IV.B.2.a

REPLY TO TECHNICAL REVIEWERS' COMMENTS

LRC-LXXVI(76)-B:
"Continuation of Underground Coal Gasification Study in Western North Dakota"
Submitted by: University of North Dakota Institute for Energy Studies;
Request for: $299,958; Total Project Costs: $719,958;
Principal Investigator: Scott Korom, Ph.D.

GENERAL COMMENTS

With respect to our relationship with the ND Industrial Commission(NDIC)/Lignite Research Council, the purpose of the Underground Coal Gasification (UCG) team at the University of North Dakota Institute for Energy Studies is to facilitate the development of UCG in North Dakota. Currently this involves working with the NDIC and our commercial partner to identify and begin to develop a site suitable for a UCG demonstration project. Developing a site for a possible UCG pilot project with a coal seam nearly 1000 ft deep will be expensive, but the potential energy provided from ND lignite would be enormous. Our pace of research is intended to be aggressive, but with the recognition that research budgets larger than the one proposed herein are not likely in the near future. Therefore, our proposal has a limited budget, but the work to be performed will fit nicely into subsequent proposals for further work. Examples are described below.

- Our proposal requests funding to install a monitoring well in each the shallower coal seam (~680 ft deep) and the deeper coal seam (~970 ft deep). These wells will be used for baseline groundwater quality monitoring and to perform slug tests to estimate the hydraulic conductivities of the coal seams. The latter objective was based on the counsel provided Dr. Cliff Mallett, Chairman of Trustees, UCG Association, and UCG Technical Director, Carbon Energy. (We chose our potential pilot site based on a report written by Dr. Mallett; he personally visited the area of our investigations.) These wells will become a part of a future network of monitoring wells for the pilot project, which will be required for additional groundwater quality monitoring and to determine groundwater flow directions and gradient. If it is determined that pumping tests are required to provide more robust estimates of the hydraulic conductivities of the coal seams, the wells proposed herein may be used with additional monitoring wells and a pumping well, to be installed in the future, to provide this information.
- Our proposal requests the purchase of a pump that may be used with the slug tests and also for the quarterly sampling of the two monitoring wells. It may be cheaper to rent a pump for these purposes. However, if we are in this project for the duration, we likely will be using the pump to sample a more comprehensive monitoring well network in the future. If so, having the pump housed with the Institute for Energy Studies will be more cost-effective.
- UCG needs to integrate the following components to be successful:
    - Geomechanics
    - Syngas composition
    - Hydrogeology
    - Economic development of syngas

The first three components were emphasized in our current project. The last two components are emphasized in our continuation proposal. Our current project has completed its hydrogeological objectives. Although geomechanical and syngas steps remain to be completed, we think it prudent to propose more hydrogeological research on the potential pilot-plant site. If a new contact was approved by the end of the current project (June 30, 2014), it is unlikely that there would be enough time to get a drilling contractor to complete the proposed work until the summer of 2015. There are lots of opportunities for drilling contractors in North Dakota these days. For our previous drilling contract, we could only get one drilling contractor (Mohl Drilling) to bid on our project (UND requires a competitive bid process after a contract has been approved.). If we submitted the bid requests in July, 2014, it is unlikely that any proven contactor could get the work done during the remaining weeks of summer; perhaps, if weather permitted, the job could be squeezed in during the fall, but some members of our UCG team have limited availability for extensive field work once university courses begin. We believe it is best to initiate further hydrogeological investigation of the site next summer (2014).

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 13-13 (Rating: 4)

This project meets each of the statutory goals and purposes listed for the Lignite Research Council.

Reviewer 13-14 (Rating: 3)

The project's main objective is to continue researching underground gasification and liquids production to gain enough knowledge to conduct a feasibility evaluation. Although the project is eligible in two categories under section 43-03-02-02, the goal falls short of meeting the criteria for a priority ranking.

Reviewer 13-15 (Rating: 4)

Research could lead to job creation in utilization of ND lignite. Research could uncover a new opportunity in the lignite industry.

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 13-13 (Rating: 4)

The objectives appear to be achievable given the scope of the project. The value of a phased project is the opportunity to evaluate the ability of the management team to deliver on the earlier objectives. Although the first phase project is still in process (see my general comments) it appears to be on schedule.

Reviewer 13-14 (Rating: 4)

The seven specific objectives should be successfully completed with sufficient data in the time allotted. Most of the data should be available to begin developing the feasibility study in the 15th month.

Reviewer 13-15 (Rating: 4)

I believe the work can get accomplished in the time frame as described.

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 13-13 (Rating: 3)

The quality of the methodology appears good, but I would have preferred more detail regarding well construction. Proper well construction is a crucial part of this project.

Reviewer 13-14 (Rating: 4)

The methodology seems to be well designed to give the date sought and conduct the feasibility study.

Reviewer 13-15 (Rating: 3)

I believe environmental risk should have more discussion. It was mentioned as a technical issue, but not elaborated on.

Reply: Korom plans to comment more on these risks in his presentation to the Lignite Research Council on November 19, 2013.

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 13-13 (Rating: 4)

The information generated by this project should be very useful in future evaluations of the UCG potential of North Dakota lignite. If these lignites are well suited for UCG, subsidence potential will very likely become one of the most important criteria to be addressed. Since the vast majority of data on coal has been collected within 200 feet of the surface, any data on these deep coals is of value.

Reviewer 13-14 (Rating: 3)

The project will advance the underground gasification knowledge as well as the liquid production technology. The project will need substantial more research before it will significantly enhance more use of lignite or marketable processes in North Dakota.

Reviewer 13-15 (Rating: 3)

I believe it could be significant; however, I am uncertain about how it will be interpreted by environmental groups. How much environmental risk exists and how will environmental groups be convinced the risk is acceptable?

Reply: Good question. Some environmental groups will never be convinced regardless of the information provided. Our desire is to demonstrate to the State, likely via the ND Department of Health, that a proposed UCG pilot plant does not pose an unacceptable environmental risk. This implies that regulations for UCG in North Dakota need to be developed. Current demonstration projects in Australia have shown that UCG can be done without causing groundwater contamination of potential drinking water supplies.

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 13-13 (Rating: 4)

While the references cited are not overly abundant, they do demonstrate knowledge of the more recent work in UCG and the involvement of several of the management team in that work.

Reviewer 13-14 (Rating: 5)

The principal investigator has included substantial references of research activity and published literature.

Reviewer 13-15 (Rating: 3)

FEED study already done by GNP will be very helpful.

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 13-13 (Rating: 4)

Members of the research team have strong backgrounds in lignite chemistry, groundwater and gasification and, to a lesser degree, UCG.

Reviewer 13-14 (Rating: 5)

The principal investigator and team are all highly qualified.

Reviewer 13-15 (Rating: 4)

I am a supporter of Dr. Benson. He works very hard to support ND lignite!

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 13-13 (Rating: 4)

The project management chart and the timetable and milestone log are well defined and reasonable. What is the significance of the decision points listed in Figure 10 and Table 1?

Reviewer 13-14 (Rating: 4)

Although the management chart does specify that counsel from the lignite research council is to be included in the management of the project, a specific communication plan seems to be lacking.

Reply: When questions come up, we contact Mike Jones for advice. This has been an efficient and effective communication strategy to date.

Reviewer 13-15 (Rating: 3)

I would guess the comprehensive assessment would be developed so work goes on; however, the chart only shows a quarter for work on it. The overall assessment is key to eventual development on the pilot plant!

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 13-13 (Rating: 2)

Only one piece of equipment is listed – a Grundfros pumping system. I believe you can rent this pump for $600 per week. If it is only to be used for quarterly groundwater sampling that would come to $2,400 rather than the $5,400 purchase price.

Although it is a supply rather than equipment, I question the use of PVC to construct a well that is 1,000 feet deep. The deep monitoring wells that I am familiar with are constructed with steel pipe. I would verify that Mohl Drilling or some other entity has had success using PVC to that depth.

Reply: Korom was also skeptical of using PVC for such a deep well. Before the proposal was submitted he contacted Mr. Alan Wanek of the ND State Water Commission and he spoke to him again recently (November 14, 2013). Mr. Wanek is of the opinion that private contractors generally used PVC pipe (schedule 80) for wells screened at a depth of 1000 ft, or less. Last summer the NDSWC installed a 2-in. PVC well into the Fox Hills aquifer; it was screened 1034-1054 ft below the ground surface. It used standard construction; that is, 20-ft lengths of PVC (schedule 80) with cemented couplers.

Reviewer 13-14 (Rating: 3)

The equipment purchase consists of a submersible pump for the well sampling with one quote provided.

Reviewer 13-15 (Rating: 4)

No major purchases.

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 13-13 (Rating: 4)

The laboratories noted in the proposal are more than adequate to perform most of these analyses. We have to assume that the bench-scale, pressurized fixed reactor that is being constructed under phase one of this project will be operational during this phase. See my overall comments.

Reviewer 13-14 (Rating: 4)

The project will have access to excellent facilities. Contractors and equipment purchase has been studied with quotes available for review.

Reviewer 13-15 (Rating: 3)

Would like to see age of equipment shown to be used to understand how up to date it is to earn a higher mark.

Reply: Our most sophisticated geomechanical testing equipment is less than three years old; it is in constant use. Our gasifier was constructed by our current project. The analytical equipment in the Environmental Analytical Research Laboratory is maintained by a lab technician who has a Ph.D. in analytical chemistry and is in constant use.

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 13-13 (Rating: 4)

A cash outlay of $300,000 by the North Dakota Industrial Commission is reasonable given the scope of the project and its potential value along with the cash and in-kind match.

Reviewer 13-14 (Rating: 3)

In the abstract it states that the project is expected to be finished in 18 months, with a total budget of $449,700, including a cash support of $150,000 from Great Northern Properties. This is the cost of the actual work on this project including conducting the feasibility study. This would not meet the 50 percent cost share threshold. But additional in-kind support of $270,000 is also provided which is FEED data and specification from the Junior GLT Project. However, the value of the FEED study was not substantiated or how the $270,000 was determined.

Reviewer 13-15 (Rating: 3)

How much of the $270,000 is involved in turning over a report?

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 13-13 (Rating: FUNDING MAY BE CONSIDERED)

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[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.

Funding to be considered.

From a reviewer's standpoint, I feel this proposal was submitted too early. It would have been beneficial had the results from Task 3 of the earlier project been incorporated into this proposal. Since Task 3 is not scheduled for completion until the fourth quarter of 2013, this proposal should have been submitted in early 2014. I realize doing so would likely have jeopardized part of the 2014 field season.

Will the portion of the test hole drilled below the 1,000 foot mark be grouted prior to installation of the monitoring well? Based on Mohl's cost calculations it appears this would be the case. The screens have to be isolated from the rest of the borehole in order to obtain legitimate slug test data.

Reply: Yes, the screen will be grouted below, if necessary, and above the well screen to isolate it from all but the coal seam being investigated.

It is unfortunate that the first proposal did not include the installation of a monitoring well in the test hole. At least one of the 2012 proposal reviewers recognized this shortcoming and asked what was going to happen to that test hole. *Reviewer 12-07 "Will the wells be plugged and abandoned or left open for later hydrological testing or logging."*

Reviewer 13-14 (Rating: FUNDING MAY BE CONSIDERED)

There are lots of challenges for lignite and coal in general at the current time. Part of the purpose of the Lignite Research Program is to fund projects that help give some answers to those challenges. Another part of the Lignite Research Program is to support research that will enhance the use of lignite and demonstrate marketable le lignite products. This project will need additional research to meet the technical issues discussed in the proposal. I see many hurdles to overcome and high risks for the underground gasification developer.

Based on the weighting of the 10 criteria in the proposal I would recommend that funding may be considered.

Reviewer 13-15 (Rating: FUND)

I recommend funding to continue supporting results found in the last testing.