CORE-CM in the Greater Green River and Wind River Basins: Transforming and Advancing a National Coal Asset DE-FE0032047

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Project Overview

CORE-CM INITIATIVE



Project and Objectives

Major Objectives

- Establish a strategic volume, including strategic plans to maximize the development of potential carbon ore, rare earth elements, and critical minerals (CORE-CM); within the creation of public-private partnerships.
- Complete detailed assessments, including State of The Art DATA (SOTA) acquisition of potential CORE-CM materials across both the Greater Green River and Wind River Basins.
- Develop planning to leverage highly trained workforces, existing and novel coal technologies, and energy infrastructure in development of CORE-CM supply chains.
- Bring together a committed network of stakeholders, gaining acceptance of new energy technology within coal regions and across communities.

Period of Performance: 2 years (Sep. 2020 to Aug. 2023)

Project Funding: Total Project \$1,959,654 DOE Contribution \$1,566,446 Participant Cost share \$393,179

Project Team

University of Wyoming School of Energy Resources Centers of Excellence

School of Energy Resources Center for Economic Geology Research School of Energy Resources Center for Energy Regulation & Policy Analysis School of Energy Resources Center for Carbon Capture and Conversion College of Business Center for Business and Economic Analysis









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Current Support

Wyoming Partners & Supporting Stakeholders:

U.S. Congressional Delegation of Barrasso, Lummis, and Cheney; Wyoming Governors Office; Wyoming Mining Association; Wyoming Representive Donald Burkhart; Wyoming Representative Mike Greear; Wyoming County Commissioners Association; Wyoming Business Council; Wyoming Small Business Development Center; Impact 307; Wyoming Counties of Sweetwater, Sublette, Fremont, Carbon, and Uinta; Kemmerer Operations, LLC; Black Butte Coal; Bridger Coal Company; Sweetwater Economic Development Coalition; Southwest Wyoming Manufacturing Partnership; Central Wyoming College; City of Rock Springs; City of Green River

Colorado Partners & Supporting Stakeholders:

Colorado State Land Board; Colorado Division of Reclamation, Mining and Safety; Associated Governments of Northern Colorado; Routt County, CO Economic Development Office; Moffat County, CO; Trapper Coal Mine; Colowyo Coal Mine

Regional Partners & Supporting Stakeholders:

Tri-State; Peabody Energy; PacifiCorp; Mango Materials; Ur-Energy Inc. The University of Texas at Austin; Concurrent Technologies Corporation: Tetra Tech; Novex, LLC; Disa, LLC; NTEC



Technical Approach - Project Tasks and Work Plan

Planned Research Activities

- 1. Assessment of main-seam coal sediments, coal mine refuse, acid mine drainage, coal combustion residuals, non-fuel coal-product residuals, and other regionally distinctive materials to evaluate potential as CORE-CM feedstocks.
- 2. Catalog waste streams from proposed CORE-CM production and other regional industries to develop reuse options that minimize disposal issues and improve CORE-CM economics.
- 3. Evaluate regional infrastructure, industries, and businesses to discover basin-specific ways to connect main CORE-CM supply chains from extraction through refining to manufacturing of non-fuel CBP and high-value CM products.
- 4. Assess both conventional and innovative technologies to overcome region-specific challenges in CORE-CM extraction, refining, and manufacturing.
- 5. Plan strategies around public-private partnerships to develop technology innovation centers in the GGRB-WRB.
- 6. Develop outreach and education strategies to collaborate with stakeholders, train future workforces, and collaborate with other CORE-CM projects.



Technical Approach - Project Tasks and Work Plan

Project Success Criteria

- The created **project coalition team** will produce **summaries and a strategic plan** to begin to implement and fulfill the CORE-CM program's upstream, midstream, and downstream goals.
- The GGRB-WRB of Colorado and Wyoming contain **abundant potential CORE-CM feedstocks**, waste-streams, opportunities for **technology development** and **placement**, **experienced stakeholders** both public and private, and regional communities supporting **extensive workforces**. Diverse planning will include these strengths.
- Using **strategies** for combining **feedstocks** and **waste-streams** in within new or **optimized technologies** with an eye to **reuse** of **existing infrastructure** and social arrangements, this project will catalyze growth, and realize the full potential of the CORE-CM resources of the GGRB-WRB.
- Summary of Environmental Justice Considerations
- Summary of Economic Revitalization and Job Creation Outcomes
- Environmental, Safety, and Health Analysis for Products Proposed to be Manufactured from CORE-CM Resources



Progress and Current Status

- Basinal Assessment of CORE-CM Resources
- Basinal Strategies for Reuse of Waste Streams
- Basinal Strategies for Infrastructure, Industries and Businesses
- Fechnology Assessment, Development and Field Testing
- Technology Innovation Centers
- Stakeholder Outreach and Education





Progress and Current Status - Assessment of Coal Sediments

A diversity of potential coal feedstocks

Evaluated across numerous coal sub-regions:

- ✓ Wind River Basin CBM and exploratory sites
- ✓ Western Wyoming (Kemmerer Mine & Haystack Mine)
- ✓ Central Green River Basin (Black Butte & Bridger Mines)
- ✓ Hannah Coal Field (retired)
- ✓ Yampa Coal Field (Colowyo, Trapper & Twenty Mile Mines)

Potential CORE-CM resources located on federal and tribal lands









Progress and Current Status - Assessment of Coal Sediments

300+ samples currently utilized within the GGRB-WRB CORE-CM assessment strategy

Hundreds to thousands of samples-to-data available!

Preliminary work identifies:

• REE & CM behavior in coals in predictable geologic behaviors





Montross, S.N.; Bagdonas, D.; Paronish, T.; Bean, A.; Gordon, A.; Creason, C.G.; Thomas, B.; Phillips, E.; Britton, J.; Quillian, S.; Rose, K. On a Unified Core Characterization Methodology to Support the Systematic Assessment of Rare Earth Elements and Critical Minerals Bearing Unconventional Carbon Ores and Sedimentary Strata. Minerals 2022, 12, 1159. https://doi.org/10.3390/min12091159

Progress and Current Status - Resource Modeling



CGS publication RS-41: Carroll, C.J., Papp, A.R., and Kinnes, D.M., 2003

WSGS publication RI 76.2019: Christopher J. Carroll, James E. Stafford, Kelsey S. Kehoe, Andrea M. Loveland, Karl G. Taboga, Elizabeth C. Cola, Deirdre R. Ratigan, and Lynsey J. Spaeth., 2019



Progress and Current Status - Resource Modeling & Gap Analysis

Mine-Scale Modeling

- Develop planning for smaller ore-body-type high-resolution model(s) at specific coal mines set within the basinal model extent & tailored to "mining districts"
- Investigate comparisons to NETL derived and future model implementation using similar SOTA data



UNIVERSITY School of OF WVOMING Energy Resources (2) Correlation of Coring & Geophysical Logging

Progress and Current Status - Basinal Strategies for Reuse of Waste Streams

Strategies and Planning for Waste Streams



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Existing Basinal Waste Streams

- Industrial
- Fossil energy & extractive industries

Potential New Waste Stream

- Proposed technologies & flow sheets
- What is currently utilized in similar processes

"Closing the Loop"

- Reduce the disposal burden of CORE-CM & existing industries
- Reduces risks & gives all basinal industries more options to absorb market and supply chain variance
- Reduces costs for all entities

Progress and Current Status - Cataloguing of Waste Streams

Initial Basinal Waste Streams Catalogue

- Development of a basinal waste streams catalogue
- Preliminary list of attributes & uses for CORE-CM
- Current & Pending data culling
- Gap Analysis & "need-to-know" for strategic planning



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Organization/Site	Activity	CORE-CM, Waste Streams, etc.
Kemmerer Mine Colowyo Mine Twentymile Coal Mine Foidel Creek Mine Bridger Coal Co. Black Butte Coal Co. Trapper Mine	Surface and underground coal mining	coal, non-spec coal-sediment, overburden
Naughton Power Station Craig Power Station Jim Bridger Power Station Hayden Power Station	Electricity production using coal from the mines above, and also natural gas at one Naughton unit.	fly ash, bottom ash, CO ₂ , flue-gas treatment byproducts
Alchem Trona Mine Allied Trona Mine Westvaco Mine Big Island Mine Ciner Mine	Trona underground mineral mining	trona, non-spec trona waste
Ciner Wyoming Genesis Alkali Solvay Chemicals Tata Chemicals	Trona processing using trona minerals from the mines above	soda ash, soda liquor, sodium sulfite, other soda- based custom products.
Shute Creek gas plant ^{[49][50]} Lost Cabin gas plant ^[51]	Gas production and separation with mixed acid gas injection and sulfur recovery	CH4, CO ₂ , H_2S & sulfur, He, water, low-pressure pore space, geothermal heat
Boysen Dam Fontenelle Dam	Hydroelectric dam, and reservoir	water, sediment
Lost Creek Uranium Jab and Antelope Uranium Maybell Mine Sugar Loaf Mine	In-Situ-Recovery of uranium, yellowcake production	uranium, vanadium, resin-wash water, spent oxidizer
Smoky Canyon Mine	Surface phosphate mine and milling	Phosphate Shurry, non-spec ore
Simplot Phosphates	Fertilizer and custom phosphate-production	Anhydrous ammonia, H2SO4, phosphoric acid, fertilizer, FSA

Progress and Current Status - Basinal Strategies for Infrastructure, Industries and Businesses

Facilitating a CORE-CM Ecosystem

Comparing potential CORE-CM development to Coal supply chains, we notice commonalities:

- Exploration
- Mining
- Processing
- Metals Processing
- Rail & freight transportation
- Materials Handling

College of Business Center for Business and Economic Analysis





Figure 17 — Rare Earth Element and Critical Minerals Supply Chain

Source: National Energy Technology Laboratory. (2022). Critical Minerals Sustainability Program. Retrieved from https://netl.doe.gov/coal/rare-earth-elements/program-overview/background.



Progress and Current Status - Businesses Mapping & Clusters

Business Mapping by NAICS Code to Identify "Clusters" Around CORE-CM Development



NAICS Code 2131 - Support Activities for Mining

NAICS Code 2121 - Coal Mining NAICS Code 2122 – Metal Ore Mining NAICS Code 2123 - Nonmetallic Mineral Mining and Quarrying



NAICS Code 3251 – Basic Chemical Manufacturing NAICS Code 3252 – Resin, Synthetic Rubber, and Artificial and Synthetic Fibers and Filaments Manufacturing NAICS Code 3259 - Other Chemical Product and Preparation Manufacturing NAICS Code 3314 – Nonferrous Metal (except Aluminum) Production and Processing NAICS Code 3328 – Coating, Engraving, Heat Treating, and Allied Activities

NAICS Code 3311 - Iron and Steel Mills and Ferroalloy Manufacturing

NAICS Code 3323 - Architectural and

Structural Metals Manufacturing NAICS Code 3329 – **Other Fabricated Metal Product Manufacturing** NAICS Code 3359 - **Other Electrical**

Equipment and Component Manufacturing

Progress and Current Status – Businesses & Infrastructure Integration

Business Mapping

- Collected information provides a wide examination of the business landscape in the basins
- Survey to businesses to hear from them on their current capabilities and perceived needs & challenges
- Results will produce strategies on how to address existing challenges and leverage current resources







Progress and Current Status - Infrastructure, Industries and Businesses Outcomes

Business Mapping & Clustering Assessment Outcomes

- Geospatial database mapping infrastructure and businesses/industries w/ EJ Mapping Overlaps
- Suggested strategies to pivot producers into new opportunities
- Skills gap analysis that maps the existing workforce skills in the region into those required in the CORE-CM industry
- Economic impact analysis of the potential effects of a fully developed CORE-CM ecosystem in the state





Progress and Current Status - Technology Assessment, Development and Field Testing

Technology Assessment and Review

- Completion of initial literature and patent reviews of potential technologies for CORE-CM benefit.
- Includes identifying:
 - Additional sampling and exploration requirements
 - Applications of conventional and unconventional mining/processing techniques
 - Beneficiation, separation, purification as well as metal recovery processes utilizing these regional resources
- Existing technology recommendations for:
 - Production of non-fuel, value-added products from coal (e.g., chemicals, polymers, carbon fiber, and activated charcoal)
 - Non-coal materials including phosphate deposits (e.g., fertilizers) and trona waste (e.g., chemicals)





Progress and Current Status - Refinement of Technology Review

Technology Review and Down Select

- Match initial literature and patent reviews of potential technologies with resource assessment results
- Technologies that may be close to State of the Art and a good fit for GGRB-WRB CORE-CM planning

Solvent extractions and carbon refinement	Crystalline carbon made with high temperature treatment and solvent extraction for electrode or nanomaterial carbon Microwave assisted amorphous to graphitic carbon conversion Carbon-carbon composites Carbon fiber derived from coal pitch Carbon-carbon composites Polymer-coal composites
Concentration and separation	REE recovery from coal ash, coal, coal basin rock, and oil shale Bioleaching of coal ore Advanced sortation for preliminary separations
Infrastructure repurposing	Retrofitting coal plants for thermal energy storage Retrofitting coal plants for small scale nuclear energy reactors



Progress and Current Status – Informed Technology Selection

Mineralogy Assessment to Guide Extraction Technology Selection

- Initial mineralogy results show the presence of small amounts of the rare earth containing minerals **apatite**, **monazite**, and **zircon** within coal sediment system hosts.
- Additional potential REE/CM hosts are also present



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Progress and Current Status – Novel Technologies

Novel Technology Review

- Novel technology review including LANL separation and processing technologies developed for actinide/lanthanide separation that could be adapted to REE extraction from coal and coal derived products.
- Novel mining techniques to be considered



Technology Innovation Center Planning

Primary: Recover of REE's and Critical Materials of specific interest determined by

- Supply, Demand & Economic attractiveness.
- Countering anticipated supply shortages (scarcity)
- Reducing foreign dependence ٠

Secondary: Manage feedstock residual carbon, in the case of carbon-ore

Tertiary: manage & use remaining mineral matter.

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GUIDING PRINCIPLES

- Technology selection offers sustainable advantages.
- Should leverage geographic, geological & resource strengths of the basin.
- Has potential to deliver competitive advantage.
- Addresses (& considers) local water availability & management concerns
- Must have material prospects for growing /diversifying local economic development & job creation.
- Are associated with a degree of novelty & newness.
- Are outwardly techno-economically sound & has positive & deliberate market impact

SELECTION CRITERIA

- Counters anticipated shortages & reduces foreign dependence for supply.
- Preferentially addressing scarcity challenges that cannot be fulfilled from other sources.
- Reduced carbon emissions & 'waste' compared to the current situation.
- Feedstock availability in sufficient quantity within the GGRB-WRB to address long term US. projected demand.
- Potential to co-process different source feedstocks.
- Economic viability, job creation prospects together with business & Investors interests.
- Leveraging existing resources, asset capabilities & competencies available within the GGRB-WRB region



Decision Criteria and Down Selection

(Preliminary Example)

- 1. Burning with CCS (baseline)
- 2. Pyrolyzing
- 3. Solvent Extraction
- 4. Concentration & Separation:
 - a. from metal ores
 - b. from coal ash,
 - c. REE-CM solution-leaching

Shortlisted technologies align with CORE-CM guiding principles and sustainability goals.

*Eliminates further consideration of burning without CCS, CBM, and Gasification options



* per CORE-CM Criteria

"Fuel Uses" are not consistent with CORE-CM Guiding Principles



Potential Supply Chain Pathways to be Analyzed Versus Resource Planning & CORE-CM Goals

Preliminary Economic Evaluation

- End-market Size (societal and economic impact)
- Local Capital Expenditure (near-term job creation & local spending)
- Labor Intensity (long-term job creation)
- Local Operating Expenditure (business growth potential & tax revenues)
- CO₂ Footprint (environment & health impact)
- Sales Per-head (knowledge intensity)

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Other Mentionable

Progress and Current Status - Outreach and Workforce Development Efforts

OBJECTIVES OF CORE-CM OUTREACH

- Providing information on the project to the target communities within the identified basins
- ✓ Assess existing resources & infrastructure
- ✓ Identify gaps in communication and training
- ✓ Make recommendations

ACCOMPLISHMENTS AND CURRENT EFFORTS

- Website and High-Level Informational Resources
- Collaboration with other CORE-CM and DOE Projects
- Collaboration with regional stakeholders (grant proposal planning)
- Expanding Stakeholder Contact List
- Initial Planning for Environmental and Social Justice Topics









WHAT ARE RARE EARTH ELEMENTS?

Rare Earths refer to the 17 elements (15 in the lanthanide series plus scandium and yttrium) that are abundant in the earths crust, but whose concentrations are less common. Rare Earth Elements can be divided into **Walky, Heavy, and Critical.**

CRITICAL MINERALS



Critical minerals are a list of 50 mineral commodities including the REE group. They are considered vital for the economic well-being of the world's major and emerging economies.

CARBON ORE

Coal, coal by-products, coal waste streams, and coal ash



WHY COAL? The feasibility of rd and the National E particularly the PR ref. BE and CM r REEs from coal an we that's compose

The feasibility of recovering REEs from the nation's vast coal-based resources has been expanded through efforts led by the U.S. Department of Energy and the National Energy Technology Laboratory. The state of Wyoming, and particularly the PRB and GGRB-WRB, are well positioned to support carbon ore, REE and CM research, by developing technologies that can help recover REEs from coal and coal by-products, making it possible to recover REEs in a way that's economical and environmentally friendly.





Progress and Current Status - Outreach and Engagement Efforts

Webinars

The webinar series has covered varying topics related to REE and CM; the webinars are open to the wider community and designed to educate and bring in more stakeholders and interested community members.

Annual Forum

In-person event hosted on-site in the GGRB to provide updates on project task and allow industry partners and stakeholders to connect





Education & Workforce Development Planning

- Discussion around utilize current K-12 education planning methods (e.g. coal mining education practices)
- Early integration CORE-CM efforts into regional Community College programs
- Include Education & Workforce Development into Technology Innovation Center strategic planning





Progress and Current Status - Outreach and Engagement Efforts

PROJECT NEEDS AT START



Information:

What questions are you being asked? What resources can we provide or where can direct attention?



People:

Who should we be talking to? How should we best be communicating?



Infrastructure: What currently exists that is applicable?

applicable?



PROJECT NEEDS NOW

Identified Gaps in Policy: We still have a lot of questions about what permitting might look like in an REE industry

Manufacturing:

With limited manufacturing happening in our region that utilizes REE and CM, an important voice is missing



Tribal and Community:

Still work to be done!

PLEASE JOIN US FOR A PRESENTATION ON TRIBAL GOVERNANCE Promited by

WES MARTEL

Senior Wind Energy Conservation Associate for the Greater Yellowstone Coalition

Thursday, October 13, 2022 School of Energy Resources Energy Innovation Center - BP Collaboration Room (2nd Floor) 12:00 - 1:30 PM Lunch Provided

PLEASE RSVP TO CHRISTINE REED BY OCT. 10 christine.reed@uwyo.edu

Project Challenges

Data Accessibility and Use

- ✓ Site Access and Data Use Agreement(s) timelines
- ✓ Initial representation of entire coal system(s)
- ***** Buy-in from non-coal extractive and processing entities

Concurrent Task Development & Task Interdependencies

- ✓ Technology Selection and Innovation Center Planning pending resource data
- ✓ Business and Infrastructure Planning with Innovation Center Planning

Contract and Personal Approvals Timelines

- ✓ Foreign Nationals approvals
- ✓ Staffing changes vs project growth

Tribal Engagement and Participation



Project Summary

Resource Assessment, Waste Streams, and Technology Selection

- ✓ Efficient sample & data acquisition to cover majority of coal reserves
- ✓ Initial model frame working around "coal districts"
- ✓ Extensive catalogue of Current and Potential Wastes
- ✓ Catalogue of potential technologies (current, novel, and SOTA)
- ✓ Initial mineral-host assessment studies

Business and Infrastructure Planning & Technology Innovation Center Planning

- ✓ Cataloguing and data basing complete
- ✓ Business and Infrastructure Planning concurrent with Innovation Center Planning needs
- ✓ Completed Scope and Criteria for Technology Innovation Center decision making/selection

Stakeholder Outreach & Education Planning Efforts

- $\checkmark\,$ Extensive activities focused on outreach and dialog with stakeholders
- ✓ Environmental and Social Justice Planning with focused outreach tasks



Appendix

Organizational Chart

Project Gantt Chart

Completed Milestones and Deliverables

Future Milestones and Deliverables

Perceived Risks and Mitigation Strategies

Organization Chart





Gantt Chart

	Name	Qtr 4, 2021 Sep Oct Nov	Qtr 1, 2022 Dec Jan Feb	Qtr 2, 2022 Mar Apr May	Qtr 3, 2022 Jun Jul Aug	Qtr 4, 2022 Sep Oct Nov	Qtr 1, 2023 Dec Jan Feb	Qtr 2, 2023 Mar Apr May	Generation Strategy Carl Strat	3 Sep
1	1 Project Management and Planning	-								-
2	1.0 Perform Project Management	_								
3	-D Project Management Plan (Update)	10/1								
4	-D Interim Report					♦ 9/1				
5	-D Energy Data Exchange (EDX) FOA-2364 REE Researcher Database Template									♦ 9/1
6	-D Inputs for NETL REE-SED Sample Data Needs									♦ 9/1
7	-D Resource Samples for Mineral Characterization and Analysis							♦ 5/1	L L	
8	1.1 Summary of Environmental Justice Considerations	-								
9	-D Summary of Environmental Justice Considerations	-								♦ 9/1
10	1.2 Summary of Economic Revitalization and Job Creation Outcomes	_								
11	-D Summary of Economic Revitalization and Job Creation Outcomes	-								♦ 9/1
12	1.3 Environmental, Safety, and Health Analysis for Products Proposed to be Manu	-								
13	-D Environmental, Safety, and Health Analysis	_								♦ 9/1
14	2 Basinal Assessment of CORE-CM Resources	-								
15	-M Internal distribution of preliminary data from 2.1 and 2.2				♦ 7/15					
16	2.1 Resource Assessment of Coal Sediments	-								
17	-D Site Access Agreement (for each site accessed during Phase 1)		◆ 12/1							
18	2.2 Resource Assessment of Coal Ash, other Coal Refuse, and Other basin specifi	-								
19	2.3 Geologic Model Development for Coal Sediments	-								
20	-M Initial geologic models at both scales complete							♦ 4/1		
21	2.4 Resource Gap Analysis and Future Characterization Plan	-								
22	-D Initial Basinal Resource Assessment Characterization and Data Acquisition Plan	-								9/1
23	-D Characterization and Data Acquisition Plan									♦ 9/1
24	3 Basinal Strategies for Reuse of Waste Streams	-								
25	3.1 Catalogue of CORE-CM Output Waste Streams	-								
20	3.2 Catalogue of hon-CORE-CM waste Streams useful to CORE-CM production	-								
27	M Encurred found R&D posteerships to Task 7									
20	- Weste Streem Besserch Cap and Challenge applyings	-				◆ 11/.	1			
29	-M Internal distribution of praliminary catalogues from 3.1 and 3.2	-			A 7/4					
21	-D Initial Waste Stream Reuse Plan	-			▼ 7/1	1				
1										-
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Completed Milestones and Deliverables

Completed Milestones and Deliverables

Task/ Subtask	Milestone Title & Description	Planned Completion Date	Verification method	Task / Subtask Number	Deliverable Title	Due Date
2.0	Internal distribution of preliminary data from 2.1 and 2.2	7/15/2022	DOE copied on internal email	1.0	Project Management Plan	Update due 30 days after award. Revisions to the PMP shall be submitted as requested by the NETL Project Manager.
3.4	Internal distribution of preliminary catalogues from 3.1 and 3.2	7/1/2022	DOE copied on internal email	2.1	Overall CORE-CM Resource Sampling Plan providing sampling locations.	Due to NETL Project Manager before accessing the site.
4.1	Internal distribution of evaluation of existing infrastructure	4/1/2022	DOE copied on internal email		sampling methods for each location, and site-specific access agreements	
5.1	Preliminary identification of existing technology SOTA	10/1/2022	DOE copied on internal email	1.0	Interim Report	Due to NETL Project Manager 12 months after award. This will include an outline of deliverable reports and preliminary findings to date.
5.2	Preliminary identification of novel technologies	12/1/2022	DOE copied on internal email			
6.1	Finish scope and criteria for Technology Innovation Center	10/1/2022	Two summaries emailed to DOE			
7.3	Host an initial forum among stakeholders and content-creators to distribute preliminary findings. Hosted by WWCC	10/20/2022	Agenda emailed to DOE along with invitation			



Future Milestones and Deliverables

Future Milestones and Deliverables				Task / Subtask Number	Deliverable Title	Due Date
Task/ Subtask	Milestone Title & Description Completi		Verification method	1.1	Summary of Environmental Justice Considerations	To be included as an appendix to the Final Scientific/ Technical Report
2.2	Forward found P&D partnerships to	Date	DOE conied on internal	1.2	Summary of Economic Revitalization and Job Creation Outcomes	To be included as an appendix to the Final Scientific/ Technical Report
5.5	Task 7	11/03/2022	email	1.3	Environmental, Safety, and Health Analysis	To be included as an appendix to the Final Scientific/ Technical Report
5.2	Preliminary identification of novel technologies	12/1/2022	DOE copied on internal email	2.4	Initial Basinal Resource Assessment	Due at the end of the Period of Performance.
2.3	Initial geologic models at both scales	4/1/2023	Visualizations of both	2.4	Characterization and Data Acquisition Plan	Due at the end of the Period of Performance.
	complete		models emailed to DOE	3.4	Initial Waste Stream Reuse Plan	Due at the end of the Period of Performance.
4.3	Initial REMI and IMPLAN outputs complete	4/1/2023	Summary emailed to DOE	4.3	Results of the Basinal Strategies for Infrastructure, Industries and Business Assessment	Due at the end of the Period of Performance.
6.2	Technology Innovation Center plan	4/1/2023	DOE copied on internal	5.3	Initial Technology Assessment and Field Development Plan	Due at the end of the Period of Performance.
	out for review by WEA/LANL		email	6.2	Initial Technology Innovation Center Plan	Due at the end of the Period of Performance.
7.3	Host final forum among stakeholders	9/1/2023	Agenda emailed to DOE	7.5	Initial Stakeholder Outreach and Education Plan	Due at the end of the Period of Performance.
	update on findings and progress into phase 2. Hosted by CNCC			1.0	Energy Data Exchange (EDX) FOA-2364 REE Researcher Database Template (per Appendix G of FOA 2364)	Due 60 days after data is produced. A (final) update is due at the end of the Period of Performance. State- specific, county-specific, and site-specific resource characterization and geographic location data (i.e., elemental concentrations; proximate/ultimate analyses; ash content; phase identification/concentrations; morphology information; etc.), and characterization information will be supplied to NETL and made publicly available through inclusion on NETL's EDX database platform.
				1.0	Inputs for NETL REE-SED Sample Data Needs (per Appendices H and I of FOA 2364)	Due 60 days after data is produced. A (final) update is due at the end of the Period of Performance. This information will be supplied in the format specified in Appendix H for uploading into NETL's Geospatial EDX Database, for use in NETL RIC's Geologic Models.
	/ERSITY School of VOMING Energy Resources			1.0	Resource Samples for Mineral Characterization and Analysis	Due to NETL Technology Manager at the end of the Period of Performance. Recipients will provide NETL with a single split REE and CM sample for each type of material or core sample assessed that reflects the highest achieved REE or CM concentration identified during conduct of the project effort, and which reflects materials used by the award recipient for their economic assessment. The quantity of sample material should be adequate for laboratory analysis of the sample. Material Safety Data Sheets (MSDS) are required to accompany material supplied to NETL.

Perceived Risks and Mitigation Strategies

	Risk Rating			Mitigation/Response Strategy		Risk Rating			Mitigation/Response Strategy	
Perceived Risk	Probability	Impact	Overall		Perceived Risk	Probability	Impact	Overall	1	
	(Low, Med, High)						ow Mod Hig		4	
Financial Risks:	-			•			Low, Mcu, Ing	u)		
Budget modifications	Low	Med	Low	The Project team has experience with projects and	Management, Planning, and Oversight Risks:					
				budgets of this type; any budget modifications will be communicated with the DOE project manager.	Project Management	Low	High	Low	Risks are negligible due to the team's collective experience in projects of this type.	
F	xx: 1	r	T		NDA-occurances	Med	Med	Med	anonymization of NDA-data upon request	
exigency at state	High	Low	Low	enterprise.	ES&H Risks:					
Cost/Schedule Ris	ks:		1		Laboratory safety risks	Low	High	Low	All personnel working in laboratories undergo required training and all labs meet safety standards.	
Project timeline	Low	Med	Low	The Project timeline was developed based on the						
mounications				Though risk is low, the Project team will communicate with the DOE project manager if timeline modifications are required.	NORM-wastes	Low	Med	Low	Avoidance of NORM	
					External Factor Risks:					
Cost overruns	Med	Med	Med	Carefully monitor & detail expenditures	Lack of acceptance from select	Med	Low	Low	The project currently has the support of a varied network of committed stakeholders that meet the	
Technical/Scope R	isks:				stakeholders				objectives of the project.	
Obstacles to data collection	Low	High	Low	Diverse access to databases, archived data, and archived samples and experience processing and summarizing	lack of public acceptance	Low	High	Low	Perform early outreach and earn social license to operate.	
				data will mitigate risk.						
Obstacles to geologic modeling	Low	Med	Low	The project team includes multiple partners with experience modeling geologic data.	Risk-mana	agement w	vill be in	npleme	nted throughout the project	
Obstacles to delivering strategic plans	Low	High	Low	The project team includes partners who are experts in their fields and have experience with comparable projects.	timeline b on the sign	y careful j nificant ex	planning pertise	g, early of the p	plan testing, and reliance roject team	
Obstacles to producing outreach materials	Low	Med	Low	Stakeholder Outreach and Education Task leads have broad experience producing outreach materials in a timely manner.						