

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

DE-FE0032047



School of
Energy Resources



Stakeholder Kickoff Meeting - October 21, 2021

Acknowledgement and Disclaimer

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Kickoff Outline

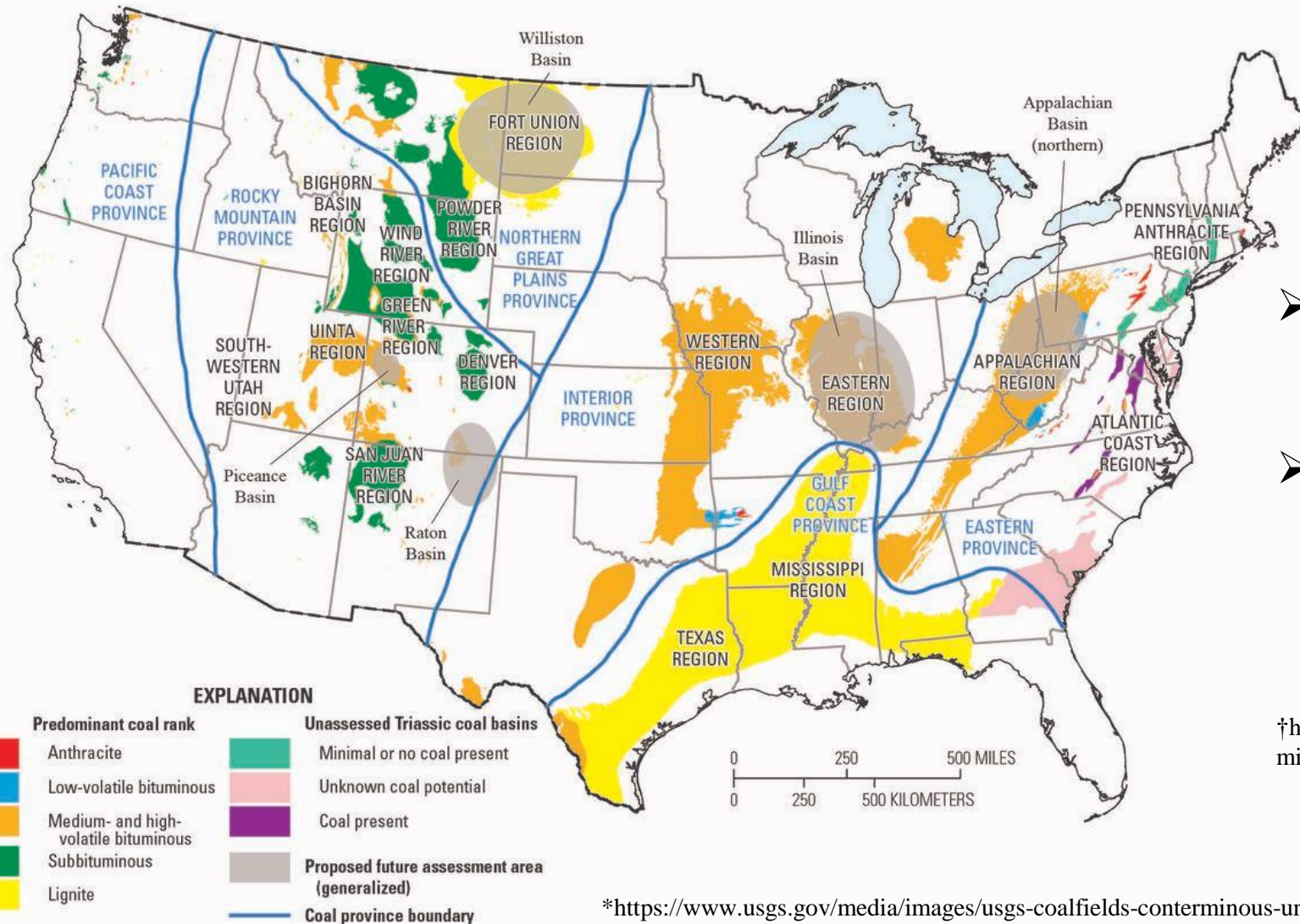
- U.S. Department of Energy CORE-CM Initiative in U.S. Basins
- Overview of Project Objectives
- Team Introductions
- Project Tasks, Goals, and Expected Outcomes
- Relevance to our Coal Region and Stakeholder Involvement
- Opportunity for Questions and Project Discussion

U.S. Department of Energy CORE-CM Initiative

- Establish 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.
- Leverage highly trained workforces, existing and novel coal technologies, and energy infrastructure in development of CORE-CM supply chains.
- Complete detailed assessments, including State of The Art DATA (SOTA) acquisition of potential CORE-CM materials across U.S. coal basins.
- Bring together a committed network of stakeholders, gaining acceptance of new energy technology within coal regions and across communities.

U.S. Department of Energy CORE-CM Initiative

Coal fields of the conterminous United States—National Coal Resource Assessment updated version



- Includes 13 DOE awarded projects across the United States †
- Provide benefit to U.S. Coal Basins and are centered around current coal mining and related industries.

†<https://www.energy.gov/articles/department-energy-announces-122-million-regional-initiative-produce-rare-earth-elements-and>

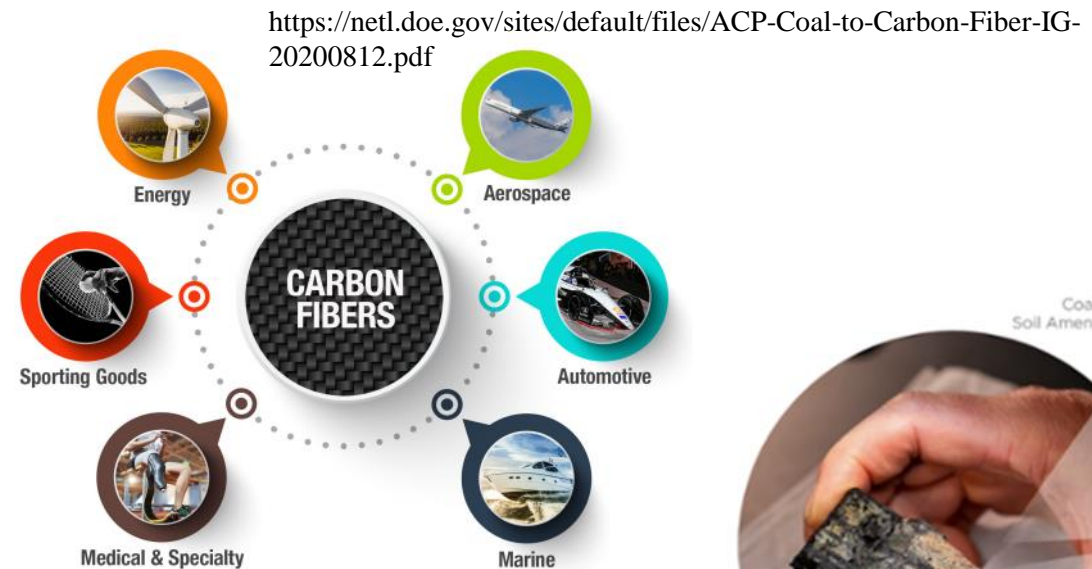
*<https://www.usgs.gov/media/images/usgs-coalfields-conterminous-united-states>

U.S. Department of Energy CORE-CM Initiative

Carbon Ore: Coal to Products



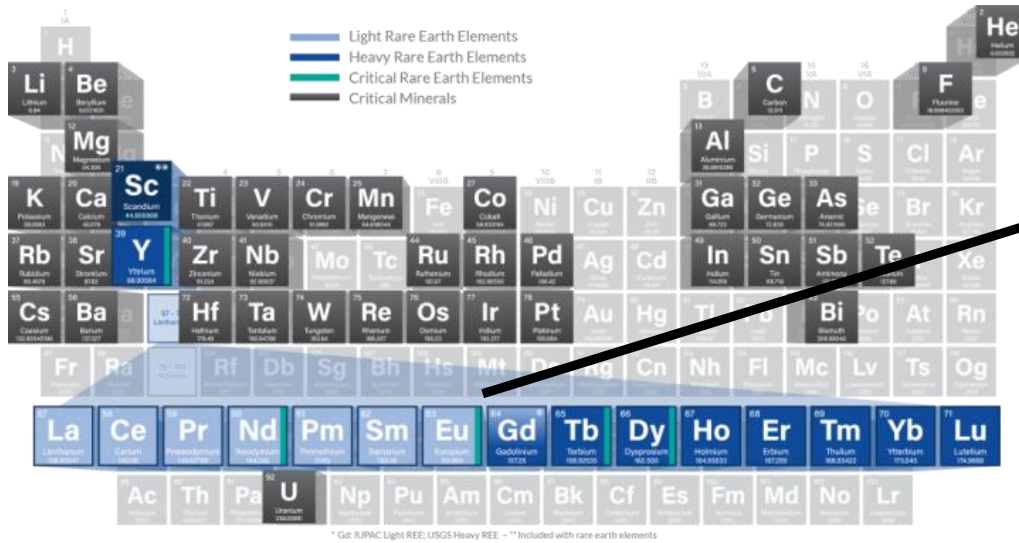
<https://netl.doe.gov/sites/default/files/2020-04/IG-Coal-to-Carbon-Products.pdf>



www.uwyo.edu/ser/research/centers-of-excellence/carbon-capture-conversion/

U.S. Department of Energy CORE-CM Initiative

Rare Earth Elements



The periodic table shows the following elements highlighted:

- Light Rare Earth Elements (blue): La, Ce, Pr, Nd, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu.
- Heavy Rare Earth Elements (dark blue): Sc, Y, Zr, Nb, Mo, Tc, Ru, Rh, Pd, Ag, Cd, In, Sn, Sb, Te, Bi, Po, At, Rn.
- Critical Rare Earth Elements (green): Sc, Y, Zr, Nb, Mo, Tc, Ru, Rh, Pd, Ag, Cd, In, Sn, Sb, Te, Bi, Po, At, Rn.
- Critical Minerals (black): Sc, Y, Zr, Nb, Mo, Tc, Ru, Rh, Pd, Ag, Cd, In, Sn, Sb, Te, Bi, Po, At, Rn.

* Ge: IUPAC Light REE; USGS Heavy REE - ** Included with rare earth elements



- 15 elements (plus two related elements)
- Utilized in almost all modern technology

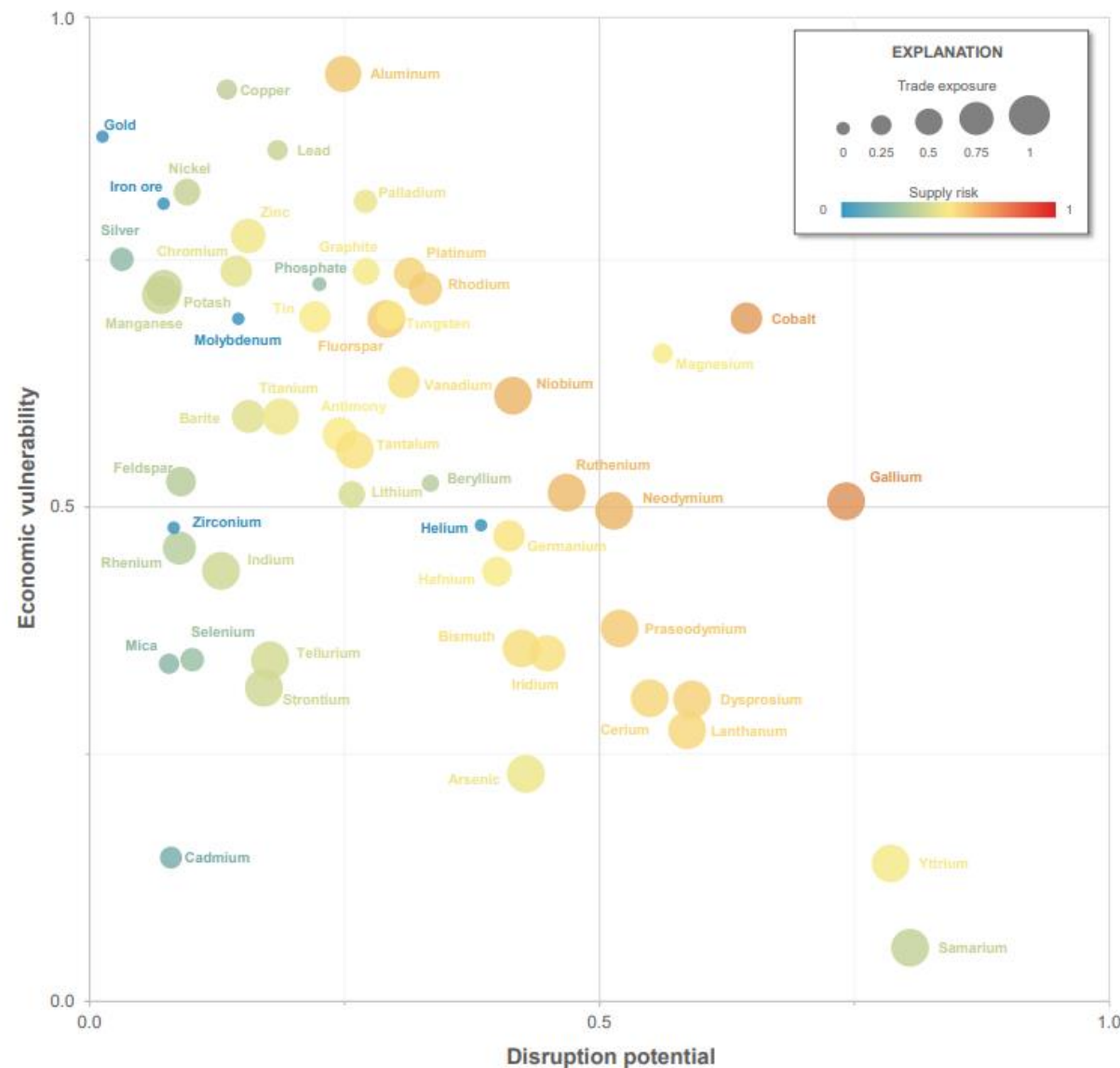


U.S. Department of Energy CORE-CM Initiative

Critical Minerals

- Includes 50 individual elements & minerals recommended for Critical Minerals Listing (CML) - including REE
- 5 additional elements & minerals for CML consideration
- 11 elements & minerals for removal from CML consideration
- And a single element not yet evaluated (U)

<https://pubs.usgs.gov/of/2021/1045/ofr20211045.pdf>



CORE-CM in the Local Region

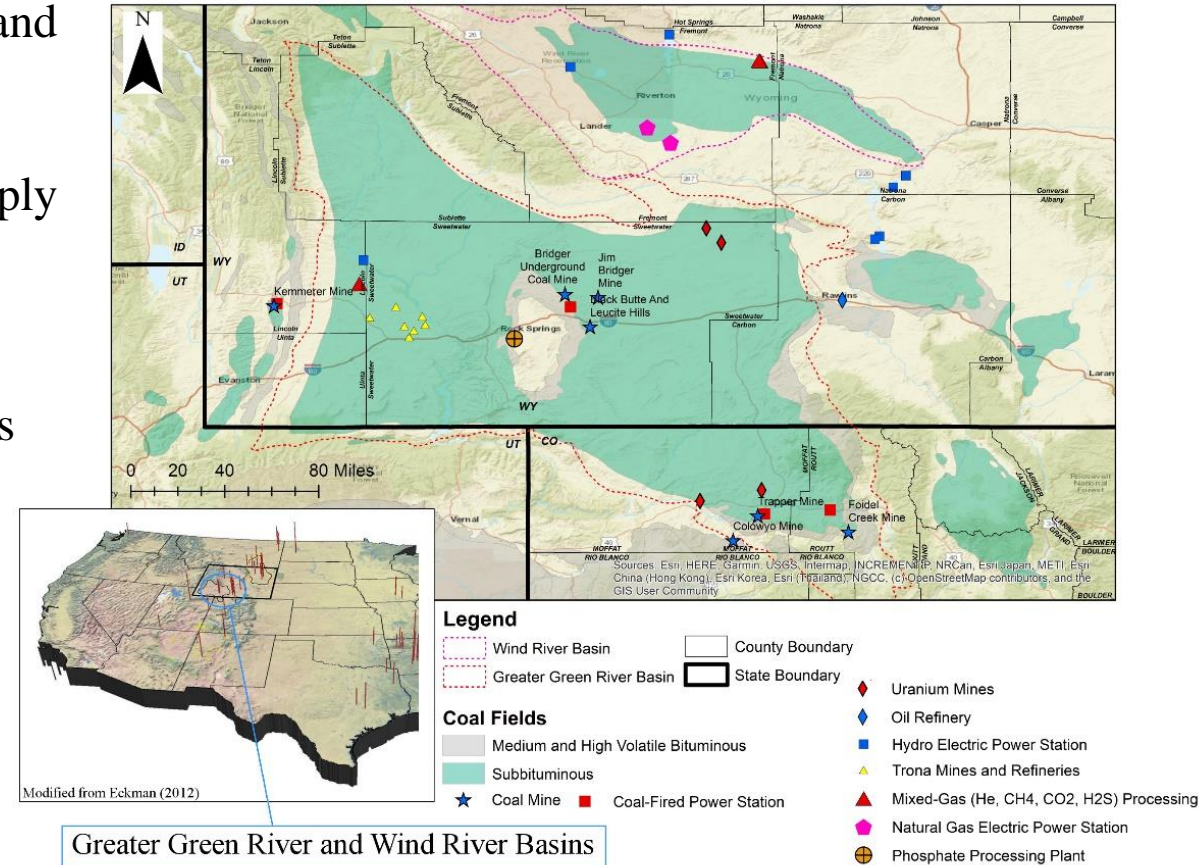
- The University of Wyoming School of Energy Resources is leading two CORE-CM projects
 - In the **Greater Green River/Wind River Basins (GGRB-WRB CORE-CM)** and the Powder River Basin
 - These projects will last two years, receiving ~\$1.5M in U.S. Department of Energy Funding
 - Both projects commenced on September 1, 2021 and will conclude in August of 2023
- Cost share for this project is provided by
 - The School of Energy Resources
 - Wyoming Energy Authority
 - Colorado School of Mines



CORE-CM in the Greater Green River and Wind River Basins

Objectives of CORE-CM in the Greater Green River and Wind River Basins

- Develop planning of regional economic growth, job creation, and associated technology innovation around coal materials
- Define regional economic growth potential to increase the supply of CORE-CM materials to manufacturers of non-fuel Carbon Based Products (CBP) and products reliant upon CM
- Plan for the use of an existing energy infrastructure, businesses and industry integration to create a CORE-CM economy
- Develop a coalition team to achieve these objectives



Our Project Team

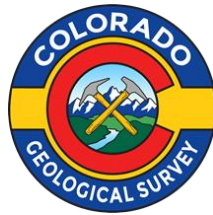
University of Wyoming

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



Coalgeo, LLC



CORE-CM Project Strategy

Integrated Strategic Plan for the Greater Green River and Wind River Basins

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

Each results in a
Strategic Plan or Assessment Summary

- 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

Task 2 Summary

Basinal Assessment of CORE-CM Resources

Task Lead: Davin Bagdonas

Research Scientist, Coal and Rare Earth Elements, UW Center for Economic Geology Research

Key Persons: Mike O’Keeffe, Mineral Resources and Geological Mapping, Colorado Geological Survey

Matthew Morgan, Deputy Director/Senior Research Geologist, Colorado Geological Survey

Matt Johnson, Research Scientist/Geomodeling, UW Center for Economic Geology Research

➤ Task 2.0 - Basinal Assessment of CORE-CM Resources

This task will evaluate available historic and current state-of-the-art (SOTA) Carbon Ore, REE, and CM data collected from within the Greater Green River and Wind River Basins. Then build an initial geologic model, propose future modeling, study trends, and identify what information should be learned in later project phases.

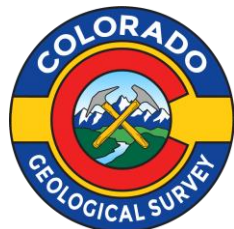
Task members:

- Center for Economic Geology Research
- Colorado Geological Survey
- Wyoming State Geological Survey (advisory)



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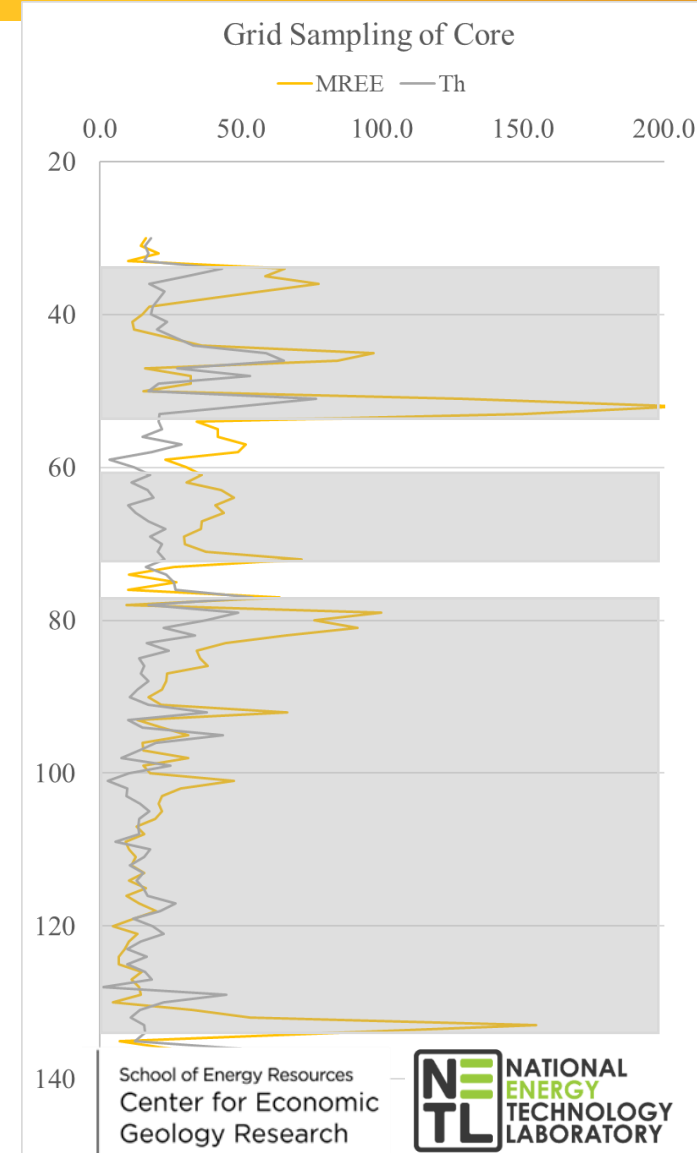


Task 2 Summary

Basinal Assessment of CORE-CM Resources

Outcomes:

- Resource Assessment of Coal Sediment Systems & Coal Ash, Refuse, AMD, and Other basin materials
 - Review existing & construct new SOTA CORE-CM data and archived samples of coal sediments
 - Estimate quantities, and character of each resource
 - Provide input to COAL DATA initiative and NETL REE Sedimentary Resource Assessment Method (REE-SED)
- Geologic Model Development
 - Target Coal Seam & Basinal Coal Sediment Systems
 - Thickness, Stratigraphic Extent
 - Collected Core Sample Measured Properties
 - Spatial Geodatabase
- Resource Gap Analysis and Future Characterization Plan



Task 3 Summary

Basinal Strategies for Reuse of Waste Streams

Task Lead: Charles Nye

Research Scientist, University of Wyoming School of Energy Resources Center for Economic Geology Research

➤ Task 3.0 - Waste Stream Reuse in the GGRB-WRB

This task will catalogue significant waste streams in the GGRB-WRB and identify potential technical, legal, regulatory and policy challenges to their reuse. This task will provide the resulting catalogue data to other tasks. The task will deliver the Initial Waste Stream Reuse Plan Deliverable.

Task members:

- School of Energy Resources
 - Center for Economic Geology Research
 - Center for Energy Regulation and Policy Analysis
- Colorado Geological Survey
- Colorado School of Mines



Task 3 Summary

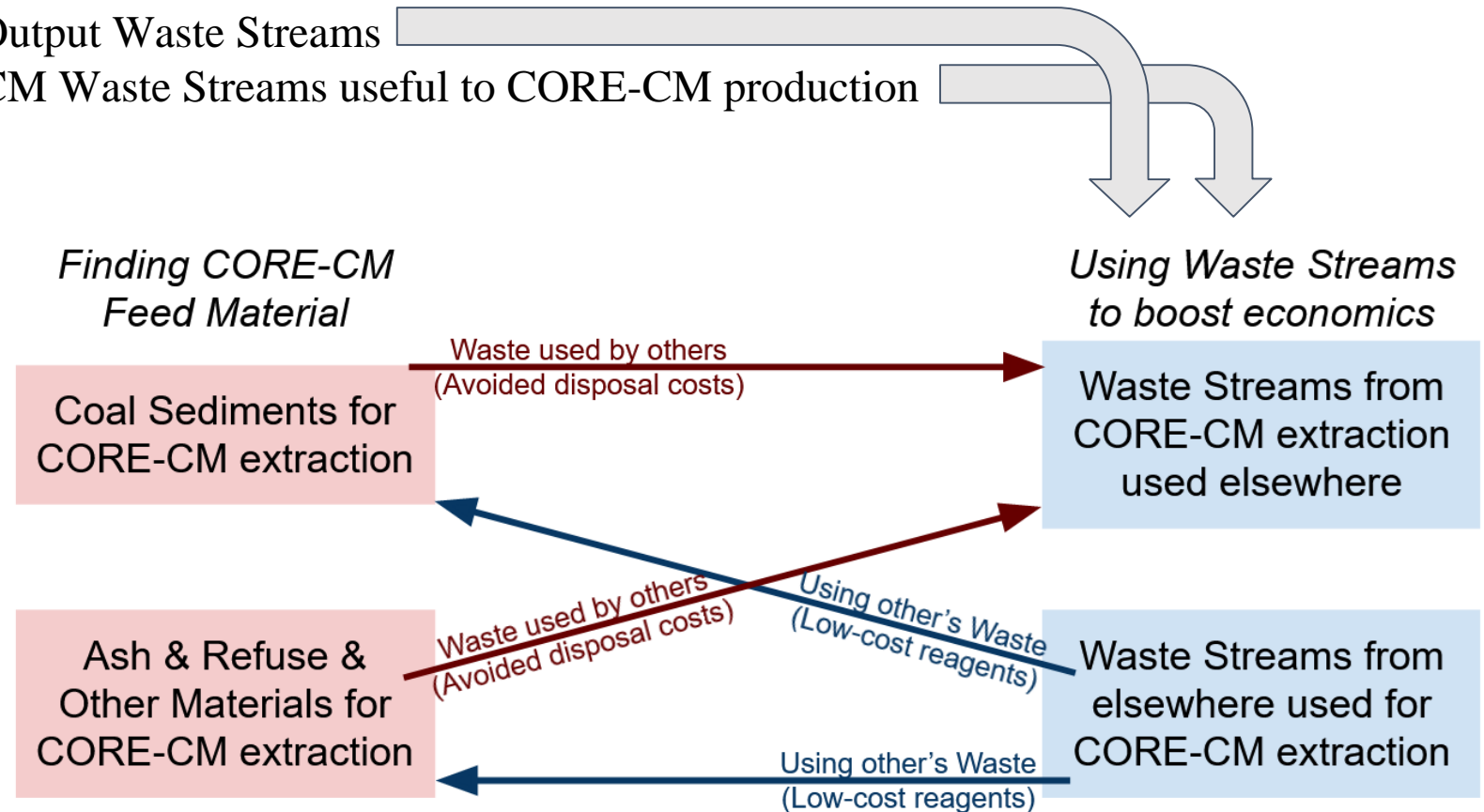
Basinal Strategies for Reuse of Waste Streams

Outcomes:

- Subtask 3.1 Catalogue of CORE-CM Output Waste Streams
- Subtask 3.2 Catalogue of non-CORE-CM Waste Streams useful to CORE-CM production
- Subtask 3.3 R&D partnerships and integration with existing industries
- Subtask 3.4 Waste Stream Research Gap and Challenge analyses

Waste Stream Reuse Plan

- Report the inventory
- Report gaps in the inventory
- Technological, social, and regulatory challenges



Task 4 Summary

Strategies for Infrastructure, Industries, & Business Integration

Task Lead: Christelle Khalaf

Ph.D., Associate Director, Center for Business and Economic Analysis (CBEA) at the University of Wyoming (UWyo)

Member of the Advisory Panel on the Anchor Economy Initiative at the Federal Reserve Bank of Philadelphia

Ph.D. Economics from NCSU & Harvard Kennedy School Executive Certificate in Leading Economic Development



Research Assistant: Rachel Pompa, Ph.D. student in the Department of Economics at UWyo

BS in mathematics & BA in economics at the University of Minnesota – Duluth

Interned with USDA ERS

➤ Task 4.0 – Facilitating a CORE-CM Ecosystem

Inventory existing infrastructure, industries, and businesses in the GGRB-WRB

Identify areas where stakeholders can cooperate to promote economic growth, job creation, and commercial success for CORE-CM in the region

Task members :

- University of Wyoming CBEA
- School of Energy Resources Center for Energy Regulation & Policy Analysis
- BSI



College of Business
Center for Business
and Economic Analysis

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Center for Energy Regulation
& Policy Analysis



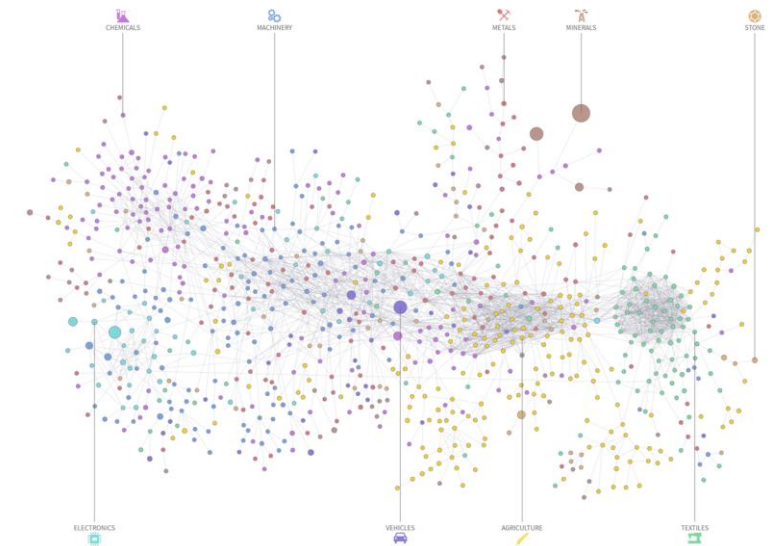
BOSTON STRATEGIES INTERNATIONAL
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Task 4 Summary

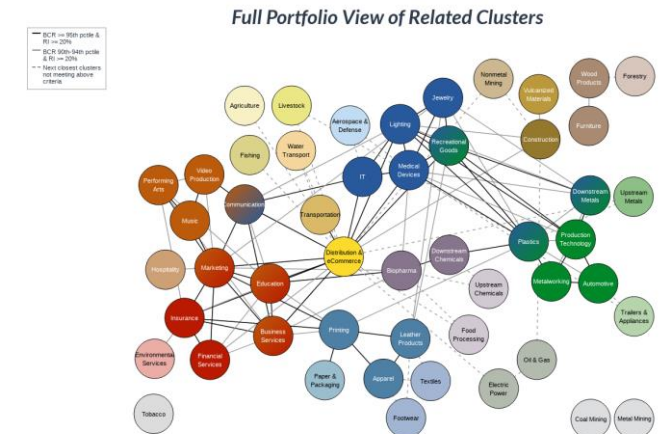
Strategies for Infrastructure, Industries, & Business Integration

Outcomes:

- Geospatial database mapping infrastructure and businesses/industries, produced by leveraging information from Dun & Bradstreet (firm-level microdata) as well as other proprietary and publicly available data (e.g., HIFLD).
- Suggested strategies to pivot producers into new opportunities based on a mapping of existing companies' core competencies into emergent CORE-CM supply chain opportunities.
- Skills gap analysis that maps the existing workforce skills in the region into those required in the CORE-CM industry.
- Outreach events to engage with key informants, regional stakeholders, and project partners in the coal and CORE-CM supply chain.
- Economic impact analysis of the potential effects of a fully developed CORE-CM industry in the state.



Note: The figure above, produced by the Harvard's Growth Lab, illustrates the product space and the figure below, produced by the Cluster Mapping Project, illustrates related industry clusters.



Task 5 Summary

Technology Assessment, Development and Field Testing

Task Lead:

Patrick Taylor, G. S. Ansell Distinguished Professor of Chemical Metallurgy
Director, Kroll Institute for Extractive Metallurgy, Department of Mining Engineering, Colorado School of Mines

Key Person:

Kirsten Sauer, Scientist, Earth and Environmental Sciences, Los Alamos National Laboratory

➤ Task 5.0 – Technology Assessment, Development and Field Testing

Investigate existing and new technologies for extraction of CORE-CM from coal and waste streams, purification of extracted CORE-CM, incorporation of purified CORE-CM into high-value products, and repurposing of coal and waste stream materials in value-added products

- Subtask 5.1 Identification and SOTA of existing technologies
- Subtask 5.2 Novel technology integration in GGRB-WRB resource chains
- Subtask 5.3 Basin-Specific Technology Planning

Task members:

- Colorado School of Mines
- Los Alamos National Laboratory



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Task 5 Summary

Technology Assessment, Development and Field Testing

Outcomes:

- Investigate existing or new technologies for the resources identified.
- Identify technology pathways for commercialization
- Assess existing technologies for the production of non-fuel value added products.
- Identify potential new technologies for the resources (cost effective and environmentally friendly). New uses for coal and waste streams.
- Help develop a basin specific strategy for commercialization.
- Suggest R&D needs and offer technology development plans and concepts for future phases
- Deliver a Preliminary Technology Assessment, development and field testing plan.

Task 6 Summary

Technology Innovation Centers

Task Lead:

Richard Horner, Director of Emerging Projects and Technology, University of Wyoming School of Energy Resources

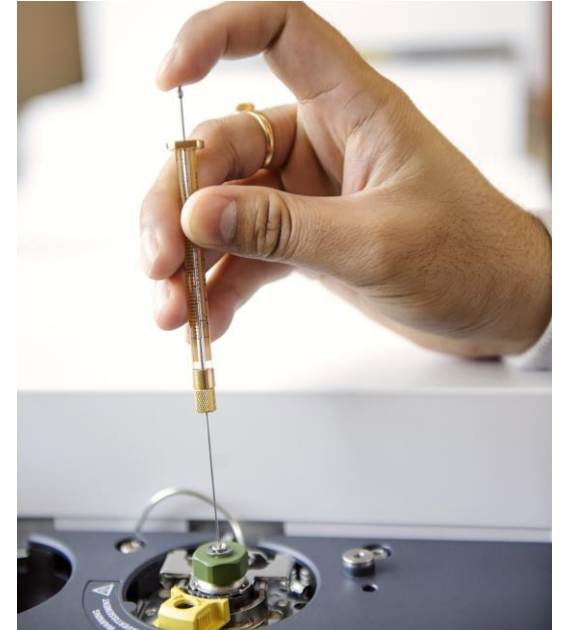
Areas of Focus:

- *Scoping and Criteria for Technology Innovation Center*
- *Technology Innovation Center Plan*



Task members:

- University of Wyoming School of Energy Resources
 - Center for Carbon Capture and Conversion
 - Center for Economic Geology Research
- BSI Energy Ventures



Task 6 Summary

Technology Innovation Centers

Outcomes:

➤ *Scoping and Criteria for Technology Innovation Center*

- Define “Technology Innovation Center” and clarify assumptions about the possible scope(s) for the Technology Center(s) in including location, capabilities, operation, and services provided.
- Suggest possible outcomes (e.g., small business development, public private partnerships, etc.) and/or performance metrics (e.g., value added, engagement, training, etc.).
- Identify opportunities and risk’s that could affect the technology readiness levels of chosen pursuits and the likelihood of achieving goals and milestones, and ways to evaluate them, such as scenario-based planning.

➤ *Technology Innovation Center Plan*

- Define possible future supply chains for Green River Basin CORE-CM products influenced by technology assessments.
- Rank and develop technology opportunity pathways to use CORE-CM products.
- Recommend a supply chain roadmap(s) based on the ranking results.
- Propose scope(s) for the Technology Innovation Centers, based on site selection possibilities, Wyoming CORE-CM product strengths, competitive advantages, distinguishing merit.

Task 7 Summary

Stakeholder Outreach and Education

Task Leads:

Christine Reed, Director, Outreach, University of Wyoming School of Energy Resources

Emma-Jane Alexander, Manager, Shell 3D Visualization Center, University of Wyoming School of Energy Resources

Areas of Focus:

- *Identify and list content-creators and experts who possess education and outreach content*
- *Identify and communicate with public and private stakeholders who must be provided the content to realize project objectives*
- *Identify and utilize content distribution methods to match stakeholders to content-creators*
- *Identify potential collaborations with other projects (DOE sponsored, CORE-CM, regional partners)*
- *Initial Stakeholder Outreach and Education Plan*

Task members:

- University of Wyoming School of Energy Resources
- Colorado Northwest Community College
- Western Wyoming Community College



Task 7 Summary

Stakeholder Outreach and Education

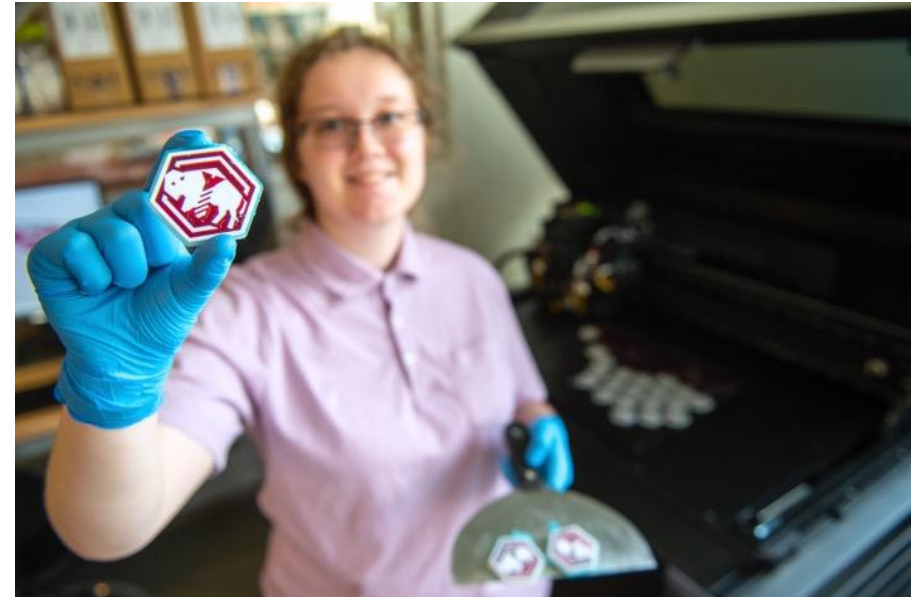
Outcomes:

➤ *Stakeholder Outreach and Education Plan*

- Report on content sources and stakeholder participation, content distribution methods and stakeholder linking, and gap analyses summary indicating missing stakeholders or content
- Report on the most effective methods to connect stakeholders across the CORE-CM value chain
- Plan with regional academic institutions to create workforce education & development planning

➤ *Host annual stakeholder Forums*

- Facilitate communication between CORE-CM stakeholders
- Hosted by regional Community Colleges
Fall of 2022 and 2023



Task 7 Summary

Stakeholder Outreach and Education



- Serving Regional Coal transition Communities of NW Colorado
- CTE/Workforce Training Oriented Programs
 - Paleo/Apprenticeship/Cyber/Traditional CTE
- Focused Regionally on Economic Development
 - Strategic Partnerships & Regional outreach
- Regional Engagement History
 - Community Town Hall meetings
 - Monthly Networking Meetings
 - College/Workforce Advisory Boards
 - Local Municipal Engagement (Chambers of Commerce/Town Councils/AGNC)



- Serving Regional Coal transition Communities of SW Wyoming
- Development of Workforce Training & Education Programs
- Economic Development Focus
 - Experience with developing energy industry teams in the region
- Direct experience with outreach programming
- Regional Engagement History
 - Strategic Business Development & Partnerships
 - Workforce Advisory Boards
 - Local Municipal Engagement

Relevance of CORE-CM and Stakeholder Involvement

Stakeholder Involvement is Critical...

- Regional forums will serve as an opportunity landscape to forward CORE-CM goals and successes
- Monthly updates will keep stakeholders informed and engaged
- Industry input to better understand potential resources
 - Site Hosting
 - Sample Plans
 - Resource Assessments
 - Data Acquisition & Use
 - Contribute Local Knowledge



Relevance of CORE-CM and Stakeholder Involvement

- Participate in planning for the next generation of coal resources
 - Development of upstream and midstream critical minerals supply chains
 - Enable the downstream manufacturing of high-value, nonfuel, carbon-based products
 - Technology diversification
 - Technology transfer
 - Technology integration
- Stakeholders are needed to inform and assist in coalition building
 - Built from partnerships
 - Private industry
 - Universities & Colleges
 - State, local, and federal government entities
 - Economic development input
 - Key roles in leadership groups



Current CORE-CM Support

Project Partners and Stakeholders include:

Industry, Academia, Non-profit Organizations, Economic Development Groups, National Laboratories, State Geologic Surveys, State-wide Agencies, and City and County Governments

Current Partners & Supporting Stakeholders:

U.S. Congressional Delegation of Barrasso, Lummis, and Cheney; Wyoming Governors Office; Colorado State Land Board; Colorado Division of Reclamation, Mining and Safety; Wyoming Mining Association; Wyoming Representative Donald Burkhardt; Wyoming Representative Mike Greear; Wyoming County Commissioners Association; Associated Governments of Northern Colorado; Wyoming Business Council; Wyoming Small Business Development Center; Impact 307; Wyoming Counties of Sweetwater, Sublette, Fremont, Carbon, and Uinta; Routt County, CO Economic Development Office; Moffat County; Kemmerer Operations, LLC; Tri-State; NTEC; Peabody Energy; PacifiCorp; Trapper Coal Mine; Colowyo Coal Mine; Black Butte Coal; Bridger Coal Company; Sweetwater Economic Development Coalition; Southwest Wyoming Manufacturing Partnership; Central Wyoming College; Mango Materials; Ur-Energy Inc.; City of Rock Springs; City of Green River; The University of Texas at Austin; Concurrent Technologies Corporation: Tetra Tech; Novex, LLC; Disa, LLC

Additional Resources & Collaboration Opportunities

LIVE WEBINAR

RARE EARTH ELEMENT AND CRITICAL MINERAL DEVELOPMENT IN WYOMING

MONDAY, NOVEMBER 15, 2021
12:00 PM



1.5 HOURS CLE WYOMING
APPLICATION PENDING



REGISTER ONLINE
WWW.UWYO.EDU/SER/EVENTS



Randy Scott
Rare Element Resources



Thomas Tarka
National Energy
Technology Laboratory



Melissa Firestone
Center for Energy
Regulation & Policy
Analysis



Jada Garofalo
Center for Energy
Regulation & Policy
Analysis



Erin Phillips
Center for Economic
Geology Research

AGNC Annual Economic Summit

August/September of 2022



ASSOCIATED GOVERNMENTS
OF NORTHWEST COLORADO

Panel Discussion Topics Include:

- *Conventional and Unconventional REE Sources & Processes*
- *A Summary of the REE Market*
- *Current REE Law and Policy*
- *Opportunities for REE Development in Wyoming*

MODERATED BY:
Scott Quillinan
School of Energy
Resources



Thank You!

Please direct inquiries to

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and/or

Christine Reed (SER Outreach Director)

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