

AGENDA
LIGNITE RESEARCH COUNCIL MEETING
GRANT ROUND LRC (103)

Thursday, November 9, 2023 - 1:30 p.m. (CT)
Bismarck State College – National Energy Center of Excellence Room #335
1200 Schafer St., Bismarck ND 58501

- I. Call to Order – Jason Bohrer
- II. **Approval of Minutes**
 - LRC Admin Meeting July 19, 2023 – Jason Bohrer
- III. Updates
 - Active Projects – Mike Holmes
 - Project Management and Financial Report – Reice Haase
 - Carbon Capture and Utilization Education and Marketing Special Grant Round Update – Reice Haase
 - Carbon Marketing Program Update – Jason Bohrer
- IV. Projects Submitted:

LRC-103A: High-Value Products from Produced Water Mineralization via Reaction with Anthropogenic CO₂
Submitted by: Semplastics EHC LLC
Request for: \$100,000
Total Project Costs: \$356,494
Principal Investigator: Walter Sherwood
Project Duration: 12 months
 - Technical Peer Reviewers' Ratings
 - Technical Peer Reviewers' Comments and Applicant's Response
 - Summary and Recommendation
- V. Voting Process
- VI. Briefing on completed Tundra FEED and CREST studies - Craig Bleth
- VII. Transmission Authority Update – Claire Vigesaa
- VIII. 2023/2024 Calendar
 - Industrial Commission Meeting – November 28, 2023
 - Spring Grant Deadline – April 1, 2024
 - Tentative Lignite Research Council Meeting – May 9, 2024
 - Tentative Lignite Research Council Meeting – Nov 14, 2024
- IX. Other Business
- X. Adjourn

Bold and underline indicate action items. Please review the available action items prior to the meeting.

MEETING MINUTES

LIGNITE RESEARCH COUNCIL ADMINISTRATIVE MEETING

Wednesday, July 19, 2023 - 11:00 a.m. (CT)

Microsoft Teams

LRC VOTING MEMBERS PRESENT:

Jason Bohrer – Lignite Energy Council
Randy Christmann – North Dakota Public Service Commission
Representative Todd Porter – North Dakota House of Representatives
Gavin McCollam – Basin Electric Power Cooperative
Mike Heger – BNI Energy
Charlie Gorecki – Energy & Environmental Research Center (EERC)
Ed Murphy – North Dakota Geological Survey
Jay Skabo – Montana-Dakota Utilities Co.
Bryan Walther – North American Coal Company
Tom Oakland – North Dakota Commerce
Brenden Brinkman - Coyote Creek Mine
Jay Kost – The Falkirk Mining Company
Tim Hagerott – Minnkota Power Cooperative
Al Christianson – Nexus Line LLC
Joseph Heringer – Land Board
Rita Faut – North Dakota Farm Bureau
Brad Tollerson – Otter Tail Power Company

OTHERS PRESENT:

Reice Haase – North Dakota Industrial Commission
Brenna Jessen – North Dakota Industrial Commission
Mike Holmes – Lignite Research Council
Angie Hegre - Lignite Energy Council
Jonathan Fortner – Lignite Energy Council
Chuck Hyatt – ND Department of Environmental Quality (NDDEQ)

GUESTS:

Kevin Connors, EERC

I. CALL TO ORDER

Meeting called to order:

Lignite Research Council (LRC) Chairman, Jason Bohrer called the LRC meeting to order at 11:03 a.m. (CT) on July 19, 2023.

II. APPROVAL OF MINUTES

Approval of May 11, 2023, LRC Meeting Minutes:

Jason Bohrer asked for a motion to approve the minutes from the above-listed meeting. Al Christianson so moved; seconded by Rita Faut. Motion carried.

III. PROGRAM FINANCIAL SUMMARY

Program Financial Update:

Reice Haase shared a brief financial summary regarding the Lignite Research, Development and Marketing Program. With the full financial summary shared the prior month, Haase gave the summary of where we stand to date. After the last grant round the projects totaled \$11.4 million. At that meeting the LRC had \$9.3 million available but since that time we have had some project decommitments and repayments that totaled over \$3 million so that left the committee at the end of the biennium with \$366,000 in uncommitted cash left in the lignite research fund. Haase said it was a good story that we were able to commit so much of our dollars efficiently to great projects. That also means you have enough funds to approve the amendment requests today. Haase shared that now that we are in the new biennium you will also start to see new income starting to fill the lignite research bucket again.

IV. ELECTION OF THE EXECUTIVE COMMITTEE MEMBERS AND CHAIR

With the update of the Executive Order; a Chairman, Vice Chairman as well as a five-person Executive committee needed to be voted on. For continuity and convenient sake, Bohrer shared the discussion was to move forward with the current committee members.

Executive Committee Members consist of:

- Jason Bohrer – Lignite Energy Council
- Randy Christmann – North Dakota Public Service Commission
- Ed Murphy – North Dakota Geological Survey
- Jay Kost – The Falkirk Mining Company
- Gavin McCollam – Basin Electric Power Cooperative
- Brad Tollerson – Otter Tail Power Company
- John Bauer – Rainbow Energy Center

Approval of Chairman and Vice Chairman:

Jason Bohrer asked for a motion to approve the Chairman and Vice Chairman positions to continue with himself and Randy Christmann. Mike Heger so moved; seconded by Al Christianson. Motion carried.

Bohrer explained that the Executive committee exists in the statute, and it functions to move quickly if decisions are needed and in the absence of the full committee. For the sake of transparency and engagement, Bohrer shared his preference is to use the full committee rather than making use of the Executive committee.

Approval of Executive Committee:

Jason Bohrer asked for a motion to re-establish the Executive committee as previously established with the last Executive Order. Jay Skabo so moved; seconded by Rita Faut. Motion carried.

V. ADMIN TOPICS

A. Conflict of Interest

Bohrer reviewed the statute and explained that if your company was to benefit from one of these projects by directly participating, if you are listed on the project, have direct connection from your individual company or entity, it would be a conflict of interest.

Bohrer shared a lot of these technologies and projects have a significant benefit to the rest of the industry, many things can be applicable to your business model or facility, but it is the direct one level of removal from your companies' finances that is consistent with the state statute on conflict of interest for individual who serve on Boards and commissions.

Bohrer shared that if there is a personal conflict of interest that would also need to be disclosed.

B. Alternates

This topic was discussed at length at the last committee meeting. Bohrer said the LRC is the only council that has alternates. It is not the way other Boards and committees' function. Bohrer shared we are not going to reestablish a consistent list of alternates. With the updated Executive Order, we have updated the list to meet quorums. This will allow for consistency with other state operations as far as their boards and commissions.

C. Remote Access

Bohrer said we will make the two meetings a year in-person, not virtual. The dates of these two meetings are shared months in advance. Should there be a special grant round or special administrative meeting, we will offer remote access.

D. Post Recordings of LRC Meetings

The state is required to keep records and has an open access requirement. The LRC meetings, as the other boards and commissions, will be recorded on Microsoft Teams. This allows for our governance to be more transparent. Reice Haase agreed that these meetings are open to the public and they can attend in-person, or they will have access to the recordings on the NDIC website.

E. Tours of Projects

Bohrer discussed whether our committee would have an interest in touring projects and hosting meetings at those locations. This would allow for increased knowledge of projects and can be incorporated in projects of the future. Haase shared that some other advisory boards are currently doing this, and it is nice for the board members to see firsthand what they are voting on. Bohrer asked for feedback and ideas via email. Gorecki offered to host at EERC or with any commercial partners.

VI. Updates

Legislative Changes – Jason Bohrer and Reice Haase

Carbon Capture Communication and Strategy Development program

A need to make sure the public understands the benefit to ND for developing a carbon industry. The Legislature directed that each of the research councils (lignite, oil and gas, renewable) allocate \$100,000 each for the creation of a CO₂ entity of some sort that would spearhead some of the marketing that is happening within our industry, research partners, and tell the story. Haase shared the CO₂ utilization concept came out this session after discussions of the value of CO₂ to ND and changing its perceptions to see CO₂ as a commodity. The concept started with a need for outreach and education for CO₂ specifically. Haase stated the action item that is needed from the Lignite Research Council is to decide how to approach it. Jason Bohrer asked for a motion to create a small working group to provide input and direction to the NDIC. Attendance would be open to the members of the Lignite Research Council. Bohrer shared the working group would need to have a better assessment of where the public is on all issues CO₂ and provide some type of baseline public opinions and research on what the

challenges are associated with CO₂. Commissioner Christmann moved that the LRC Chairman appoint a working group; seconded by Charlie Gorecki. Motion carried.

Lignite Plant of the Future

An element of funding was allocated for the lignite plant of the future to understand the needs, the market, the challenges including regulatory, economic, access to capital, industry, interests, and other issues with building a new lignite power plant. The funding is to help find what we can provide members and Legislators to make policy changes to incentivize new lignite power plants.

The lignite plant of the future was added to our budget bill, it's not an appropriation for new dollars it's a commitment for existing dollars. The addition of the directed \$500,000 study on Technology options for Future Lignite-Fired Power generation is listed in the amendment request below LMFS-22-43.

VII. R&D Update / Amendments

Mike Holmes gave a Research & Development update along with the EPP Amendment information. He shared the breakdown of active projects consisting of 50% other emerging markets, 23% Rare Earth Element-Critical Minerals, 19% Carbon Management, and 8% miscellaneous. He shared a graph of the breakdown with the active projects NDIC is funding and the totals. The NDIC funding totals \$44.4 million of which 71% is Carbon Management, 13% Rare Earth Element-Critical Minerals, 11% Emerging Markets, and 5% miscellaneous. Total project funding is \$161.84 million.

With the report, Holmes shared several of the active and recently completed Lignite Research Program projects with some detail. Holmes shared current strategic studies as well as future studies and planned white papers. As always, Holmes encouraged the group to reach out for any further explanation or detail.

He shared in detail each task of the EPP and how they change with the amendment. The tasks included

- 1-Project Management
- 2-Research and Development
- 3-Environmental Strategies
- 4-Markets and Planning Strategies
- 5-Legal Strategies
- 6-Transmission Activities

(Details of the amendments below)

Amendment to LMFS-22-43

Enhance, Preserve and Protect, Research & Development, Environmental, Legal, Power Markets and Transmission Planning Services

Duration: January 1, 2023-December 31, 2025

Proposer: Lignite Energy Council

PM/PI: Angie Hegre PM & Michael Holmes PI

Purpose: The Enhance, Preserve and Protect project continues to build on the ongoing commitment and cooperation among government agencies, elected leadership and the lignite industry to insure the long-term viability of the ND lignite industry.

Objectives include:

- Build on previous work to preserve and protect the existing lignite fleet in ND.

- Employ and update Advanced Energy Technology (AET) Program.
- Identify opportunities to enhance the future of the state’s lignite resources.
- Monitor regulatory policy that could jeopardize the future of lignite.
- Be flexible and timely, working with industry and regulators to make the best use of lignite.

Opportunities already identified include:

- Rare Earth Elements and Critical minerals
- Developing carbon materials from lignite
- Managing CO₂ through Carbon Capture Utilization and Storage (CCUS)
- Evaluating next generation lignite conversion systems

Amendment Changes:

- Addition of the directed \$500,000 study on Technology Options for Future Lignite-Fired Power Generation.
- Transmission Authority base funding will be provided by the state with continued support from the EPP Project.
- The net effect of these two changes requires additional funding of \$204,418.

Conflicts of Interest: Lignite Energy Council Members (indirectly) and EERC.

Amendment to FY20-091-226

PCOR Initiative to Accelerate CCUS Deployment

Duration: 5 years
Proposer: Energy and Environmental Research Center (EERC)
PM/PI: Kevin Connors

Purpose: The EERC – through its Plains CO₂ Reduction (PCOR) Partnership – is working with partners in the lignite industry to secure \$500,000 initially from the Lignite Research Council with another \$1.5 million set aside for anticipated increased funding from the DOE. The goal of this project is to accelerate and facilitate the buildout of CCUS infrastructure in North Dakota and neighboring states. The PCOR Partnership includes the primary players in North Dakota’s lignite industry who have been working with the EERC over the last 16 years to validate the technical and economic viability of CCUS technology. This new project – which will be largely funded by the DOE – will benefit North Dakota by working towards monetizing recently passed Federal legislation that provides tax credits for energy companies to capture and geologically store CO₂. This phase of the project is planned for a five-year time frame. The current request is for the final increment of \$500,000 to bring the NDCI funding to \$2,000,000 of the previously approved \$2,000,000.

Background:

- The North Dakota Industrial Commission (NDIC) committed to supporting PCOR’s 5-year effort by matching U.S. Department of Energy (DOE) funding with cash cost share:
 - Up to \$2M through the Lignite Research Program (LRP).
 - Up to \$2M through the Oil and Gas Research Program (OGRP).
- The EERC applied for \$5M in additional funding from DOE in 2022. DOE recompeted the appropriated funds through a new Funding Opportunity Announcement (DE-FOA-0002799).

Likewise, 2023 appropriated funds will be recompeted per DOE's Notice of Intent (DE-FOA-0003013).

LRC Recommendation: Approve the final \$500,000 funding increment for the PCOR partnership with a cost-share level of at least 70% for the project.

Conflicts of Interest: EERC and most of the Lignite Industry as PCOR partners

VIII. AMENDMENT MOTIONS

Chairman Bohrer asked for a motion to authorize the Lignite Council to work with the Industrial Commission to add a separate sub task to the EPP project to incorporate the \$500,000 study for the Future Lignite-Fired Generation Plant. Al Christianson so moved; seconded by Todd Porter. Motion carried.

Chairman Bohrer asked for a motion to approve the final \$500,000 increment of funding for the PCOR Partnership with a cost share level of at least 70%. Mike Heger so moved; seconded by Jay Kost. Motion carried.

IX. 2022-2023 CALENDAR

Chairman Bohrer announced that the next NDIC meeting is scheduled for July 28, 2023. A reminder of the fall grant deadline of October 1, 2023, with the LRC meeting on November 9, 2023, and the Industrial Commission following on November 28, 2023.

X. OTHER BUSINESS

XI. ADJOURNMENT

There being no further business, Chairman Bohrer requested adjournment of the LRC meeting. Commissioner Christmann so moved; seconded by Jay Skabo.

The North Dakota Industrial Commission meeting, when these recommendations will be considered, will be held on July 28, 2023.

Angie Hegre, recording secretary



LIGNITE RESEARCH PROGRAM PROJECT MANAGEMENT REPORT

Reice Haase, Deputy Executive Director, NDIC

November 9, 2023

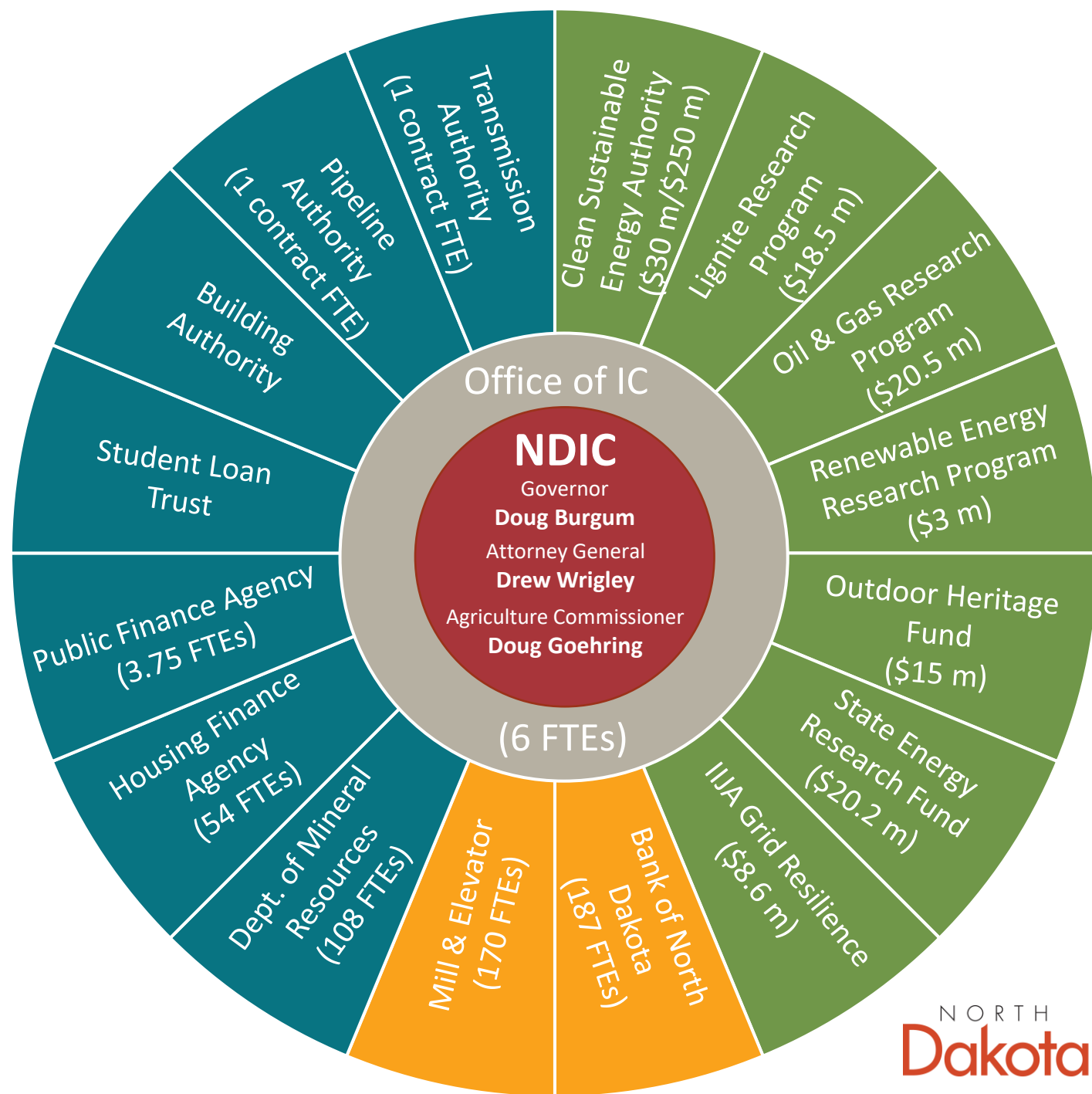
NORTH
Dakota

Be Legendary.™

Industries, Agencies, and Programs

Legend

- Commission
- Office of IC
- Agency Role
- Grant Program
- State-Owned Enterprise

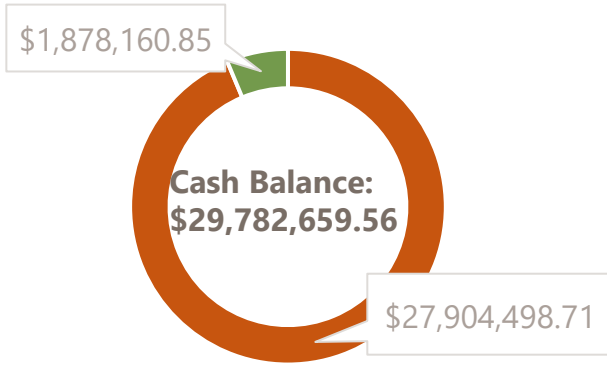


Updated to reflect 68th Legislative Assembly changes

INDUSTRIAL COMMISSION-MANAGED FUNDS

(AUGUST 31, 2023)

Lignite Research Fund



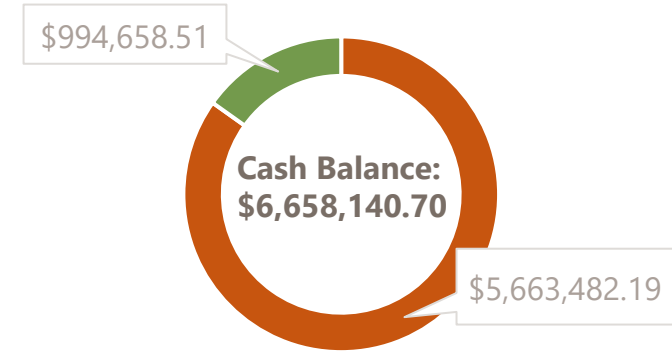
■ Committed ■ Uncommitted

Oil and Gas Research Fund



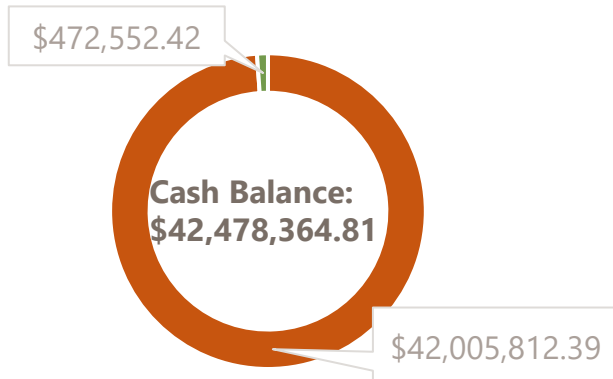
■ Committed ■ Uncommitted

Renewable Energy Fund



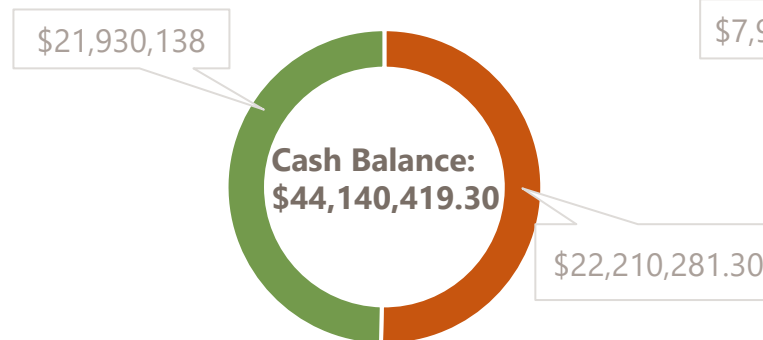
■ Committed ■ Uncommitted

Outdoor Heritage Fund



■ Committed ■ Uncommitted

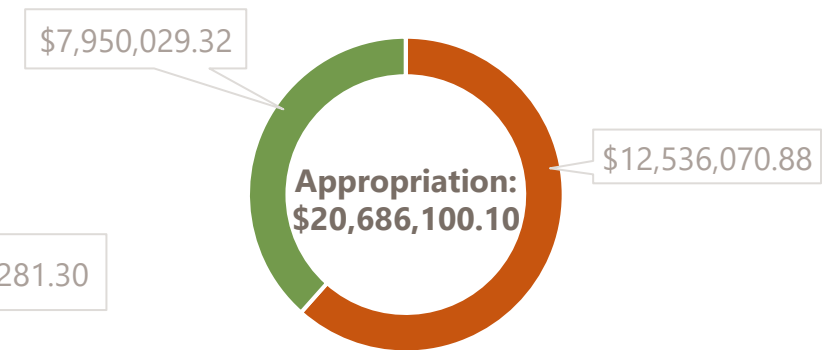
CSEA Fund*



*Does not include ARPA or Loans

■ Committed ■ Uncommitted

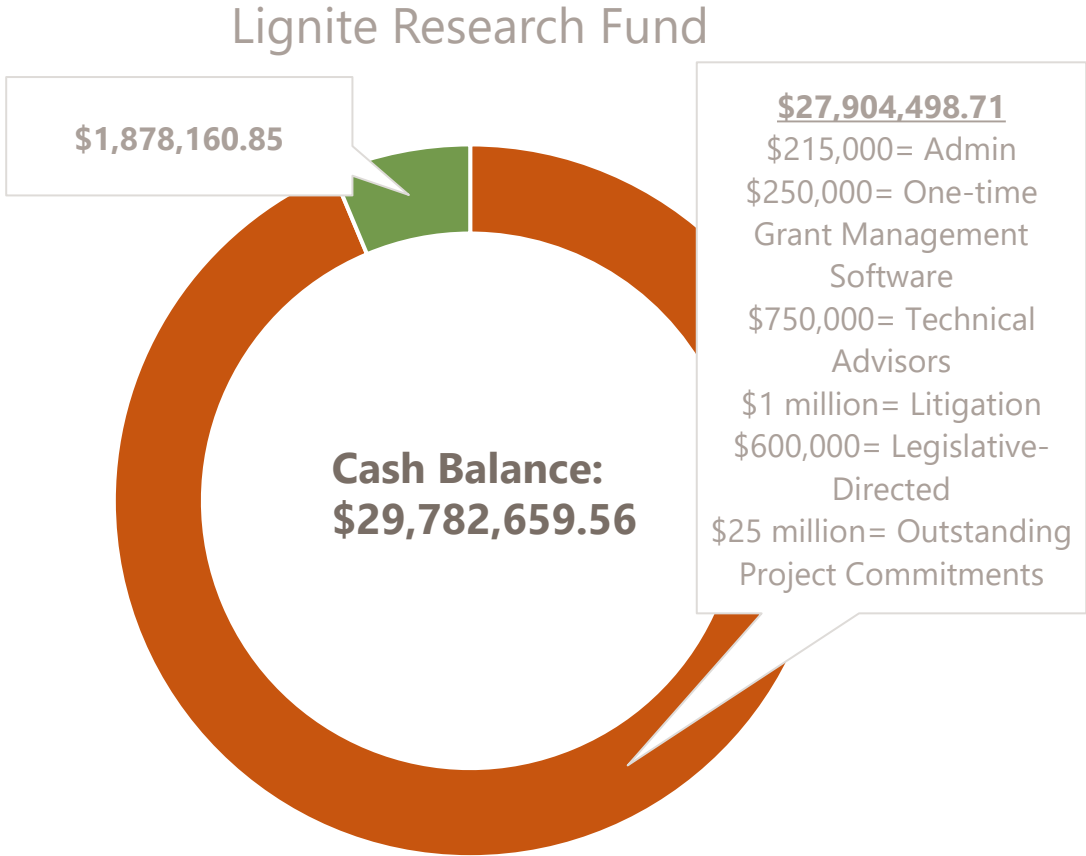
SERC Fund



■ Leg. Directed ■ Remaining ■ Spent

LIGNITE RESEARCH FUND BALANCE

NOVEMBER 9TH, 2023



■ Committed ■ Uncommitted



Funding Source:

- Coal severance and conversion taxes (\$8.5 million)
- \$10 million oil extraction tax



254 Cumulative Projects



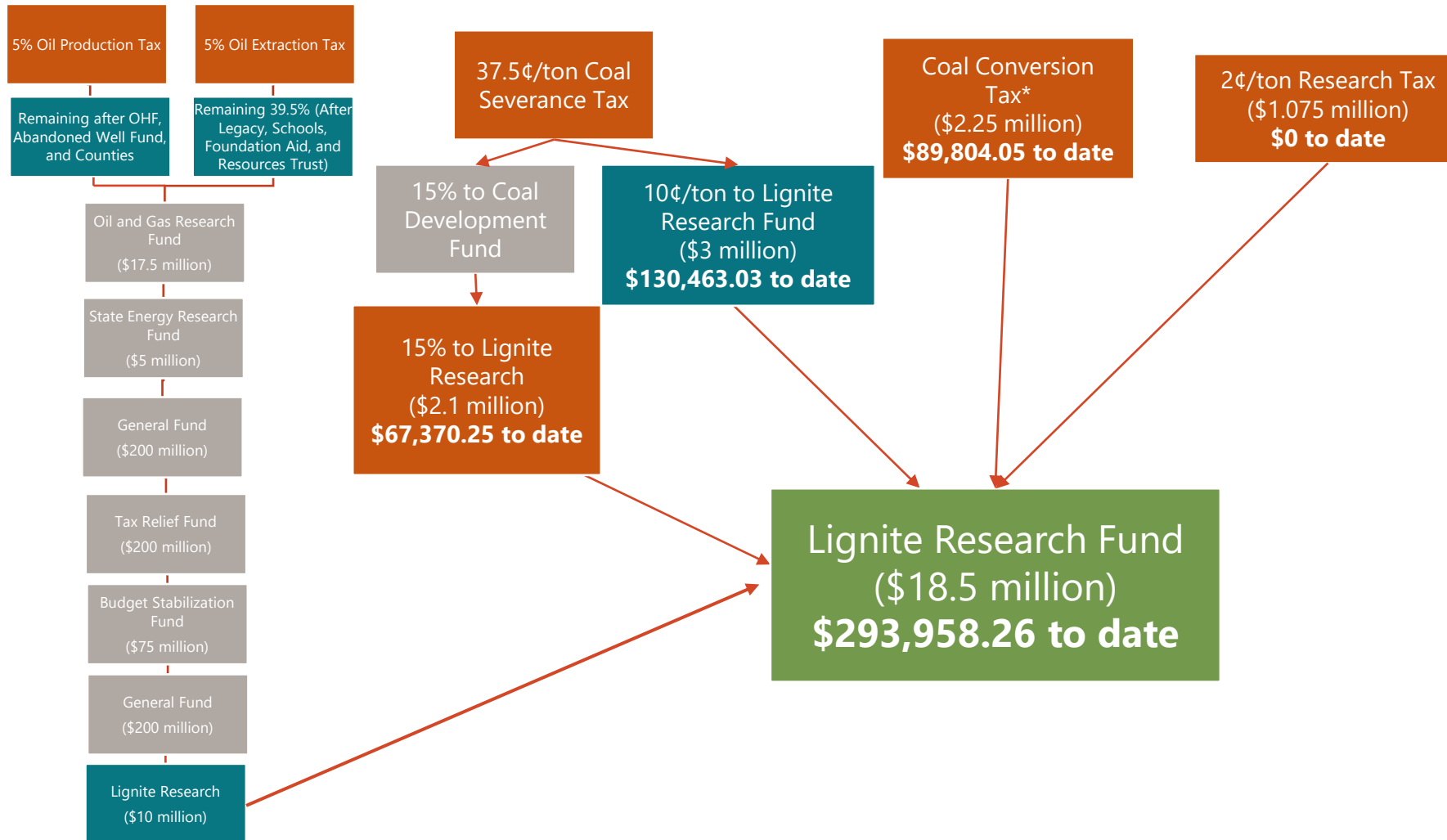
28 Active Projects



Cumulative Value:

- \$134.8 million granted
- \$2.7 billion project value

2023-2025 BIENNIUM APPROPRIATION AND FORECASTED INCOME





INDUSTRIAL COMMISSION OF NORTH DAKOTA

Doug Burgum
Governor

Drew H. Wrigley
Attorney General

Doug Goehring
Agriculture Commissioner

Memorandum

TO: Doug Burgum, Governor and Chairman
Drew Wrigley, Attorney General
Doug Goehring, Agriculture Commissioner

FR: Reice Haase, Deputy Executive Director

DT: October 31, 2023

RE: Special Grant Round for Carbon Capture and Utilization Education and Marketing

Section 10 of HB 1014 passed by the 68th Legislative Assembly included an appropriation of \$300,000 "to contract for carbon capture and utilization education and marketing". The lignite research fund, oil and gas research fund, and renewable energy development fund are directed to each contribute \$100,000 to the effort. The Commission is directed to develop the contract in consultation with each of the fund's respective research councils.

The next meetings of the respective councils are currently scheduled as follows:

- Renewable Energy Council: November 6th, 2023
- Lignite Research Council: November 9th, 2023
- Oil and Gas Research Council: December 2023

Each research program has a similar process for accepting grant applications, including a similar application, technical review, Council recommendation, and contracting with the Commission. A combined special grant round would facilitate a thorough review of applications and would allow the Commission to efficiently consult with all three councils prior to considering a contract that would meet the legislative intent of HB 1014.

Therefore, I recommend that the Commission authorizes a special grant round of the combined Renewable Energy, Lignite Research and Oil and Gas Research Councils for the purpose of soliciting proposals to conduct carbon capture and utilization education and marketing, during which the Commission would consider for approval only such applications that receive a positive recommendation from all three research councils.

SECTION 10. TRANSFER - FUNDS UNDER THE CONTROL OF THE INDUSTRIAL COMMISSION TO INDUSTRIAL COMMISSION FUND - CARBON CAPTURE EDUCATION.

The sum of \$300,000, or so much of the sum as may be necessary, included in the appropriation in subdivision 1 of section 1 of this Act, may be transferred from funds under the control of the industrial commission to the industrial commission fund to contract for carbon capture and utilization education and marketing in consultation with the lignite research council, the oil and gas research council, and the renewable energy council. Of the \$300,000, the industrial commission may transfer:

1. Up to \$100,000 from the lignite research fund;
2. Up to \$100,000 from the oil and gas research fund; and
3. Up to \$100,000 from the renewable energy development fund.

September 29, 2023

Mr. Reice Haase
Deputy Executive Director
ATTN: Lignite Research Program
North Dakota Industrial Commission
State Capitol – 14th Floor
600 East Boulevard Avenue, Department 405
Bismarck, ND 58505-0840

Subject: Semplastics Proposal Entitled “High-Value Products from Produced Water Mineralized via Reaction with Anthropogenic CO₂”

Dear Mr. Haase:

Semplastics is pleased to submit the subject proposal in partnership with the University of North Dakota (UND) Energy & Environmental Research Center (EERC). The application solicits the support of the Lignite Research Program for the execution of a bench scale project to test a technology that takes two waste streams, produced water and carbon dioxide, and makes a value-added product of carbonate ceramic composites for building products while improving the quality of the brine water such that it can be reused rather than disposed of.

The \$100 application fee for this proposal is provided. Semplastics is committed to completing the project as described in the proposal if the Commission makes the requested grant. If you have any questions, please contact me by phone at (407) 353-6885 or by e-mail at wgeaster@semplastics.com.

Sincerely,



William G. Easter
CEO, Semplastics EHC LLC

**High-Value Products from Produced Water Mineralization
via Reaction with Anthropogenic CO₂**

Proposal Submitted to the Lignite Research Council's
Lignite Research, Development, and Marketing Program

Principal Investigator: Walter J. Sherwood, Ph.D.

Date of Application: September 29, 2023

Amount of Request: \$100,000

Semplastics EHC LLC

269 Aulin Avenue, Suite 1003

Oviedo, FL 32765

Telephone: (407) 353-6885

Point of Contact: William G. Easter

Email: wgeaster@semplstics.com

TABLE OF CONTENTS

Abstract3

Project Summary.....4

Project Description.....4

 Objectives.....4

 Methodology4

 Anticipated Results6

 Facilities, Resources, and Techniques.....6

 Environmental and Economic Impacts While Project Is Underway8

 Ultimate Technological and Economic Impacts8

 Why the Project Is Needed.....9

Standards of Success9

Background.....10

Qualifications.....11

Value to North Dakota11

Management and Timetable.....12

Budget and Matching Funds13

Tax Liability.....13

Confidential Information.....14

ABSTRACT

Objective: The objective of this project is to develop and demonstrate a cost-effective method to mineralize sodium and other Group 1 elements as well as Group 2 elements in produced water with high levels of total dissolved solids (TDS) while capturing and sequestering carbon dioxide (CO₂). The project will demonstrate a laboratory-scale process for the production of commercially useful products from sodium, lithium, and Group 2 (divalent elements such as calcium) carbonates formed by the mineralization of captured CO₂. These carbonates will be utilized to produce samples of building products such as panels, coated mixed carbonates (MxC) in polypropylene, and sodium bicarbonate or other commercially useful sodium compounds.

Expected Results: The key outcome from this study will be a process to combine two waste streams to produce high-value materials and products while permanently sequestering significant amounts of CO₂. This process uses no toxic inputs and produces no toxic waste streams, but rather results in water that can be utilized beneficially. This result will be accomplished by performing a proof of concept at bench scale through (1) design and construction of a system able to mineralize up to four kilograms of CO₂ per day, producing divalent carbonates such as calcium carbonate and softened brine which will be used to mineralize additional CO₂ to produce sodium and potentially lithium compounds; and (2) initial design of a larger scale mineralization system capable of mineralizing over ten kilograms of CO₂ per day, utilizing CO₂ from an actual combustion source.

Duration: 12 months (September 25, 2023 – September 24, 2024).

Total Project Cost: The proposed total cost is \$356,494, with Semplastics contributing \$256,494 as cash cost share and \$100,000 requested from the Lignite Research Program (LRP).

Participants: The project lead for the proposed project is Semplastics, with the project conducted in partnership with the North Dakota Industrial Commission (NDIC) through LRP, and the University of North Dakota (UND) Energy & Environmental Research Center (EERC).

PROJECT SUMMARY

Semplastics proposes to develop a cost-effective method to mineralize sodium and other Group 1 elements as well as Group 2 elements in high-TDS produced water to capture and sequester carbon dioxide. This result will be accomplished by designing and constructing a laboratory-scale process for production of commercially useful products from sodium, lithium, and Group 2 (divalent elements such as calcium) carbonates formed by the mineralization of captured CO₂. These carbonates will be utilized to produce samples of building products such as panels, coated mixed carbonates (MxC) in polypropylene, and sodium bicarbonate or other commercially useful sodium compounds. Additionally, with our project partner, the EERC, a scaled-up design for a larger pilot system will be produced based on information obtained from the bench-scale system and experimental results.

PROJECT DESCRIPTION

Objectives

The objective of the project is to develop and demonstrate a cost-effective method to mineralize sodium and other Group 1 elements as well as Group 2 elements in produced water with high levels of total dissolved solids (TDS) while capturing and sequestering carbon dioxide (CO₂). The project will demonstrate a laboratory-scale process for the production of commercially useful products from sodium, lithium, and Group 2 (divalent elements such as calcium) carbonates formed by the mineralization of captured CO₂. This system will be used to produce samples of building products such as panels, MxC in polypropylene, and sodium bicarbonate or other commercially useful sodium compounds. From the lessons learned in developing the bench scale system, the EERC will perform initial design of a larger-scale pilot scale system capable of using actual combustion exhaust as the CO₂ source.

Methodology

This project will be performed in seven separate tasks. The proposed study has a 14.5-month period of performance.

Task 1.0 – Design and Build Lab-Scale Mineralization System

The lab-scale system will be able to mineralize up to four (4) kilograms of CO₂ per day. It will be designed to produce divalent carbonates such as calcium carbonate and softened brine which will be used to mineralize additional CO₂ to produce sodium and potentially lithium compounds. Components will include a reaction vessel, pumps, piping, support structure, thermocouples, liquid and gas flow controllers, and a heating system.

Task 2.0 – Evaluate Process Parameters

The lab-scale system will be used to understand, explore, and optimize the process. Parameters to be tuned will include CO₂ input flow rate, divalent & monovalent content of produced water, pH of water, reaction temperature, and removal of iron. Outputs will be evaluated for Group 2 Divalent Metal Mineralization and for Group 1 Monovalent Metal Mineralization. The aim of this task will be to understand the process in order to provide inputs for the design and construction of a larger system.

Task 3.0 – Analyze Produced Water Input and Carbonate Outputs

Under this task, testing will be performed on water and resulting carbonates from two sources: Bakken and the Permian Basin. Input and output water will be tested for compositional analysis. Particle size distribution of both the mixed divalent and monovalent carbonates will be carried out to determine the best mix design for incorporation with resin systems.

Task 4.0 – Produce Test Panels and Carbonate Filled Plastics

For this task, composite plates will be produced that incorporate the carbonates produced with the lab-scale system. These materials will be mixed with Semplastics-proprietary resins using a proven process to produce sample materials that could be developed into replacements for conventional building materials. The aim of this task is to determine how the carbonates from various water sources affect the strength and porosity of the composites. Mixed carbonates will also be demonstrated as a filler in polypropylene to demonstrate other beneficial uses. New resin formulations will be developed as needed to improve material properties or to decrease overall cost of the materials.

Task 5.0 – Test Components and Materials

In this task, we will evaluate coatings of mixed carbonate utilizing scanning electron microscopy (SEM). We will also evaluate the microstructure of the plastic matrix after coated particles are used as filler in polypropylene and look at fractured surfaces to understand bonding characteristics. Flexural and tensile testing of injection molded tensile samples will be conducted. Sample plates will be tested for flexural strength, hardness, density, and porosity, and compared to commercial alternatives.

Task 6.0 – Initial Design of Pilot Plant Mineralization Plant

We will produce an initial design for a larger scale mineralization plant utilizing CO₂ from an actual combustion source based on lessons learned from the lab-scale system design and its performance. The larger unit will target the ability to mineralize over ten (10) kilograms of CO₂ per day.

Task 7.0 – Produce Final Report

This task will encompass all activities related to producing the final report. This will include gathering data from the experimental work, organizing the structure of the report, editing, formatting, and review before the final report is delivered.

Anticipated Results

The process, lab-scale system, and scale-up design produced under this project will support the mission of the Lignite Research Program (LRP) to concentrate on near-term, practical research and development projects that provide the opportunity to preserve and enhance development of our state's abundant lignite resources. Quarterly reports and a comprehensive final report will report the findings of this study.

Facilities, Resources, and Techniques

All work will be performed at facilities owned and operated by Semplastics and EERC using existing equipment. Semplastics will perform the bulk of the experimental work, with assistance from the EERC on analytical methods and system design. The EERC will perform the scale-up design for the larger pilot scale system.

Semplastics will utilize its extensive knowledge and experience gained from over a decade of plastics and composites development. X-MAT®, the Advanced Materials Division of Semplastics, launched in 2013. X-MAT has developed a revolutionary, high-performance material that combines some of the best properties of metals (electrical conductivity), engineering plastics (lightweight) and ceramics (high operating temperature). X-MAT has had several successful partnerships including work with NASA, Space Florida, and the Department of Energy's National Energy Technology Laboratory (NETL). X-MAT's game-changing material has been previously proven in several applications including fireproof roof tiles, lightweight space mirrors, battery electrodes, and 3D-printed ceramics. X-MAT technology can be custom-engineered to fit many specifications and has unlimited potential market applications.

Semplastics' work will be performed primarily at our advanced research laboratory located in the Central Florida Research Park adjacent to the University of Central Florida (UCF), which includes 1,500 square feet of research and engineering space. The research lab has the required equipment to conduct the Semplastics portion of the research, including ovens, furnaces, hydraulic presses, CNC router, and all related equipment and supplies. Analytical equipment for materials characterization and testing includes:

- Shimadzu IRTracer-100 Fourier transform infrared (FTIR) spectrometer
- Shimadzu DSC-60Plus differential scanning calorimeter (DSC)
- Shimadzu TGA-50 thermal gravimetric analyzer (TGA)
- Particulate Systems Particle Insight particle size and shape analyzer
- Atago NAR-1T Liquid refractometer
- Brookfield Ametek DVEELVTJ0 viscometer
- Test Resources 313 Series universal test machine (UTM)

Project administrative services will be provided by Semplastics. The project team is committed to providing all necessary personnel and resources to ensure the timely completion of all activities outlined in this proposal.

The EERC has over 254,000 square feet of laboratory and technology demonstration facilities. Their labs address a multitude of standard and nonstandard tests designed to exceed client needs. They

perform all scales of materials analysis and characterization, using state-of-the-art equipment and experienced staff to provide sample analysis, characterization, and research. Available equipment includes:

- Hitachi SU5000 field emission scanning electron microscope (FESEM)
- VG PQ ExCell ICP-MS quadrupole mass spectrometer with 27-MHz ICP RF generator
- Bruker D8 Advance X-ray diffractometer
- Rigaku ZSX Primus II Wavelength dispersive x-ray fluorescence spectrometer
- EERC-designed and built solvent absorber and stripping system that is used to capture the CO₂ from the flue gas generated by the EERC pilot-scale combustion test furnace

Semplastics and the EERC represent decades of experience in product development and process engineering and design. All project participants have committed the necessary resources to execute this project. These same industry experts have been a part of several novel composite production projects on similarly sized systems within the state of North Dakota.

Environmental and Economic Impacts While Project Is Underway

The proposed work is a bench-scale laboratory study and will not have any environmental impacts to the study area or to partner facilities. The proposed work will, however, change economic impacts through the introduction of a near-term value-added product from the capture and sequestration of anthropogenic CO₂. This process combines two waste streams to produce high-value materials and products while permanently sequestering significant amounts of CO₂. The process uses no toxic inputs and produces no toxic waste streams, but rather results in water that can be utilized beneficially rather than treated as an additional waste stream.

Ultimate Technological and Economic Impacts

Utilization of this technology has the potential to permanently capture thousands of tons of CO₂ per day to make materials useful in industrial applications and construction. This outcome aligns with progress toward Governor Burgum's goal of North Dakota carbon neutrality by 2030 as well as societal

objectives of carbon-negative building construction. The potential products to be made from the carbonates extracted from produced water, such as tiles and siding, will contain 32% by mass of captured CO₂. The process is source-agnostic and can utilize CO₂ from point sources or from direct air capture. If North Dakota is to maintain its current power industry and reach carbon neutrality, it will require an “all of the above” approach when it comes to carbon sequestration. The proposed technology will have a significant impact on carbon sequestration while producing valuable products from a second waste stream of produced water. Implementation of this process in the state at the industrial scale could create tens to potentially hundreds of new jobs to operate facilities that can be sited at produced water injection sites.

Why the Project Is Needed

While the proposed technology is not sequestering CO₂ at the same scale as carbon capture and sequestration (CCS) at large power plants, it can profitably use the “mined” minerals in produced water to make construction materials (e.g., roof tiles, siding) at scale. A 100,000 barrel per day treatment facility could capture more than 400 tons of CO₂ each day, which will certainly move the needle on greenhouse gas emissions. The technology also reduces the use of freshwater in oil and gas production in the state, because the softened brine at the end of the process is made much more useable for recycling into fracturing operations and for beneficial reuse in industrial applications.

STANDARDS OF SUCCESS

This project is a bench-scale project to move the technology from proof-of-concept to a higher technology readiness level (TRL) that will enable the process to be integrated into a more complex system defining all steps required to produce the end product as described previously. As such, the proposed work will move the technology from TRL 3 (experimental proof of concept) to TRL 4 (technology validated in laboratory as a system). This information will then be utilized to initiate the scale-up design for a pilot scale system to move up to TRL 6 (system model development demonstrated in a relevant environment at larger scale). The standard of success will be the laboratory integration of the individual

steps required to produce the final product and the development of the scaled-up system design to be executed in follow-on development work.

BACKGROUND

In proof-of-concept work, Semplastics has already constructed a four-liter reactor in which to add water, CO₂, and caustic solutions while monitoring the temperature of the reaction. This reactor has been utilized in early experiments to produce carbonates from produced water which were then filtered from the residual brine and mixed with a proprietary resin to produce a carbonate plastic composite sample (Figure 1). Additionally, Semplastics has produced many coal ceramic composites for making building components such as bricks, blocks, building panels that have outperformed their traditional market components. With assistance from the EERC, the carbon ceramic composite material production process has been scaled to pilot scale and the material produced has been used to make products to demonstrate the feasibility and performance characteristics of the coal ceramic composites. These experiences enable the Semplastics and EERC team to be successful in moving the proposed technology closer to commercial readiness.

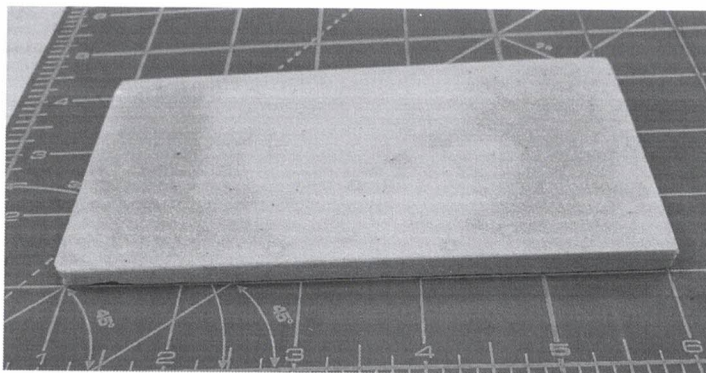


Figure 1. A 3" x 5" x 0.25" MxC-filled inorganic resin panel (~75% MxC by mass).

QUALIFICATIONS

Semplastics will serve as the lead organization for the proposed project. Dr. Walt Sherwood, Semplastics' Chief Scientist, will serve as the Principal Investigator. Dr. Sherwood has been responsible for the development of multiple proprietary resins including the resin systems used to make coal ceramic composites to develop stronger and lighter building products such as bricks and blocks. Dr. Sherwood will ensure that the project is carried out within budget, schedule, and scope. Dr. Sherwood will also be responsible for communication with project partners and EERC project personnel.

Dr. Bruce Folkedahl will be the lead at the EERC to assist in performing the initial scale-up design for the next phase of the technology development. Dr. Folkedahl has worked with Semplastics on many previous coal ceramic composite development projects and has an intimate understanding of the tools and techniques required to pilot-scale such technologies.

VALUE TO NORTH DAKOTA

The proposed project's primary value to North Dakota will be in maintaining and adding new jobs to the state and local economies in areas where current and new regulations threaten to significantly reduce activity in coal utilization, one of the state's most vital resources. The power industry and a newly created carbon capture and sequestration (CCS) industry will preserve and gain new jobs as a result of this project. If the proposed work moves into eventual commercialization, the technology will assist in providing new revenue sources not only for the operating power plants that capture CO₂ but also other sources of CO₂ capture systems such as direct air capture systems, ethanol plants in the state that capture CO₂, and other systems of CO₂ capture. Additionally, the process will aid in reducing the disposal of produced water in oil and gas production and potentially make disposal unnecessary by turning the brine into useful products while improving the water quality such that it can be used in industrial processes. One such use would be to reuse the water in the fracturing process, reducing the need for fresh water and reducing costs.

MANAGEMENT AND TIMETABLE

Semplastics is the lead organization for this project and will oversee all tasks and management activities associated with this project. Semplastics will schedule regular internal and external meetings with project staff and advisors to ensure that the project is conducted using acceptable scientific methodologies and practices in accordance with the project plan (budget, schedule, deliverables, and milestones) and is meeting quality objectives. Semplastics will keep all partners informed of project progress and coordinate activities as necessary for the execution of a successful project and will be responsible for timely submission of all project deliverables and transfer of data and products to the team.

Once the project is initiated, the project team will engage in weekly conference calls to review project status and future directions. Quarterly reports and a final report will be prepared and submitted to project sponsors for review.

The primary deliverable for the project will be a final report detailing all project activities and the successful completion of a laboratory bench scale system illustrating process improvements. The final report will also contain the initial scale-up design of the process to bring it to pilot-scale level in follow-on work.

Milestones proposed for this project are associated with the completion of each task listed in the Methodology section above. The project period of performance is 12 months (September 25, 2023 – September 24, 2024). The proposed overall schedule for this effort is depicted in the table below.

Task	Month											
	1	2	3	4	5	6	7	8	9	10	11	12
Task 1: Design and build lab-scale system	█	█										
Task 2: Evaluate process parameters		█	█	█	█							
Task 3: Analyze inputs and outputs		█	█	█	█	█	█	█	█			
Task 4: Produce test panels and materials			█	█	█	█	█					
Task 5: Test produced components				█	█	█	█	█	█			
Task 6: Design and build larger plant			█	█	█	█	█	█	█	█	█	
Task 7: Produce final report												█

BUDGET AND MATCHING FUNDS

The proposed project budget (Table 1) is \$356,494, with \$100,000 requested from NDIC and matching funds of \$256,494 from Semplastics. The budget includes subcontracts for B2K4 Consulting and the EERC, as well as a consultant for Technical and Business Assistance (TABAs) services. The requested funding is needed to enable the EERC to support the development of this technology while also supplying North Dakota produced water for use in process development and demonstration. Reduced funding from NDIC will result in reduced scope for process scale-up activities and significantly delay the prospect of moving this technology to market.

Table 1. Project budget.

Project Associated Expense	NDIC Share (Cash)	Semplastics Share (Cash)	Total Project
Labor	\$0	\$39,120	\$39,120
Travel	\$0	\$3,525	\$3,525
Materials	\$0	\$10,645	\$10,645
Subcontractor – EERC	\$100,000	\$50,000	\$150,000
Subcontractor – B2K4 Consulting	\$0	\$25,060	\$25,060
Testing	\$0	2,500	\$2,500
Consultant – TABA Services	\$0	\$6,479	\$6,479
Fringe	\$0	\$10,171	\$10,171
Indirect	\$0	\$92,214	\$92,214
Fee	\$0	\$16,780	\$16,780
Total Cash Requested	\$100,000	\$256,494	\$356,494

TAX LIABILITY

Semplastics does not have an outstanding tax liability owed to the State of North Dakota or any of its political subdivisions.

CONFIDENTIAL INFORMATION

No confidential information is contained in this proposal.

TECHNICAL REVIEWER RATINGS SUMMARY

LRC (103A): “High-Value Products from Produced Water Mineralization via Reaction with Anthropogenic CO₂”

Submitted by: Semplastics

Principal Investigator: Walter Sherwood

Project Duration: 12 months

Request for: \$100,000

Total Project Costs: \$356,494

Rating Category	Weighting Factor	Technical Reviewer Rating			Average Weighted Score
		34-01	34-02	34-03	
Objective	9	4	4	5	
Achievability	9	4	3	4	
Methodology	7	5	4	4	
Contribution	7	3	3	4	
Awareness	5	4	4	5	
Background	5	5	4	4	
Project Management	2	4	4	4	
Equipment Purchase	2	5	5	5	
Facilities	2	4	5	5	
Budget	2	4	4	4	
Average Weighted Score:		207	188	218	204

Maximum Weighted Score:

250

OVERALL RECOMMENDATION:

FUND

FUNDING MAY BE CONSIDERED

DO NOT FUND

	X		X	
		X		

TECHNICAL REVIEWERS' COMMENTS

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 34-01 (Rating: 4) *The concept of utilizing two waste streams to create a useful product is definitely within the intent of the goals. CO₂ is a byproduct of lignite utilization so that fits directly with lignite research.*

Reviewer 34-02 (Rating: 4) *The project proposes to develop cost effective methods to mineralize group 1 elements from produced water and sequester CO₂. As stated, it appears that the activity is being driven by a desire to clean up produced water with an opportunity to sequester CO₂ at the same time. This has potential to benefit ND industry including both oil and gas and power generating units in ND.*

Reviewer 34-03 (Rating: 5) *Bench scale project will attempt to develop a cost-effective way to mineralize elements in wastewater with high dissolved solids in combination with sequestered CO₂ to produce carbonates for use in making usable building products.*

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 34-01 (Rating: 4) *This work is clearly in the research stage. The tasks being evaluated under this proposal are defined, budgeted, and scheduled as such.*

Reviewer 34-02 (Rating: 3) *Based on the information given it appears likely that the team will most likely be successful in achieving their goals with the budget and timeline noted.*

Reviewer 34-03 (Rating: 4) *The 12-month project for \$356,494 is likely achievable given the tasks and experience of the members. \$100,000 or 28.1% of this bench scale project is being asked of the NDIC.*

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 34-01 (Rating: 5) *The nature of the work to be performed here is similar to previous work that the parties to the proposal have done before. LRC has worked with EERC on numerous projects, and we can have confidence in their work product. Semplastics also has applicable experience.*

Reviewer 34-02 (Rating: 4) *The methodology noted will mostly result in a successful project.*

Reviewer 34-03 (Rating: 4) Seven tasks have been laid out in detail with appropriate team members identified for them. Detail and experience of the team members/facilities makes for a likely positive outcome.

4. **CONTRIBUTION**

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

Reviewer 34-01 (Rating: 3) This work utilizes a byproduct of lignite utilization so even at commercial scale would not create a large demand for influencing utilization of lignite.

Reviewer 34-02 (Rating: 3) This reviewer believes the project could very likely be successful in achieving its goals. My question is how applicable will those results be to the lignite industry. First of all, there are no estimated economics given so it's not possible to compare this to other options. It would be good to know if it's economical on its own or would a tipping fee be required. Second, they state that both waters from ND and Texas will be used in the study. How will the economics in each case compare? Certainly, if the Texas water is superior in terms of performance, then that's where development would occur. I don't believe that would impact ND CO₂ emissions. If it is successful with ND produced waters, they state that a plant would be situated at an existing produced water treatment facility which would require a pipeline from a plant with a CO₂ capture system. How would the value proposition from this technology compare to other options for using the CO₂ product from the plant.

Reviewer 34-03 (Rating: 4) Utilization of high solid wastewater from various sources including fracking in combination with sequestered CO₂ to produce salable products has the potential to benefit more than one ND goal as well as increase valued jobs.

5. **AWARENESS**

The principal investigator's awareness of other 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 34-01 (Rating: 4) Both Dr. Sherwood and Dr. Folkedahl are well qualified for this work.

Reviewer 34-02 (Rating: 4) The information in the proposal indicates the Team is aware of current work in this area.

Reviewer 34-03 (Rating: 5) Dr. Walt Sherwood, Semplastics, has developed proprietary resins, plastics, composites and worked with the DOE, NETL, and NASA in the past. They have already worked with a four-liter reactor in their Lab.

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 34-01 (Rating: 5) Both Semplastics and EERC have facilities and other staff that are capable of supporting the principal investigators in their work.

Reviewer 34-02 (Rating: 4) There is limited information on the background of the principal investigator. The experience of the EERC is very good and well known.

Reviewer 34-03 (Rating: 4) Dr. Bruse Folkendahl, EERC, will lead EERC's involvement and will assist with analytical methods and scale-up design.

7. **PROJECT MANAGEMENT**

The project management plan, including a well-defined milestone chart, schedule, financial plan, and plan for communications among the parties involved in the project, is: 1 – very inadequate; 2 – inadequate; 3 – adequate; 4 – very good; or 5 – exceptionally good.

Reviewer 34-01 (Rating: 4) The proposed budget and timeline are achievable.

Reviewer 34-02 (Rating: 4) The project management plan includes a milestone chart that will allow the sponsors to remain informed on progress and challenges with the proposed work.

Reviewer 34-03 (Rating: 4) The tasks are well defined. Milestone chart, schedule, financial plan and communications via reporting at each task and final report also mentioned. All elements above were included in the proposal.

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 34-01 (Rating: 5) None identified.

Reviewer 34-02 (Rating: 5) No equipment will be purchased.

Reviewer 34-03 (Rating: 5) \$10,645 for materials is in Semplastics budget but none required by NDIC's budget.

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 34-01 (Rating: 4) The existing facilities and equipment are suitable for completion of this project.

Reviewer 34-02 (Rating: 5) The facilities at Semplastics and the EERC are very good and include all equipment required.

Reviewer 34-03 (Rating: 5) Both Labs and equipment to complete the tasks already exist at Semplastics and EERC.

10. **BUDGET**

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

Reviewer 34-01 (Rating: 4) *The proposed support from the lignite research program is equivalent to the budget amount allocated to the subcontract with EERC. That along with the overall budget for the project suggests that ND will get value for the commitment.*

Reviewer 34-02 (Rating: 4) *The financial commitment from Semplastics is significant as the request is for \$100,000 from NDIC out of a budget of over \$350,000. This provides for good leverage of the requested funds.*

Reviewer 34-03 (Rating: 4) *If the team can succeed with combining the high dissolved solid wastewater with sequestered CO₂ the potential is high for the utilization of waste to salable building products.*

OVERALL COMMENTS AND RECOMMENDATIONS:

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 34-01 (Rating: FUND) *This project definitely falls into the research category of technology development. It may be hard at this point to visualize a pathway all the way to commercialization, but I applaud Semiplastic for the innovative concept and undertaking this work to establish the foundation on which further development would be based.*

Reviewer 34-02 (Rating: FUNDING MAY BE CONSIDERED) *The proposed work offers the potential for significant value for the energy industries in North Dakota. The governor has challenged the energy industry to be carbon neutral by 2030. This is a significant challenge for the fossil fuel industry and will require significant development work to identify opportunities to change how things are done while allowing for the availability of low-cost energy to meet the needs of the state. Finding ways to look at CO₂ as a resource instead of a problem will be key to success in this endeavor. As I look to the proposed work, I struggle with the connection to the lignite industry as compared to the larger fossil fuel industry. Therefore, I agree the work offers significant potential value. I am questioning if it is appropriate for Lignite Energy funds to be the only source of funds for this work. I would suggest funding can be considered.*

Reviewer 34-03 (Rating: FUND) *There is a minimum of risk for the State of North Dakota to assist Semplastics and EERC to bench scale this project because the potential to convert waste stream into valued construction materials while creating valued jobs could be a decent reward. Only 28.1% (\$100,000) is being asked for of the NDIC which will go directly to EERC for their tasks on the project. Both Semplastics and EERC have the experience and facilities to accomplish this bench scale evaluation. All elements for a successful proposal are there so I would recommend funding this project.*