September 1, 2000

Karlene Fine, Executive Director
North Dakota Industrial Commission
State Capitol
600 East Boulevard Avenue Dept 405
Bismarck, ND 58505-0840

Dear Ms. Fine:

Subject: LEC Grant Application Amendment

Enclosed please find a proposal entitled "Construction of a Forced Oxidation Plant for Gypsum Production". Great River Energy has participated in studies funded by the Commission to evaluate the feasibility of producing gypsum in the Coal Creek Station scrubber system, as well as a market feasibility study for the end product. The Commission approved funding for this project in 1998. Since then Great River Energy has reviewed the project estimates, conducted a pilot study of alternative oxidation technology, and produced a small amount of gypsum product. The results of the pilot study have increased our confidence in the potential for success of the demonstration project, and therefore, we request that the Commission consider increasing the funding amount for this project. We look forward to continued support of the coal combustion by-product market in North Dakota in the form of full scale funding of this production facility.

If you have any questions regarding this proposal, please feel free to contact me at (701) 442-7007 at your convenience.

Sincerely,

GREAT RIVER ENERGY

Russ Nelson
Project Manager

Enclosure

c: Andrew Stewart, En-Rock
Dennis Taylor
John Weeda
Al Christianson
Gordon Westerlind
File: WO 98012

CONSTRUCTION OF A FORCED OXIDATION PLANT FOR GYPSUM PRODUCTION – AMENDED PROPOSAL

Submitted to:

Karlene Fine, Executive Director

North Dakota Industrial Commission
Lignite Research Program
State Capitol
600 East Boulevard Avenue Dept 405
Bismarck, ND 58505-0840

Submitted by:
Gordon Westerlind
Great River Energy
17845 East Highway 10, P.O. Box 800
Elk River, MN 55303

Funds Requested from the
North Dakota Industrial Commission

Contract FY98-XXIX-80 Grant	$926,500
Amended Total Grant Request	$1,673,600

Gordon Westerlind, Vice President, Generation

September 2000

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CONSTRUCTION OF A FORCED OXIDATION PLANT FOR GYPSUM PRODUCTION UTILIZING NORTH DAKOTA LIGNITE COMBUSTION PRODUCTS

ABSTRACT

Beneficial utilization of coal combustion by-products (CCB's), which includes by-products of flue gas desulfurization (FGD) processes, is both economically and environmentally advantageous. In a project funded in 1995 by the Industrial Commission of North Dakota and Cooperative Power, the Energy & Environmental Research Center (EERC) determined that FGD sludge produce in the Coal Creek Station (CCS) scrubbers could be converted into gypsum through forced oxidation. This research was performed at a laboratory scale with excellent results. The gypsum product was characterized and found to have properties that make it a potentially valuable resource in agricultural applications, feedstock for cement manufacture, wallboard production and other applications. This potential was investigated in a market feasibility study funded in August of 1997 by the North Dakota Industrial Commission and Cooperative Power Association. The EERC reported that the FGD gypsum samples characterized in their study all had low concentrations of regulated elements such as the RCRA (Resource Conservation and Recovery Act) elements. Since this material is environmentally benign, its utilization is environmentally positive because it reduces the use of finite natural resources, reduces greenhouse gas emissions produced from mining and manufacturing, and reduces the need for solid waste disposal. The premise in developing a market for FGD gypsum in North Dakota is based on these environmental issues, and

the use in North Dakota's agricultural community through replacement of imported natural materials.

In 1998, the North Dakota Industrial Commission approved funding up to $926,500 for the construction of full-scale commercial gypsum conversion facilities in one of the two (2) scrubbers at Coal Creek Station. This forced oxidation conversion system will convert the FGD sludge into gypsum, dewater the material and prepare it for shipment to the agricultural, feedstock for cement manufacture, wallboard and other markets.

Since approval of that funding in 1998 Great River Energy hired an engineering firm to develop the project process design and found the original project funding to be inadequate. The original project budget was $3,705,800. We have explored alternative oxidation technology, conducted a pilot study of that technology and produced a small amount of gypsum product that meets quality requirements for the potential market.

The revised project estimate for a project with a reduced scope that includes processing the FGD sludge from only one of the two (2) scrubbers at Coal Creek Station is $5,200,000. This amended request is to increase the funding approved by The North Dakota Industrial Commission from $926,500 to $1,673,600. This grant level is one to one matching on the additional funds necessary to complete the project.

CONSTRUCTION OF A FORCED OXIDATION PLANT FOR GYPSUM PRODUCTION

1.0 PROJECT SUMMARY

The construction of a commercial production facility is proposed to utilize information reported by the Energy & Environmental Research Center (EERC) on a project funded by the North Dakota Industrial Commission and knowledge gained through the pilot study. The EERC project developed preliminary technical information on the conversion of Coal Creek Station (CCS) FGD sludge into gypsum. The pilot study confirmed on a short duration production run that the CCS FGD sludge could indeed be converted to gypsum. The goal of this project is to construct a fully operational system to produce high quality gypsum from FGD sludge. This gypsum will be utilized statewide and regionally for agricultural applications, feedstock for cement manufacture, wallboard production, and other applications. The accomplishment of this project will provide the commercial system needed to begin taking full advantage of the North Dakota Lignite (NDL) gypsum resource in the marketplace. The proposed project will focus on production of NDL gypsum produced at Great River Energy's Coal Creek Station near Underwood, North Dakota, but the product will have a positive economic impact statewide. Since it is proven that transportation of imported gypsum for agriculture will be eliminated, thus enhancing in the market for this material, the economic benefit to North Dakota is far reaching.

The approach for this project involves construction of a full scale conversion system, a dewatering system, and a product loading area. This construction will take place within the confines of the existing CCS scrubber area. The project is anticipated to be accomplished in a twelve month time period, and be fully operational by the end of 2001.

2.0 BACKGROUND

Every year at CCS, some 100,000 tons of scrubber sludge is produced and disposed of in landfills on site. This material is produced in the wet scrubbing system utilized at CCS and is the result of removing sulfur dioxide from the flue gas by reaction with lime slurry. The material produced is calcium sulfite which is thixotropic in nature and thus extremely difficult to dewater. The calcium sulfite product requires conversion to calcium sulfate, or gypsum, to make it available for utilization. A national survey published by the American Coal Ash Association indicates commercial viability of FGD gypsum nationwide in a variety of applications. In a 1997 report to the Industrial Commission of North Dakota, the Energy & Environmental Research Center (EERC) indicated that the CCS scrubber sludge can be converted to calcium sulfate in an external forced oxidation system. Great River Energy recently completed a pilot study with Baker Process to demonstrate an induced oxidation process at Coal Creek Station. The pilot study produced gypsum product with expected quality and expected production costs. An FGD gypsum production system using equipment of the same design and similar size as proposed for this project was recently successfully started up at a power plant in Alabama.

Primarily because lignite and coal combustion byproducts are frequently disposed and disposed coal combustion products (CCPs) are regulated as solid wastes, concern about the potential for negative environmental impact from utilization of these materials was addressed in the EERC study. However, there is overwhelming evidence that this material is environmentally benign and that utilization is environmentally positive because it reduces the use of finite natural resources, reduces greenhouse gas emissions produced from mining and manufacturing, and reduces the need for disposal. In addition, the EERC reported that the NDL gypsum samples characterized in their study, had low concentrations of regulated elements such as the RCRA (Resource Conservation and Recovery Act) elements (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver). Further evidence of the environmentally benign nature of NDL gypsum was indicated by the results of the North Dakota State Health Department's prescribed leaching tests. All of these issues make the utilization of NDL gypsum an alternative environmentally preferable to disposal. It is important to note that utilization can also be an important economic benefit by reducing costs for disposal and will benefit the Lignite and agricultural industries in North Dakota.

The goal of the proposed project is to construct a facility to produce high quality gypsum for utilization as an agricultural soil amendment, production of gypsum wallboard, feedstock for cement manufacture and other applications and markets where FGD gypsum can replace other more costly materials or limited natural resources. The construction of this facility will strengthen the position of NDL through sound by-product utilization and the creation of local jobs to support the process from manufacture through delivery.

3.0 PROJECT DESCRIPTION

3.1 Introduction

Recent improvements at CCS have focused on utilization of all high volume by-products: fly ash, bottom ash and FGD material. The utilization of the first two products is fairly simple as no external processing is needed, however, for the FGD material the conversion to calcium sulfate is required. This external conversion of calcium sulfite to calcium sulfate through forced oxidation has been proven for the CCS product on a laboratory, bench, and pilot scale. The conversion of NDL scrubber sludge to gypsum has not been proven on a commercial scale and so funding of a project to perform this conversion is of a great benefit to the Lignite industry. The technology and costs of conversion with the proposed technology is available and being utilized elsewhere in the country. The proposed project focuses on the commercial production of this by-product for economic and environmental benefit.

3.2 Goals and Objectives

The primary goal of this project is to construct a forced oxidation conversion system to produce nearly 90,000 tons per year of high quality gypsum for introduction

into the marketplace. Utilization of existing conversion testing and technology will ensure the success of producing the product. A market evaluation has determined the area(s) with the highest potential rate of return and value to North Dakota. The project is deemed to be a fairly simple construction project for a processing facility. The lowest cost for production is a definite goal of this project.

3.3 System Description

The project will involve the purchase of equipment for oxidation, dewatering and loading for shipment. The construction of supporting facilities including foundations and structures is also included. This construction will take place in a normal fashion on the basis of plans and specifications with a specific target product quality. Construction of the facility will be managed by Cooperative Power utilizing in-house engineering supplemented with consultants knowledgeable with the conversion process. Contracts will be awarded for equipment supply and installation on the basis of a turnkey project.

The calcium sulfite currently produced in the CCS scrubber system must be converted into calcium sulfate through an oxidation process. This will involve the introduction of oxygen at a reduced pH, which allows for the maximum amount of conversion to be obtained in the shortest time period. This pH dependent reaction was confirmed by the study completed by the EERC and by bench tests and the pilot test conducted by Baker Process. The oxidation reactions in the presence of air and sulfuric acid are as follows:

$$CaSO_3 \bullet 1/2H_2O + H_2SO_4 + 1\text{-}1/2\ H_2O \rightarrow CaSO_4 + 2\ H_2O + H_2SO_3$$

$$CaSO_3 \bullet 1/2H_2O + H_2SO_3 \rightarrow Ca(H\ SO_3)_2 + 1/2H_2O$$

$$Ca(H\ SO_3)_2 + H_2O + 1/2O_2 \rightarrow CaSO_4 \bullet 2H_2O + SO_2$$

As shown in the schematic diagram (PI-90P01-1) and the layout drawings found in Appendix C, the conversion system feed will come from the blowdown system of the current scrubber reaction tanks. This slurry which contains approximately 20% solids will be pumped to two (2) oxidation towers that are approximately 20 feet tall and 20 feet in diameter. Sulfuric acid and air will be introduced into this oxidation tower and the conversion of the calcium sulfite to calcium sulfate will be completed.

The flow from the oxidation tower will be pumped to a hydroclone for initial dewatering to approximately 30% to 40% moisture. The concentrated slurry from the hydroclone will then be sent to a vacuum belt filter or similar device for final dewatering to a moisture content of 10% to 15%. Any washing of the filter cake for removal of chlorides will be done on the belt filter.

The dewatered gypsum from the filter will then be (1) sent to storage; or (2) loaded into trucks or railcars for immediate shipping.

It is anticipated that the entire process train for each scrubber can be housed within the existing scrubber buildings. There is anticipated need to construct some storage facilities for the finished product.

3.4 Marketing

Marketing of the product is under contract to EN-ROCK, Incorporated of Fargo, ND. They have investigated the highest market potential products and are putting a transportation and contract system in place.

3.5 Financing

The financing of the remaining portion of construction will be provided by Great River Energy or through other arrangements.

4.0 STANDARDS OF SUCCESS

The standards of success for this project include: 1) the economic success of the products produced; 2) the creation of support jobs within the North Dakota area; and 3) the savings in disposal costs and landfill space required at Coal Creek Station. These standards will be addressed in the overall economic success of this project.

5.0 QUALIFICATIONS

Mr. Russ Nelson will act as Project Manager for this proposed project. Mr. Nelson has a degree in Mechanical Engineering. He has nearly 30 years of experience in the engineering and construction fields, the last 21 years being with Great River Energy. He is currently a member of the board of the American Coal Ash Association and is involved in all aspects of by-product utilization and testing.

Alan Christianson will act as the on-site coordinator for this proposed project. Mr. Christianson has over 20 years of experience in the operations area at Coal Creek Station. He is also familiar with the construction industry in North Dakota.

Several key staff with Baker Process and their affiliate companies, including Todd Wisdom and Tom Toton are being utilized as consultants in the process portion of the project. They have extensive experience in the design and construction of conversion systems throughout the United States.

Resumes for key participants in this project are included in Appendix A.

6.0 VALUE TO NORTH DAKOTA

The primary benefit to North Dakota and the Lignite producers is the economic benefit that can be realized by utilities when the disposal of a high volume byproduct, such as FGD sludge, can be minimized. This disposal cost avoidance that is anticipated to result from developing markets for NDL gypsum can be significant. Additionally, North Dakota benefits when lower cost replacements can be found for commonly used materials and when the state's agricultural community can benefit. Each of these benefits is an anticipated result of this project.

7.0 MANAGEMENT

The proposed project will be managed and coordinated by Mr. Russ Nelson, of Great River Energy. Mr. Nelson is a Project Manager at Great River Energy and is responsible for all aspects of construction projects at CCS. Mr. Nelson's resume is included in Appendix A.

8.0 TIMETABLE

The timetable for the proposed project is as follows:

Activity	Completion Date
Begin Engineering	November 31, 2000
Prepare Plans and Specifications	January 15, 2001
Finalizing Scope	March 2, 2001
Release Procurement	April 2, 2001
Begin Construction	April 16, 2001

Equipment Installation	November 2, 2001
System Start-up	November 16, 2001
System Turnover to Plant	November 30, 2001
Commercial Operation	December 14, 2001
Close-out	December 31, 2001

A detailed project schedule will be completed after the retention of the consulting engineer.

9.0 BUDGET

A budget detailing the costs for the proposed research is included in Appendix B. The total project cost is estimated to be $5,200,000. Great River Energy anticipates securing $3,526,400 of the funding through conventional financing. The funds being requested from the Industrial Commission of North Dakota are $1,673,600. An affidavit stating that Great River Energy does not have an outstanding tax liability owed to the state of North Dakota or any of its political subdivisions is also included in Appendix B.

9.1 Detailed Budget

This is the proposed budget for one scrubber conversion. CCS has 2 scrubbers.

Item	Description	Unit Price	Quantity	Estimated Cost
1	Oxidizer Tanks	$300,000.00	2 ea.	$600,000.00
2	Oxidizer Discharge Pumps	$7,500.00	4 ea.	$30,000.00
3	Vacuum blower	$100,000.00	2 ea.	$200,000.00
4	Hydroclones	$50,000.00	2 ea.	$100,000.00
5	Control Slurry Valves	$2,500.00	2 ea.	$5,000.00

6	Vacuum Belt Filter	$475,000.00	1 ea.	$475,000.00
7	Concrete, Structural Steel	$250,000.00	1 lot	$250,000.00
8	Acid Tank	$10,000.00	1 ea.	$10,000.00
9	Acid Pump	$1,000.00	3 ea.	$3,000.00
10	Storage and Loadout	$300,000.00	1 ea.	$300,000.00
12	Equipment Installation	$1,500,000	1 lot	$1,500,000.00
13	Miscellaneous Equipment			$227,000.00
		Single Unit Total		$3,700,000.00

Other Costs	
Internal Costs; materials & labor	$457,000.00
Contingency @ 10 %	$370,000.00
Costs to date	$200,000.00
Interest During Construction	$473,000.00
Total Estimated Project Cost	**$5,200,000.00**
Great River Energy Responsibility	$3,526,400.00
Requested from NDIC	$1,673,600.00

10.0 REFERENCES

1. New York State Electric and Gas and ORTECH; "The Gypsum Industry and Flue Gas Desulfurization (FGD) Gypsum Utilization: A Utility Guide," EPRI report TR-103652, Project 3571-01, Final Report, February 1994.

2. Pflughoeft-Hassett, D.F; Eylands, K.E.; and Hassett; "Oxidation of North Dakota Scrubber Sludge for Soil Amendment and Production of Gypsum," EERC, Final Report to the NDIC anticipated late in 1997.

3. American Coal Ash Association, Inc., 1993. "1993: Coal Combustion Byproduct-Production and Consumption," Washington, DC.