Williston Basin Carbon Ore, Rare Elements, and Critical Minerals Initiative 6-Month Update Meeting

March 23, 2022

John P. Kay (PI)
Principal Engineer
Assessing Our Resources
Assessing the Markets
Looking Ahead
Q&A Time
Carbon Ore, Rare Earth, and Critical Minerals Initiative
CORE-CM

- U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL)-led program
  - Catalyze economic growth.
  - Job creation in energy communities.
  - Energy communities not to be left behind.
  - Domestic production of rare-earth elements (REEs) and critical minerals (CMs).
  - Strengthen our national economy and security.
Uncertain Times – Susceptibility to Supply Disruptions

Developing domestic resources is as critical as ever.
13 Coalition Teams – CORE-CM Initiative

**US BASINS**

1. Appalachian Basin, North
2. Appalachian Basin, Central
3. Appalachian Basin, South
4. San Juan River-Raton Basin
5. Illinois Basin
6. Williston Basin
7. Powder River Basin
8. Uinta Basin
9. Green River-Wind River Basin
10. Gulf Coast Basin
11. Alaska Basin
12. Cherokee-Forest City Basin
13. Mid-Appalachian Basin

Source: NETL
Williston Basin Has . . .

Resources
Infrastructure
Knowledge
Team Players

Project Partners
U.S. Department of Energy
North Dakota Industrial Commission
Lignite Research Program

Lead Organization
EERC

Principal Investigator
J. Kay

Project Advisors
EERC Leadership Team
M. Mann, UND IES

Core Team
UND IES; Pacific Northwest National Laboratory;
UND Nistler College; North Dakota State University;
Montana Tech; Critical Materials Institute

Industry, Governmental, and Research Resources
Williston Basin CORE-CM Initiative Members
Stakeholder Meetings

- **Go**
  - October 2021
  - Project initiation

- **Fall**
  - October 11, 2022
  - First annual meeting in Bismarck

- **Hi**
  - Today
  - 6-month virtual stakeholder meeting

- **Fin**
  - May 2023
  - Phase 1 ends

- **'23**
  - January–March 2023
  - Final stakeholder meeting
Environmental Justice Considerations

Fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.

Your input requested.
Environmental Justice Considerations

Your input requested.

Effective strategies
Pitfalls to avoid
People to connect with
Thank you!
Basin Assessment Goals

ACQUIRE
Geologic Data from Partners

COMPILE
Database

BUILD
GIS-Based Geologic Model

ANALYZE
Spatial Data

IDENTIFY
Data Gaps for Future Sampling

Process Underway
Data Acquisition

- Partner-provided data
  - Rare-earth element (REE)
  - Critical mineral (CM)
  - Geologic data
# Data Sources

## REE and CM Sample Data

<table>
<thead>
<tr>
<th>New Data Sources</th>
<th>Existing Data Sources</th>
<th>Data Requested</th>
</tr>
</thead>
<tbody>
<tr>
<td>North Dakota Geological Survey (NDGS)</td>
<td>Previously submitted data to the Energy Data eXchange (EDX)</td>
<td>NDGS</td>
</tr>
<tr>
<td>UND Institute for Energy Studies</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Coal Geology Data

<table>
<thead>
<tr>
<th>New Data Sources</th>
<th>Existing Data Sources</th>
<th>Data Requested</th>
</tr>
</thead>
<tbody>
<tr>
<td>BNI Coal (well log data)</td>
<td>CoalQual Database</td>
<td>USGS</td>
</tr>
<tr>
<td></td>
<td>U.S. Geologic Survey (USGS)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>National Coal Resources Data System (NCRDS)</td>
<td>Freedom Mine</td>
</tr>
<tr>
<td></td>
<td>USGS</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Falkirk Mine</td>
</tr>
</tbody>
</table>
Data Compilation Status

- 1556 samples have been combined from multiple data sources.
  - REE concentrations
  - CM concentrations
  - Sampling information
  - Location information
Data Challenges

• Incomplete data

• Data-sampling clusters

• Unpublished data
REE and CM Sample Data Locations
Work in Progress – Data Template

Add Missing Data Fields → Add New Data
REEs and CMs

[Image of the Periodic Table with highlighted elements for Light, Heavy, Critical Rare Earth Elements, and Critical Minerals, along with symbols and notes for Gd, IUPAC Light REE; USGS Heavy REE, Included with rare earth elements, Fluorspar: Ca & F, Uranium: Fuel Material (USGS 2021).]
REE Concentration Data

Light REEs

Heavy REEs

Log\(_{10}\) - Concentration, ppm

High Value

Low Value

Median Value
Geologic Model

- Well spatial locations throughout the Williston Basin from the NCRDS
- Lithology descriptions – rock type
- Coal seam thickness
- Coal seam depth

Harmon Coal exposed along East River Road, Slope Co.
Geologic Model – Cross Section
Work in Progress: Geologic Model

• Currently collecting and incorporating wireline data provided by North American Coal Corporation and BNI Coal.

• The wireline logs will be used to further calibrate the structural surfaces of the coal beds.
Future Work

Complete Incorporation of Wireline Logs into Geologic Model

Spatially Tie Geologic Model to REE and CM Sample Data

Identify Sampling Data Gaps – Where might we find areas to sample that look promising for high concentration of REEs?
How You Can Help

Suggest or share data sources

• REE concentration data

• CM concentration data

• Geologic information
  – Well logs
  – Coal thickness and depths
  – Lithology descriptions

This Photo by Unknown Author is licensed under CC BY-SA-NC
Thank you.

Critical Challenges. Practical Solutions.
ASSESSING WASTE STREAM REUSE

Bruce Folkedahl

Advisors
Shane Addleman – PNNL
Tom Lograsso – Critical Minerals Institute
William Cohen – Current Lighting Solutions LLC
What Are We Looking For?

Waste streams that could become:
- Fuels
- Feedstocks
- Consumables

In production of rare-earth elements (REEs), critical minerals (CMs), or high-value, nonfuel, carbon-based products.
What’s the Plan?

• Compile a database of waste resources.
  – Identify resources
    ♦ Potential use
    ♦ Volume of resources
    ♦ Associated costs
    ♦ Potential regulatory issues
    ♦ Location
  – Any required enabling technologies
• Integrate into the GIS-based model.
What Are Some of the Resources Identified So Far?

Sources identified as feedstocks for REEs, CMs, and carbon products
- Lignite mining waste
- Roof
- Floor
- Tonsteins
- Combustion by-products – ash
Why Lignite Ash?

Other Waste Sources – Shales

Of 43 Niobrara and Pierre samples, 9.3% had total REE levels greater than 300 ppm.

One location in the Bakken identified with REE levels over 2400 ppm.
Average REE Levels in North Dakota Shales

![Graph showing average REE levels in North Dakota shales. The graph plots concentration in ppm against elements, with data points for different formations including Upper Bakken, Lower Bakken, Niobrara, Pierre, and Sample 120821.](EERC_CN58397.CDR)
Other Waste Resources?

Energy for Process

• Low-pressure/temperature steam from power generation
• Flare gas from oil production
• Methane from landfills
• Geothermal heat
Other Waste Resources?

- Chemical waste streams
  - Acidic materials
  - Basic materials
  - Organic materials
Sources for Waste Chemicals

- Saline aquifers
- Produced water from oil production
- Oil refinery waste streams
Then What?

- Identify data gaps
  - What do we know?
  - What do we need to learn?

- Produce a hierarchy of best potential waste streams
  - Proximity to process sites
  - Free or negative cost
  - Improved environmental sustainability
  - Regulatory considerations
  - Transport
How You Can Help

- Technologies from partners to be evaluated
  - From any of the supply chain sectors
  - At any technology development level
  - Making a product needed or not currently made

- Resources and sites for future testing
  - Ores or waste streams for processing and testing
  - Piloting/testing/sites – Phase 2: 2024
TECHNOLOGY ASSESSMENT, DEVELOPMENT, AND FIELD TESTING

Co-PI: Nolan Theaker
Co-PI: Bruce Folkedahl

Advisors
Shane Addleman – PNNL
What Are We Trying to Achieve?

- Identify technologies across supply chain.

- How do we fill these gaps?
Mining Technologies

- Mining methods
  - High-value ore
  - Thin seams or sections (<2 foot)

- Ore exploration and tracking
  - New technologies
  - Rapid, in-the-field analysis
Ore Concentration

- Physical methods
  - Density separation
  - Wettability
  - Magnetics
Ore Concentration

- Chemical methods
  - Acid–base leaching
  - Solvent extraction

Image Credit: West Virginia University

Image Credit: BTL Liners
Separation and Processing

• Separating – generating a high-purity material

• Processing – converting the high-purity material into a usable form
Manufacturing – Making the Products We Need

Identify:
- Intermediate products
- Final products
Assessment – Williston Basin Coal and Hard Rock

- How will technologies perform with Williston Basin lignite?
- What concentration/form of ore is needed?
Assessment – Williston Basin Non-Rock Resources

- What else might contain REEs and CMs?
- What technologies are needed to process these?
Assessment – Technology Readiness

• Time to market
  – Scale of the technology tested
  – Risks with scale-up
  – Does this work for Williston Basin resources?

Image Credit: UND Institute for Energy Studies

Image Credit: NETL – REE/CM Website
How You Can Help

• Technologies from partners to be evaluated (June 30, 2022)
  • From any of the supply chain sectors
  • At any technology development level
  • Making a product needed or not currently made

• Resources and sites for future testing (Phase 2)
  • Ores or waste streams for processing and testing
  • Locations to place pilot demonstrations
STRATEGIES FOR INFRASTRUCTURE, INDUSTRIES, AND BUSINESS

Jason Laumb
Task Lead

Task Assistants
Dean Bangsund – NDSU
David Flynn – UND Nistler School
Mike Ryder – Graduate Student
Kirk Williams – EERC
Strategy – What Do We Have?

• Identify basin infrastructure, businesses/industries, and economic challenges.
• Identify markets, barriers to market penetration, size, distribution, and needs.
  – Competitive environment
    ♦ What is the competition?
    ♦ How is this product superior?
      - Lower CO₂ footprint?
      - Cheaper?
      - Available?
Strategy – Know Your Customer

Raw REEs/CM?

Final Products?

- Magnets
- Aggregate
- Computer components
- Graphite/graphene

Photo Credit: Tima Miroshnichenko from Pexels
Strategy – What Do We Need?

- Additional infrastructure and resources
- Ideas to spur economic growth
- Logistical needs to fill supply chain gaps
Business Boundary Timeline and Team

STAGE 01
Existing Infrastructure
Jason Laumb
Angie Morgan and others
EERC

STAGE 02
Businesses and Industries
Revisit infographics
David Flynn
UND Nistler School

STAGE 03
Market Assessment
Infrastructure and Supply Chain Gaps
Dean Bangsund
Ag Economics
UND
NDSU
Advantageous Transportation Infrastructure

- Rail
- Truck
- Port in Duluth
Key Findings, cont.

- Regional industries
  - End users of final products
  - Defining business model

Mountain Pass REE Mine, California
Extraction to Concentrate – Hub and Spoke

Extraction Facility
REE Oxides

REE Salts

Extraction Facility
REE Oxides

Extraction Facility
REE Oxides

Extraction Facility
REE Oxides

Extraction Facility
REE Oxides

Extraction Facility
REE Oxides
Barriers: Limited Market Penetration and Price Control

Market Assessment
• Key barrier – market penetration
  – Large purchase agreement
  – China controls the price!
• Use of CMs in our region?
Key Takeaways

1. Critical mineral users and markets are influenced globally.
3. Key market barrier is the buyer.
How You Can Help

- Additional critical materials that have come to light because of political unrest in Europe?
- Supply of critical materials that is impacting your business?
- Forecasted supply chain issues for components using critical materials?
TECHNOLOGY INNOVATION CENTERS

Bruce Folkedahl

Advisors
Shane Addleman – PNNL
Tom Lograsso – Critical Minerals Institute
William Cohen – Current Lighting Solutions LLC
Technology Innovation Centers – Pushing the State of the Art

Working with Project Partners to Formulate Plans

• Basin-specific public–private partnerships
• Develop and validate CORE-CM technologies at laboratory scale

Photo by Cytonn Photography from Pexels
What’s the Plan?

- **Accelerate research** that will enable commercial deployment of advanced processing and production of rare-earth elements (REEs), critical minerals (CMs), and high-value, nonfuel coal products.
- **Support engagement** of public–private partnerships and basinal industries to advance new and innovative technology development.
- **Advance opportunities** for the education and training of the next generation of technicians, skilled workers, and STEM professionals.
Creation of TIC Plans

Create the Public–Private Partnership
- Led by the EERC
- Support from a core group of advisors
  - Organizational structure
  - Governance
  - Prospective participants

TIC Plan
Integration of the basin’s natural resources, infrastructure, industrial needs, and waste stream reuse opportunities

Photo by Chokniti Khongchum from Pexels
Creation of TIC Plans – Create the Innovation Pipeline

Identify Existing State/Regional Innovation Centers

Examples of Governance and Structure

Technology Innovation Centers and Business Incubators
  • UND Center for Innovation
  • NDSU Research Technology Park
  • Grand Sky Business Park
  • UND Tech Accelerator

Programmatic Centers (training and advice)
  • Jamestown Regional Entrepreneur Center
  • CTB (Center for Technology and Business) Bismarck

State Agencies
  • Accelerate North Dakota
  • State-Led Economic Development Regions

Photo by Anete Lusina from Pexels
How You Can Help

Public and Private Partners
• Suggestions for board members by June 2022

Resources and Sites for Future TIC
• Evaluating site, structure, and governance
• Implementation – Phase 2: 2024
THANK YOU
ENGAGING STAKEHOLDERS

Charlene Crocker
EERC Outreach Team Lead

Dan Blaufuss, EERC Outreach Coordinator
Nikki Massmann, EERC Director of Communications
Outreach Plan

01 Who are the audiences?

02 What should they know?

03 Why should they care?

04 How will they respond?

Elements of an Outreach Plan

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A Stakeholder Is

One who is involved in or affected by a course of action. Anyone with an interest in the Williston Basin.

- Current Coalition members
- Future Coalition members
- Legislators
- Local and regional officials
- Entrepreneurs/employees
- Perspective customers/employees
- Educators (postsecondary and K–12)
- General public
Williston Basin CORE-CM Messaging

Nine-second sound bite:

*Williston Basin CORE-CM is investigating the use of lignite coal resources to produce a domestic supply of the chemical elements, minerals, and nonfuel carbon-based products essential to healthcare, technology, clean energy, and national security and to catalyze economic growth and job creation.*

Image Credit: Lignite Energy Council – BNI Coal Center Mine
Why Should I Care about Critical Minerals?

The Williston Basin CORE-CM Initiative

CORE-CM: Critical Minerals

What is the Benefit of the CORE-CM Project?

Why is Carbon Critical?

Setting the stage for future expansion in the Williston Basin

The Williston Basin CORE-CM project seeks to set the stage for future expansion and transformation of coal and carbon-based resource utilization within the Williston Basin by the production of rare-earth elements (REE), critical minerals (CM), and novel carbon-based products. The project will identify critical emerging technologies and potential development avenues for the production and utilization of REE and CM from coal and carbon. The project will investigate and develop potential uses of REE and CM in various sectors, including the energy, manufacturing, and construction industries. This will involve identifying market opportunities, assessing the economic viability of REE and CM production, and developing strategies for the responsible extraction and utilization of these resources.

About the Williston Basin

The Williston Basin is a large sedimentary basin centered in western North Dakota with portions reaching into South Dakota, Montana, and Canada. It has a rich and extensive history of producing critical resources for the United States, and recent research has highlighted the potential for REE and CM in the basin. The project will investigate the potential for REE and CM production from coal and carbon in the Williston Basin.

Underc.org/wb-corecm
Outreach – Stakeholder Meetings

- **Go**: October 2021
  - Project initiation

- **Fall**: October 11, 2022
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- **Fin**: May 2023
  - Phase 1 ends

- **January–March 2023**: Final stakeholder meeting
What Do YOU Want to Know and HOW?

- Materials, delivery methods, audiences?

- Where do you network?
  - Forums
  - Conferences
  - Seminars/webinars
How You Can Help

Help us improve our messaging and outreach.

Respond to the survey coming in your e-mail.

– Critique today’s meeting.
– What other information would you like?
– What materials would you find helpful?
– What conferences/meetings would be good venues for CORE-CM?
Charlene Crocker
Outreach Team Lead
ccrocker@undeerc.org
701.777.5018 (phone)
Q & A
How You Can Help

Data

- REE and CM concentration data
- Geologic information
  - Well logs
  - Coal thickness and depths
  - Lithology descriptions
How You Can Help

Technologies to Be Evaluated (June 30, 2022)
• From any of the supply chain sectors
• At any technology development level
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Resources and Sites for Future Testing (Phase 2)
• Ores or waste streams for processing and testing
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Photo by RODNAE Productions from Pexels
How You Can Help

Supply Chain and Business Matters

- Additional critical materials that have come to light due to political unrest in Europe?
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Photo by Fred from Pexels
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Respond to the survey coming in your e-mail.
– Critique today’s meeting
– What other information and materials would help?
– What conferences/meetings would be good venues for CORE-CM?
Final Details

- Please reach out if you can partner with us.
- Watch your e-mail for a survey.
- Slides from this event will be online.
- Project website: undeerc.org/wb-corecm.
ACKNOWLEDGMENT

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