work that needs to happen, if the industry is to continue to survive and grow. My recommendation is to fund the project.

Reviewer 14-05 (Rating: FUND)

Strong recommendation to fund.

Reviewer 14-06 (Rating: FUND)

This proposal has several strengths and merits:

- The proposal addresses an area of great concern – Greenhouse Gas Emissions.
- Dr. 's Mann, Benson and Srinivasachar are outstanding researchers in this field.
- The technology is based on well-known chemical and engineering concepts.
- The proposed work has industrial and Federal commitments.

However, there exist some areas of concern:

- The element proposed as the metal absorption specie has been evaluated for numerous uses in related areas of gasification, generation (MHD) and liquefaction; none of the technologies based on the use of this metal specie have been successfully commercialized in these areas due in part to ‘sorbent attrition’ costs.
- The full value of the technology contribution to NDJ is behind the “Confidentiality” stamp. The need to preserve “confidentiality” will limit the value to the industry.
- Chasing solutions to the GHG problem is elusive. Is the target GHG or the coal industry?
- The standard of success is arbitrary. Specific quantifiable performance goals are desirable.

In spite of the areas of concern, this proposal is outstanding and warrants a recommendation to FUND.