



NARUC

National Association of Regulatory Utility Commissioners

R&D Spotlight: The Wyoming Innovation Center and New Market Opportunities for Coal Resources

October 11, 2-3 PM ET

Moderator: Hon. Mary Throne, Wyoming

Panelists:

Cindy Edwards, Area Director, Economic Development Administration for the U.S. Dept. of Commerce

Dr. Holly Krutka, Executive Director of University of Wyoming's School of Energy Resources

Dr. Christina Lopano, Geochemist, Research and Innovation Center, National Energy Technology Laboratory

Opening Remarks

Hon. Mary Throne, WY



Panelists

- **Cindy Edwards**, Economic Development Administration
- **Dr. Holly Krutka**, University of Wyoming School of Energy Resources
- **Dr. Christina Lopano**, Research and Innovation Center, National Energy Technology Laboratory



UW School of Energy Resources

Prepared for
NARUC Webinar

October 11, 2022



UNIVERSITY
OF WYOMING

School of
Energy Resources

THE WORLD NEEDS MORE COWBOYS.

Topics

- Wyoming Innovation Center
- SER mission and pillars
- Centers of Excellence Model
- Carbon Engineering Program



Wyoming Innovation Center (WyIC)

Focus on Advanced Carbon Technologies – Using coal as a source of carbon for manufacturing



Wyoming Innovation Center (WyIC)

- Rare earth elements
- Critical minerals
- Activated carbon
- Carbon fiber
- Graphene
- Asphalt
- Agricultural char
- Much more



Wyoming Innovation Center (WyIC)

- Partners in the WyIC project
 - UW School of Energy Resources
 - Campbell County
 - City of Gillette
 - Governor's office
- Local Contractor
 - Powder River Construction
- Architect
 - Arete – Sheridan
- Subcontractors
 - APEX
 - Scott Brothers



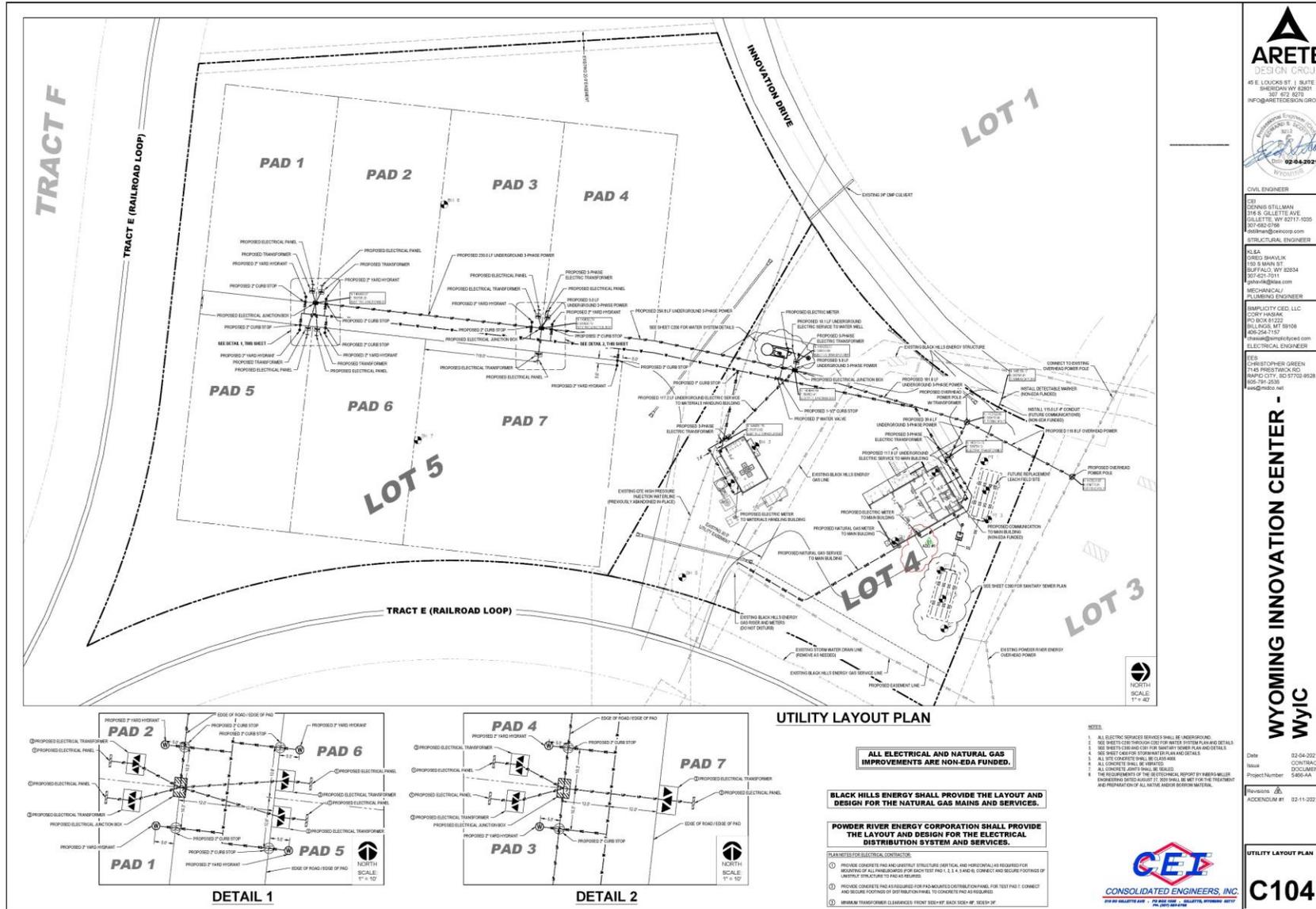
Wyoming Innovation Center (WyIC)

Completed March 2022



Wyoming Innovation Center (WyIC)





CIVIL ENGINEER
CSEI
CHRIS STELLAMAN
374 S. GILLETTE AVE.
SULLYVILLE, WY 82711-1000
307.452.0700
stello@aretedesign.com

MECHANICAL/PLUMBING ENGINEER
SLEA
CHRIS SHANKLIN
100 S. MAIN ST.
SULLYVILLE, WY 82804
307.452-2011
shanklin@aretedesign.com

ELECTRICAL ENGINEER
SIMPACT CITY CED, LLC
CORY HANSEN
100 S. RIZZLE
SULLYVILLE, MT 59108
307.524.7170
cshansen@simpactcityced.com

MECHANICAL ENGINEER
CHRISTOPHER GREEN
THE WYOMING RD.
BRAND CITY, SD 57703-8520
305-79-3333
cg@cgmbio.net

WYOMING INNOVATION CENTER - WYIC
LOT 1 & S. FORT LARSON SUBDIVISION

Date: 02-04-2021
Issue: CONTRACT DOCUMENTS
Project Number: 5400-AA

Revisions:
ACCORDUM #1: 02-11-2021

UTILITY LAYOUT PLAN

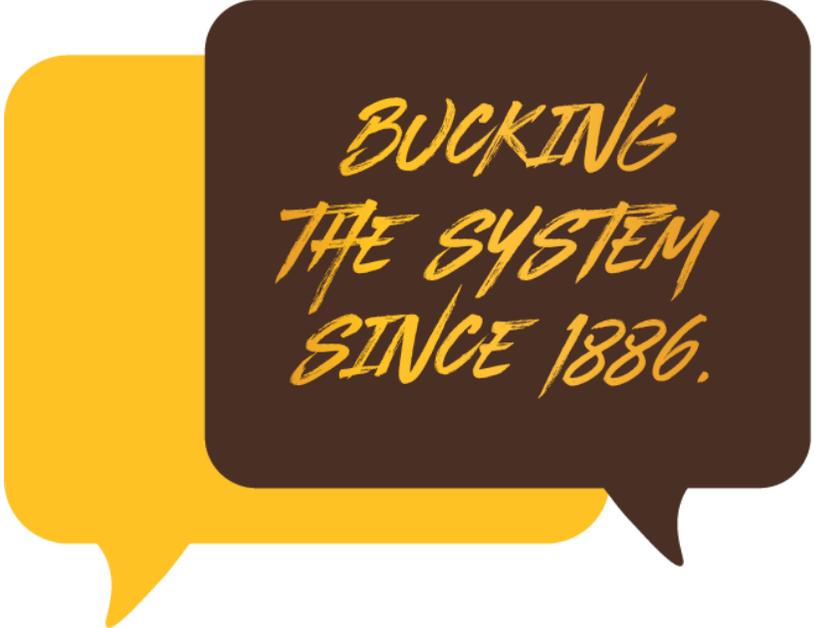
C104

SER Mission and Pillars

*THE WORLD NEEDS MORE
ADVENTUROUS SPIRIT.*

SER's Mission:

Energy-driven economic
development for
Wyoming



*BUCKING
THE SYSTEM
SINCE 1886.*

SER Pillars

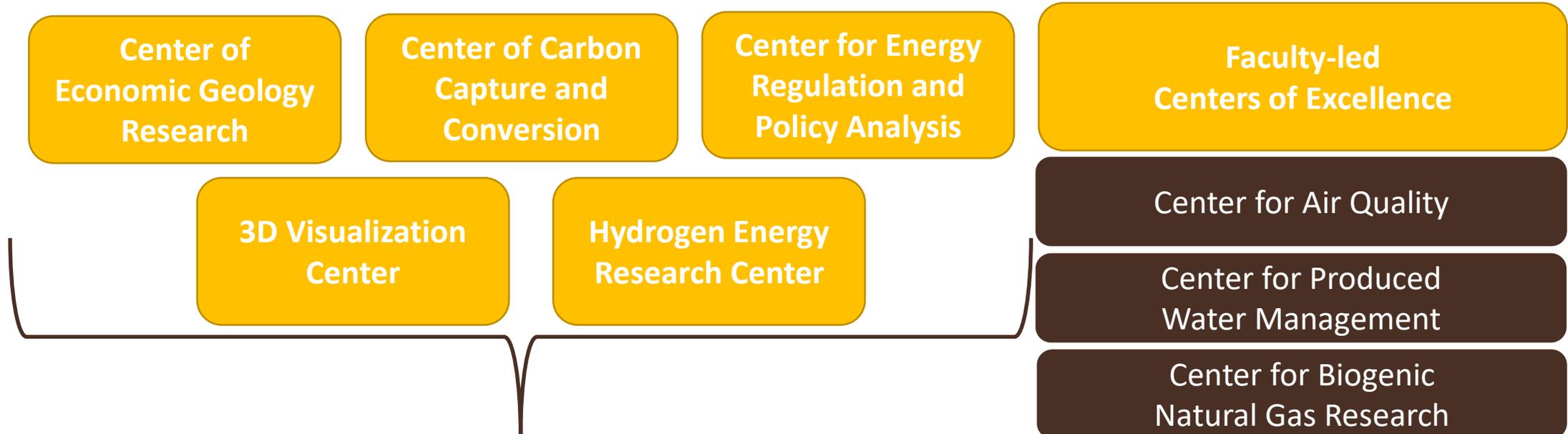
- **Academics**
 - Train students for careers in the Wyoming energy industries
- **Outreach**
 - Engage with stakeholders across state and beyond
 - Support elected and appointed officials
- **Research**
 - Develop technologies to advantage utilization of Wyoming natural resources
 - Focus on economic development
 - Conduct applied research focused on commercialization



SER Research Portfolio

*THE WORLD NEEDS MORE
ADVENTUROUS SPIRIT.*

SER Research Structure



Staff-led Centers of Excellence

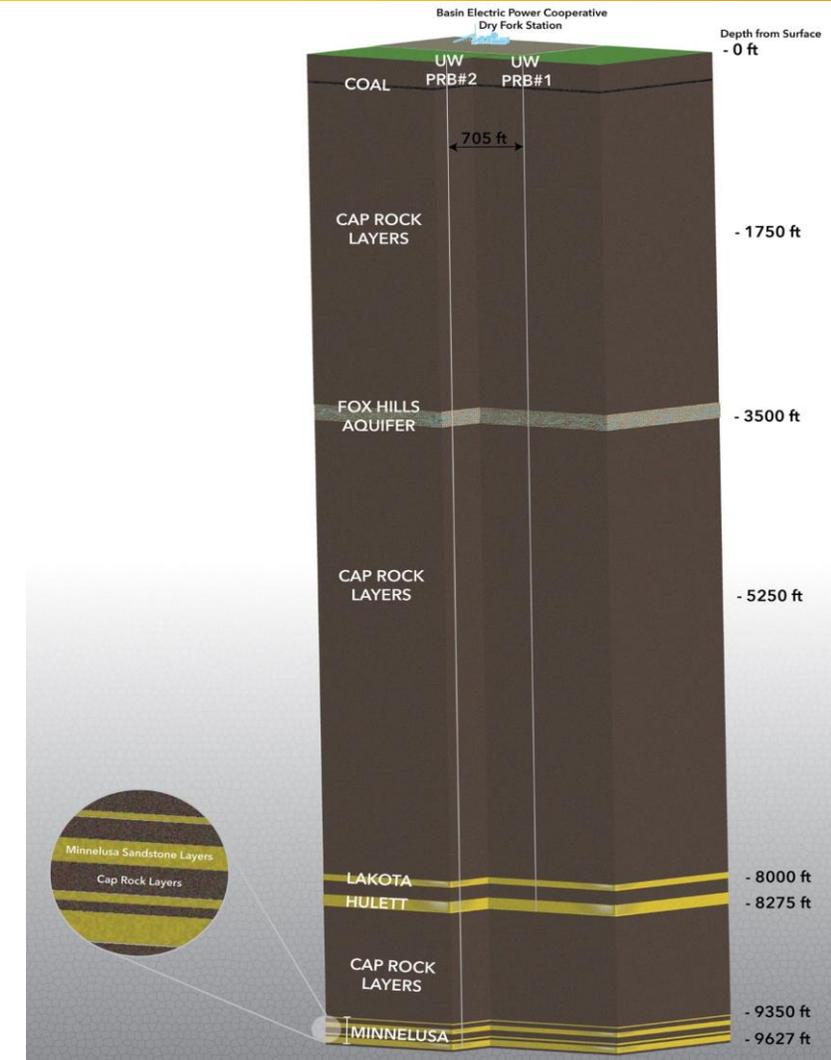


Partner Organization

Enhanced Oil Recovery Institute

CCUS Update

- Wyoming CarbonSAFE
 - Two test wells completed and sampled
 - Completed baseline monitoring assessments
 - 3D seismic survey
 - Storage hub property models and injection feasibility simulations
 - Regulatory assessments
 - Economic/business case assessments
 - Developing risk and MVA assessments
 - Completing permits to construct
- Building the commercial strategy
 - Supporting commercial developers on CCUS projects
 - Partnering with industry on IJA funding requests
- Public engagement





Thermo-chemical (Coal Refinery) Process Technology

The process consists of the deliberate decomposition of coal to make high-volume, environmental and health friendly, non-combustion products.



- Integrates 3 proven technology platforms to convert coal



- Products range from engineered commodities, high-value chemical compounds, and petrochemical feedstocks.
- Zero waste and low carbon footprint
- Commercial-scale conversion expected

Thermo-chemical Processing Solvent Treatment, Pyrolysis & Separation

Subject of Patent Application:
WO 2019/055529



Soil Fertility Products
Building Materials
Engineered Carbon & Char Products



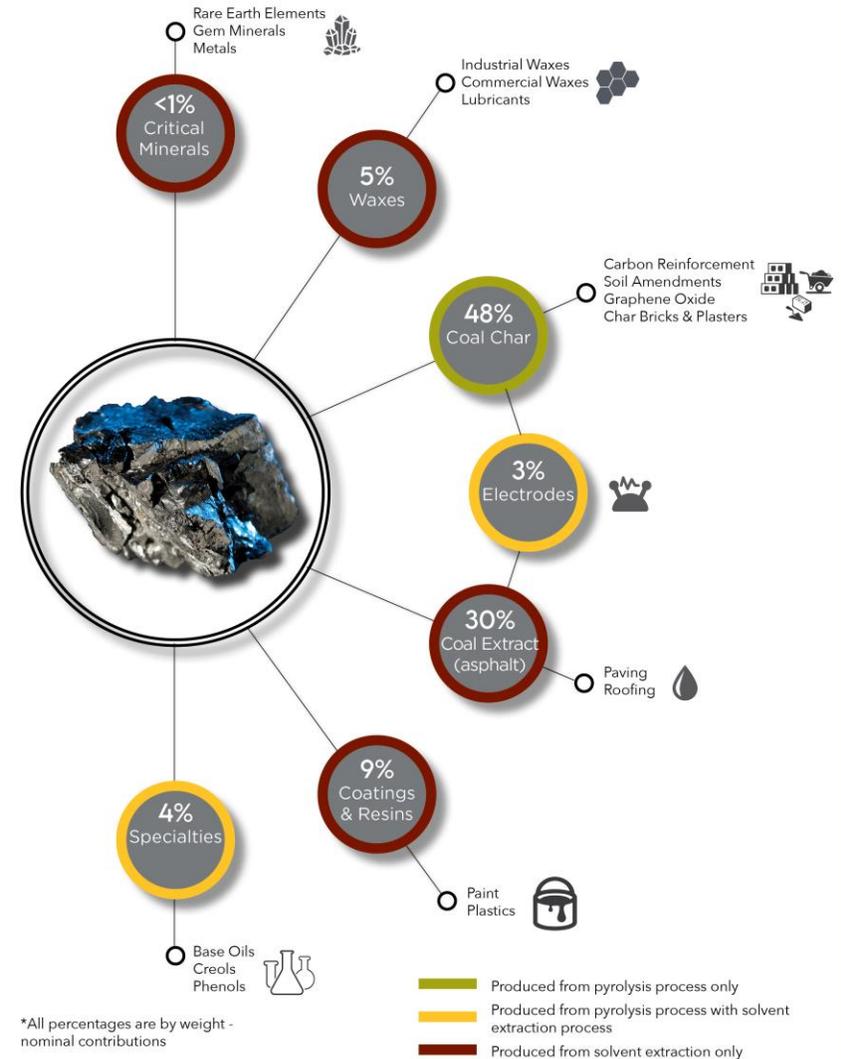
Phenol, Creosote, Base Oils
Graphine Oxide
Paving and Roofing Products
Resins & Coatings
Carbon Fiber Mats



Petrochemical Feedstocks for use in other conversion processes

Coal to Products

Using every component in Wyoming coal



Coal-Related Research Update

- Coal refinery demonstration: Groundbreaking held and site work has begun
- Coal char brick: Demonstration house complete and data is being collected
- Soil amendments: Completed second round of greenhouse experiments using corn as a crop
- Asphalt: Continued development on coal derived asphalt binders and rejuvenators
- Increased research activity with regards to polymers and resins
- Coal transportation study nearly complete
- Increasing engagement with industry



UW School of Energy Resources

Prepared for
NARUC Webinar

October 11, 2022



UNIVERSITY
OF WYOMING

School of
Energy Resources

THE WORLD NEEDS MORE COWBOYS.



Cindy Edwards
Area Director / Denver Regional Office

EDA's Mission

To lead the federal economic development agenda by promoting innovation and competitiveness, preparing American regions for growth and success in the worldwide economy.

- Increase America's global ECONOMIC COMPETITIVENESS
- Support COMMUNITY-LED ECONOMIC DEVELOPMENT
- Help communities develop RESILIENT AND AGILE local economies
 - SIX REGIONAL OFFICES
 - DENVER— 10 STATE REGION



EDA's Investment Priorities



Equity



Recovery & Resilience



Workforce Development



Manufacturing



**Technology-Based Economic
Development**



**Environmentally-Sustainable
Development**



Exports & Foreign Direct Investment

Eligible Entities for EDA funding

- District Organization of an EDA-designated Economic Development District (EDD);
- Indian Tribe or a consortium of Indian Tribes;
- State, county, city, or other political subdivision of a State, including a special purpose unit of a State or local government engaged in economic or infrastructure development activities, or a consortium of political subdivisions;
- Institution of higher education
- Public or private non-profit organization or association acting in cooperation with officials of a political subdivision of a State

EDA does not provide funding to for-profit entities or individuals



EDA in Wyoming:

Since 2010, EDA has invested in **46 projects across Wyoming** totaling nearly **\$34 million**. These projects include:

Economic Development Assistance Program (EDAP) funding:

- Technical Assistance
- Partnership and Short-Term Planning
- Public Works
- Economic Adjustment Assistance
- Assistance to Coal Communities

Supplemental Appropriations:

- Disaster Relief
- COVID-19 Recovery Investment (CARES)
- ARPA Statewide Planning
- ARPA Statewide Travel and Tourism
- ARPA – Economic Adjustment, Tourism, Indigenous Communities



Wyoming Innovation Center



- 2019: EDA awarded \$1.46 million to Campbell County Economic Development Corporation to match \$1.46 million in state and local investment.
- Funding for new facility to serve as Advanced Carbon Products Innovation Center to advance coal-related technologies to move from lab to market.
- Project is estimated to create 40 jobs and catalyze \$15 million in private investment.

EDA Related investments supporting Ecosystem



- \$2.8 million for Northern Wyoming Community College District for capacity expansion, including equipment for training high-skill, high-demand careers using the latest technology.
- \$2.8 million for Campbell County for infrastructure and construction of Pronghorn Industrial Park to facilitate heavy industrial growth and diversify their extraction economy.
- \$579,000 for Gillette College Foundation to establish Office of Transformation to coordinate strategic planning and implementation of innovative economic development strategies to promote regional diversification and resiliency.
- \$500,000 for STEM equipment to supply workforce training equipment and initiatives at Gillette College.

EDAP - EDA Assistance to Coal Communities:



EDA awards funds on a competitive basis to coal communities through its Assistance to Coal Communities (ACC) initiative to assist impacted communities that support:

- Economic Diversification
- Job Creation
- Capital Investment
- Workforce Development
- Re-employment Opportunities

Competitive - rolling application process

Construction and non-construction projects

Generally \$500,000 - \$3 Million EDA investment

Requires matching funds – 20-50%



ARPA - Coal Communities Commitment

Ten percent of EDA's \$3B ARPA funding is invested in communities and regions that demonstrated how changes in the coal economy have resulted or are anticipated to result in job losses and layoffs in any coal-reliant commercial sector.

EDA's \$300 million ARPA *Coal Communities Commitment* - ensures support for coal communities as they recover from the pandemic and create new jobs and opportunities.

To demonstrate eligibility, applicants provided appropriate third party economic and demographic statistics that documented the extent to which contractions in the coal economy have negatively impacted the community or region.



Interagency Working Group on Coal (IWG)

- EDA participates in on-going IWG to discuss and coordinate activities in the State
- Promotes job-creating investments in communities impacted by coal mine and power plant closures and proactively investing in communities likely to be impacted declines in coal production and generation from coal-fired power plants.
- Provides a forum for communities and agencies to coordinate efforts and investments by federal agencies to support coal community transformation and diversification
- Partners include representatives from DOE, EPA, SBA, USDA, DOI, Wyoming state and local agencies and regional economic development representatives.



Resources

Visit our website for resources: www.eda.gov



Wyoming Contact:

Economic Development Representative

Aaron Pratt

406-599-9795

apratt@eda.gov



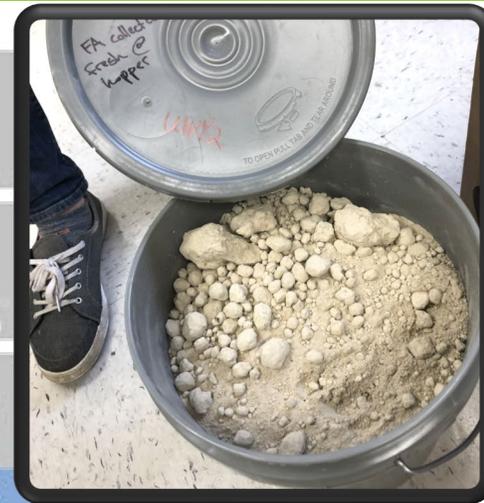
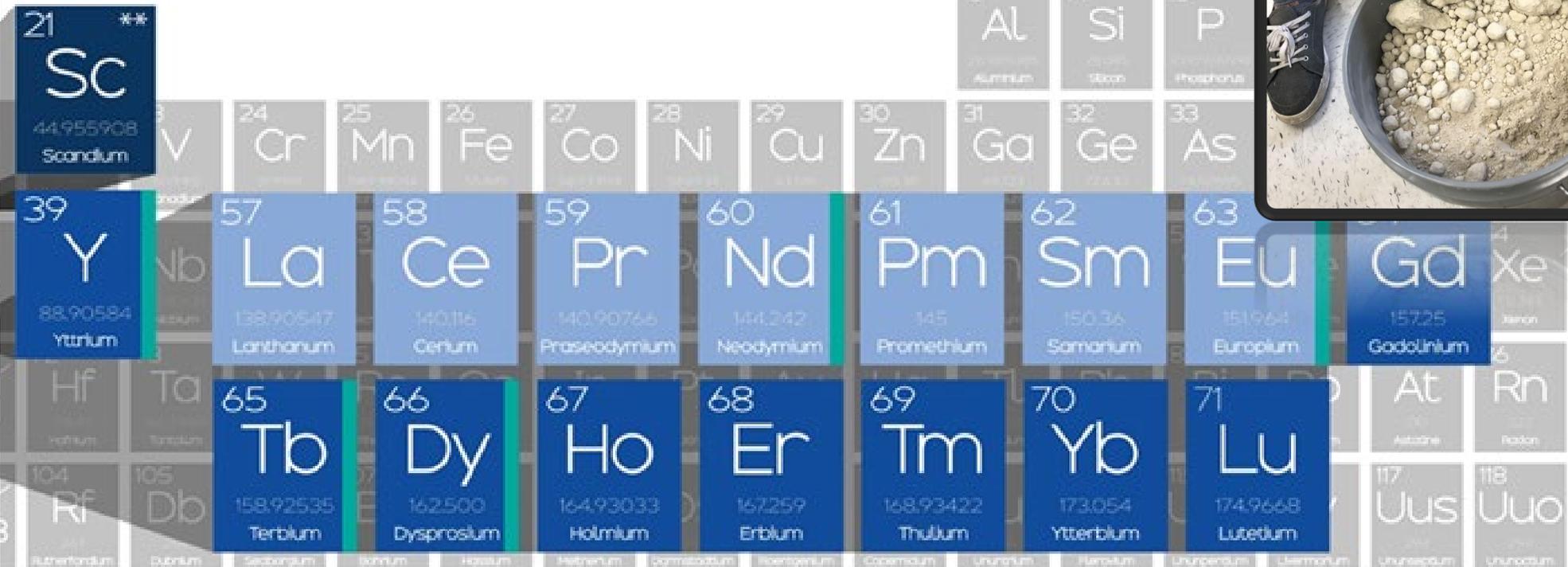
REE Recovery from Powder River Basin Coal Byproducts

NARUC Webinar – R&D Spotlight: the Wyoming Innovation Center & New Opportunities for Coal Resources

Dr. Christina Lopano October 12, 2022

Resources from Wastes

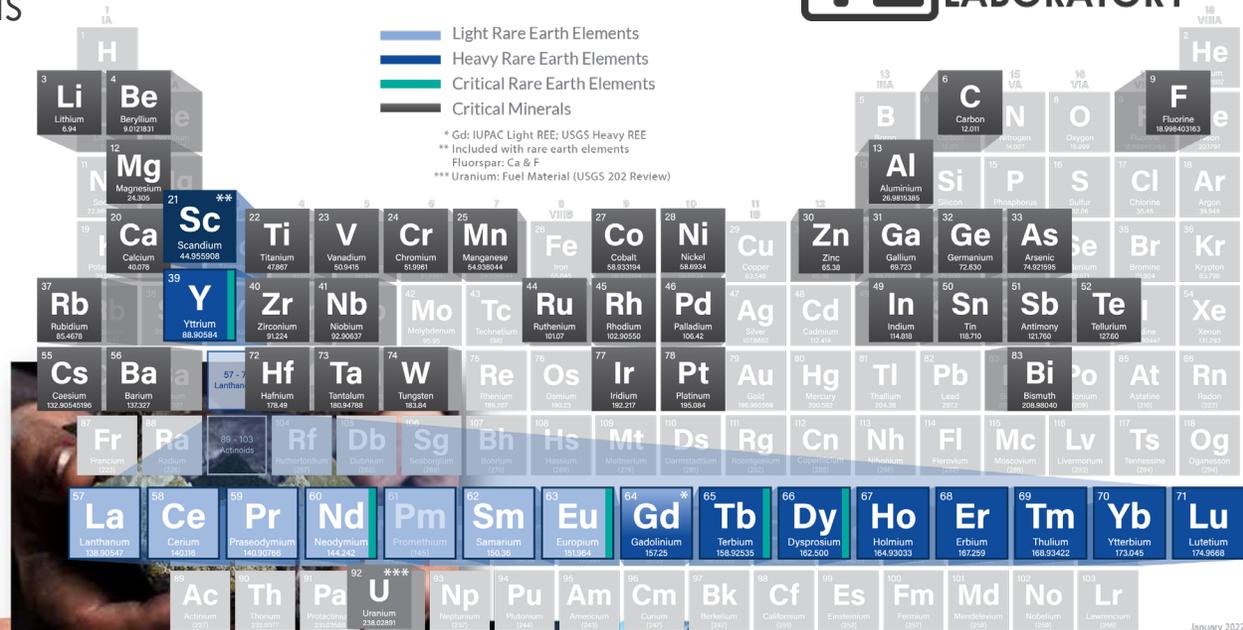
— Heavy Rare Earth Elements
— Critical Rare Earth Elements



Critical Minerals & Rare Earth Elements (REE)

Challenge: Foreign Dependence on Critical Minerals

- Import-dependent on >80% of U.S. rare earth element (REE) demand
- Import-dependent (>50% from foreign source) on >40 of 50* critical minerals
- Import-reliant (100% from foreign source) for at least 12 critical minerals

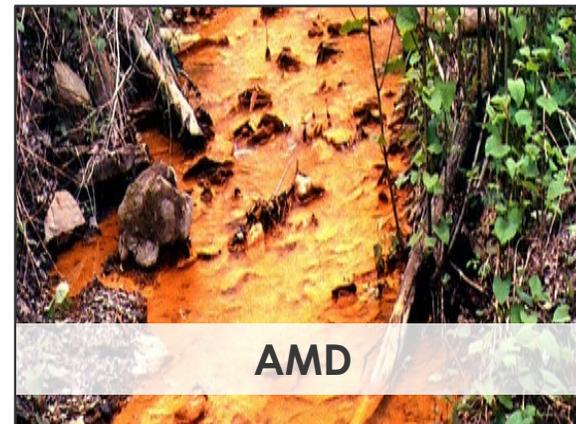
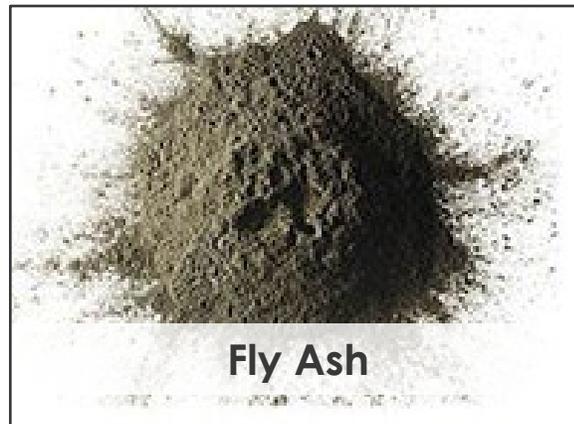
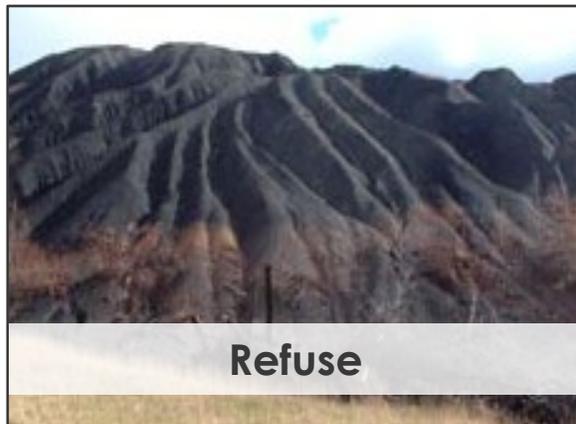


Vital for the development of green-energy technologies

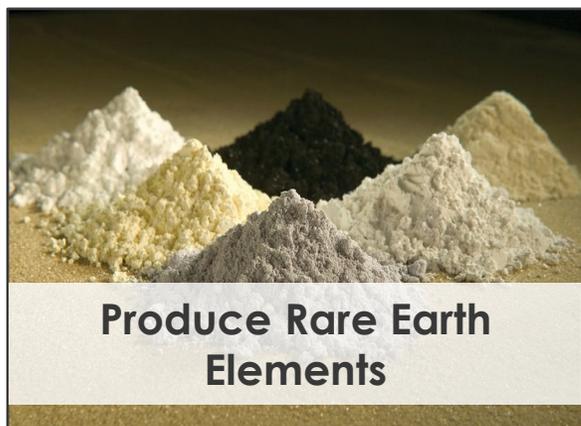


Valorization of FE Waste Streams

Carbon ore, coal byproducts, O&G drill cuttings, produced waters

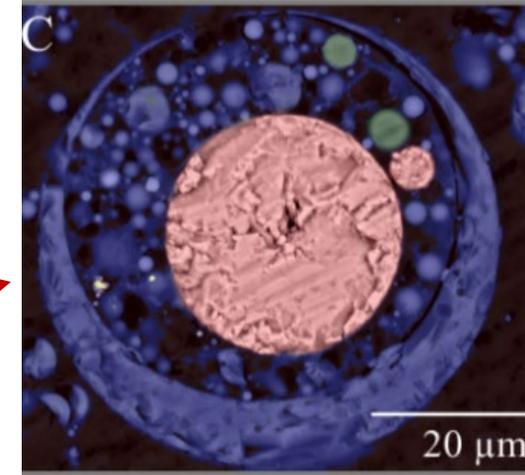


— **COULD BE PROCESSED TO...** —



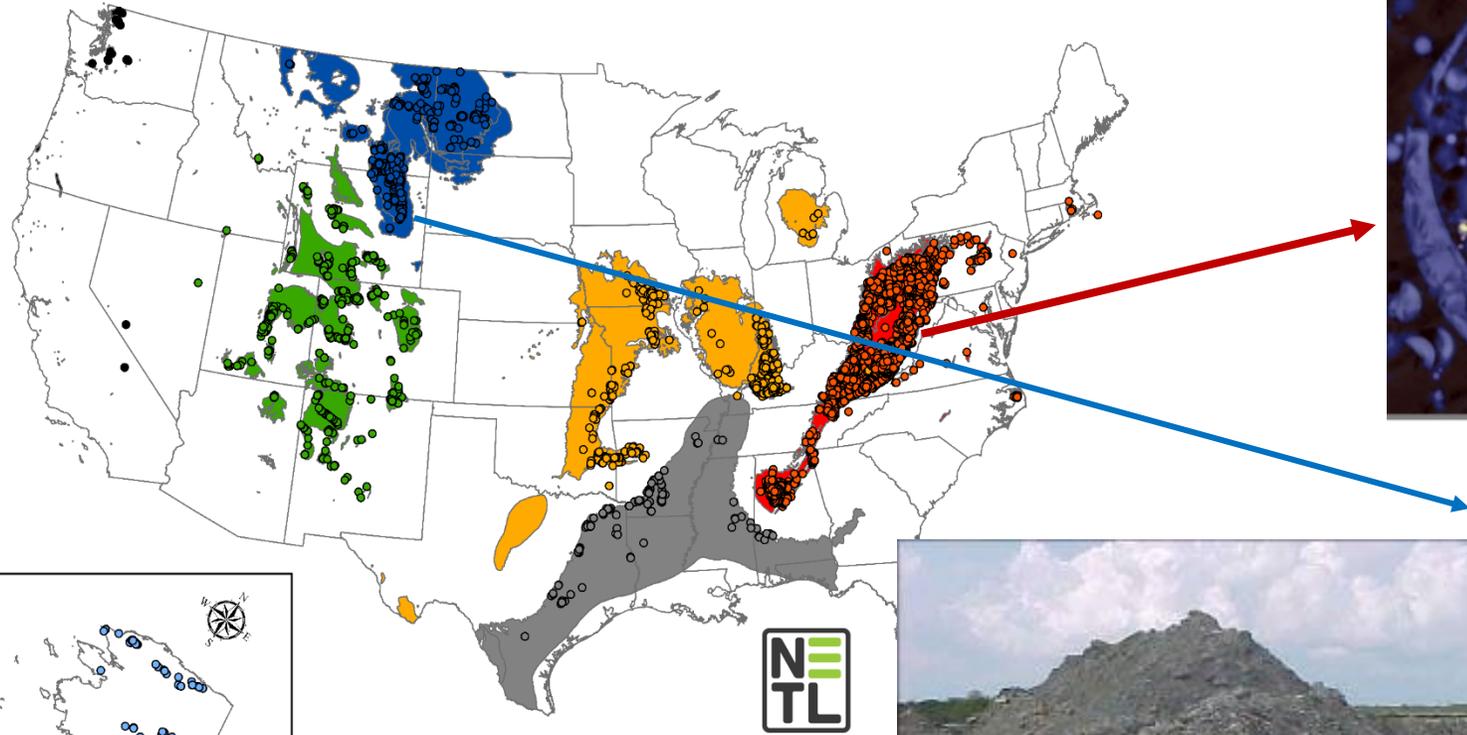
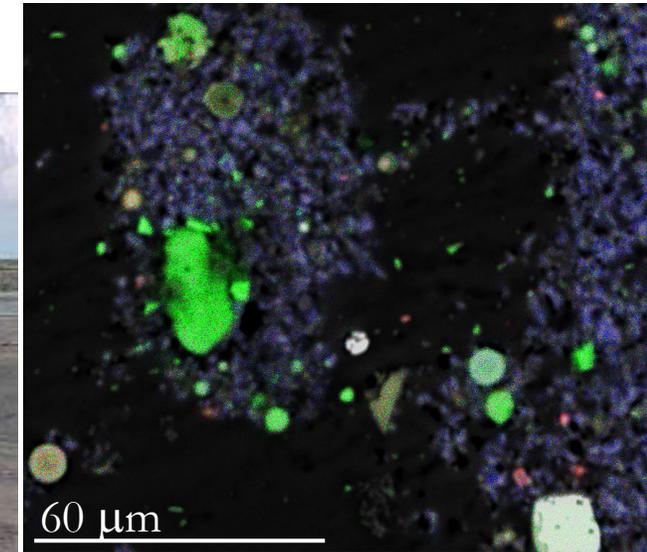
Coal Combustion Ash Wastes

~ up to 60% Ash is Disposed as Waste (millions of tons/yr)

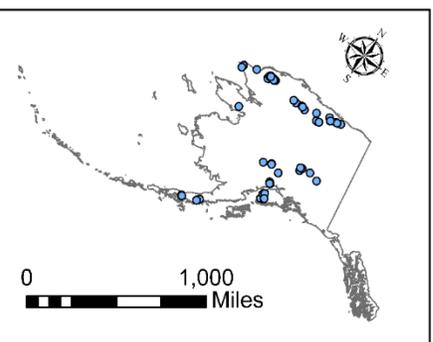


SEM BSE image of fly ash particles

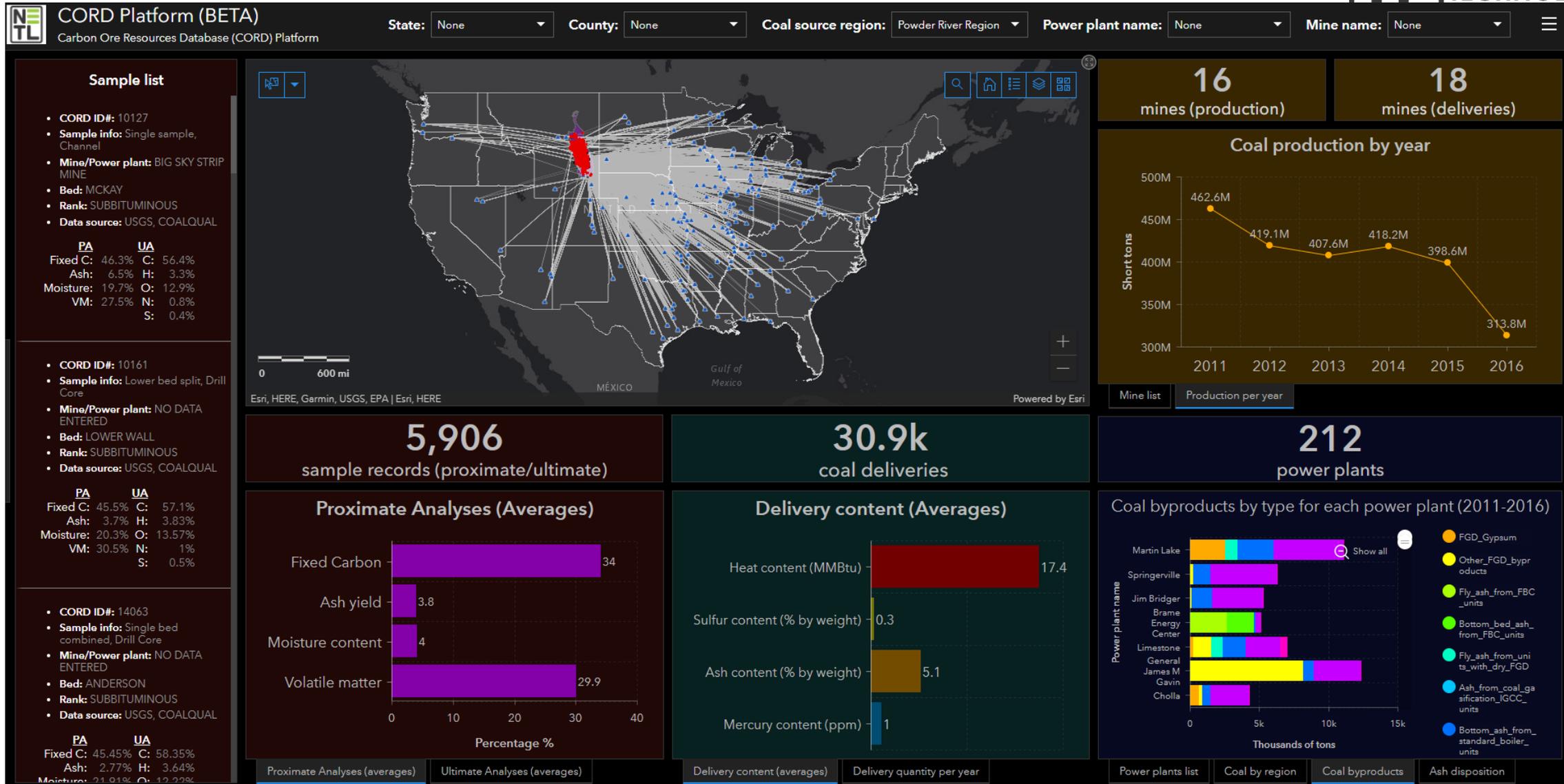
- amorphous Si-Al - purple
- Fe-oxide - red
- Ca-oxide - green
- REE mineral - yellow



0 125 250 500 750 1,000 Miles
Data Sources: United States Geological Survey (USGS)



NETL Data Analytics: Understanding the Resources



Fundamentally Understanding the Resource

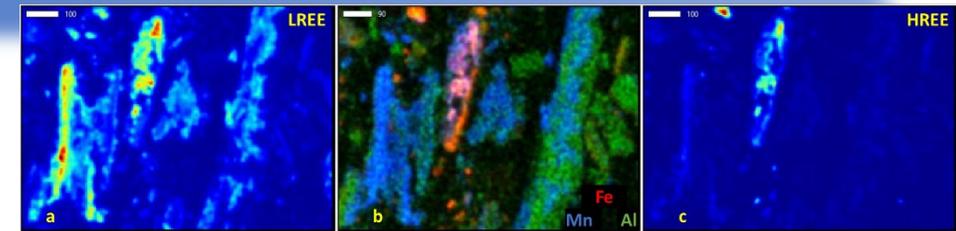
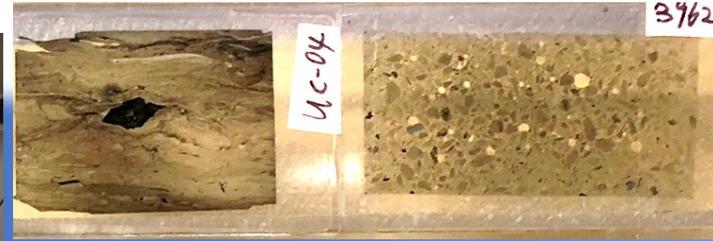
Ash & AMD Characterization to Recovery



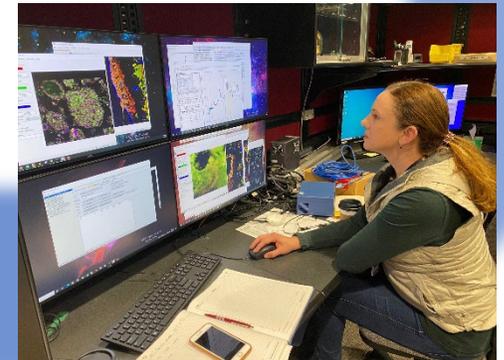
AMD solids



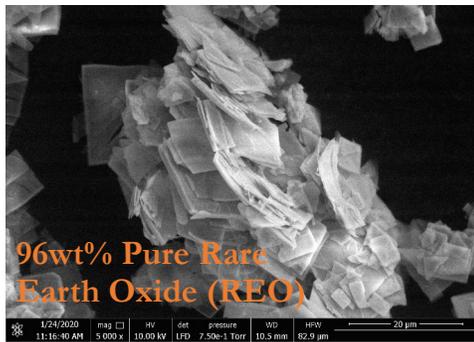
Fly ash



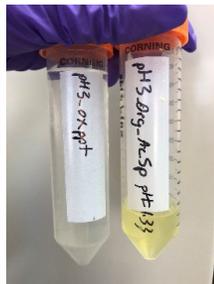
Utilize **characterization** of major REE-hosting solid fractions in different CCBs to **innovate targeted extractions** for efficient and economical REE recovery.



Stuckman, M.Y., Lopano, C.L. and Tarka, T. (2021)
U.S. Patent Pending, Serial No.: 63/053,925
<https://netl.doe.gov/node/10318>



96wt% Pure Rare Earth Oxide (REO)

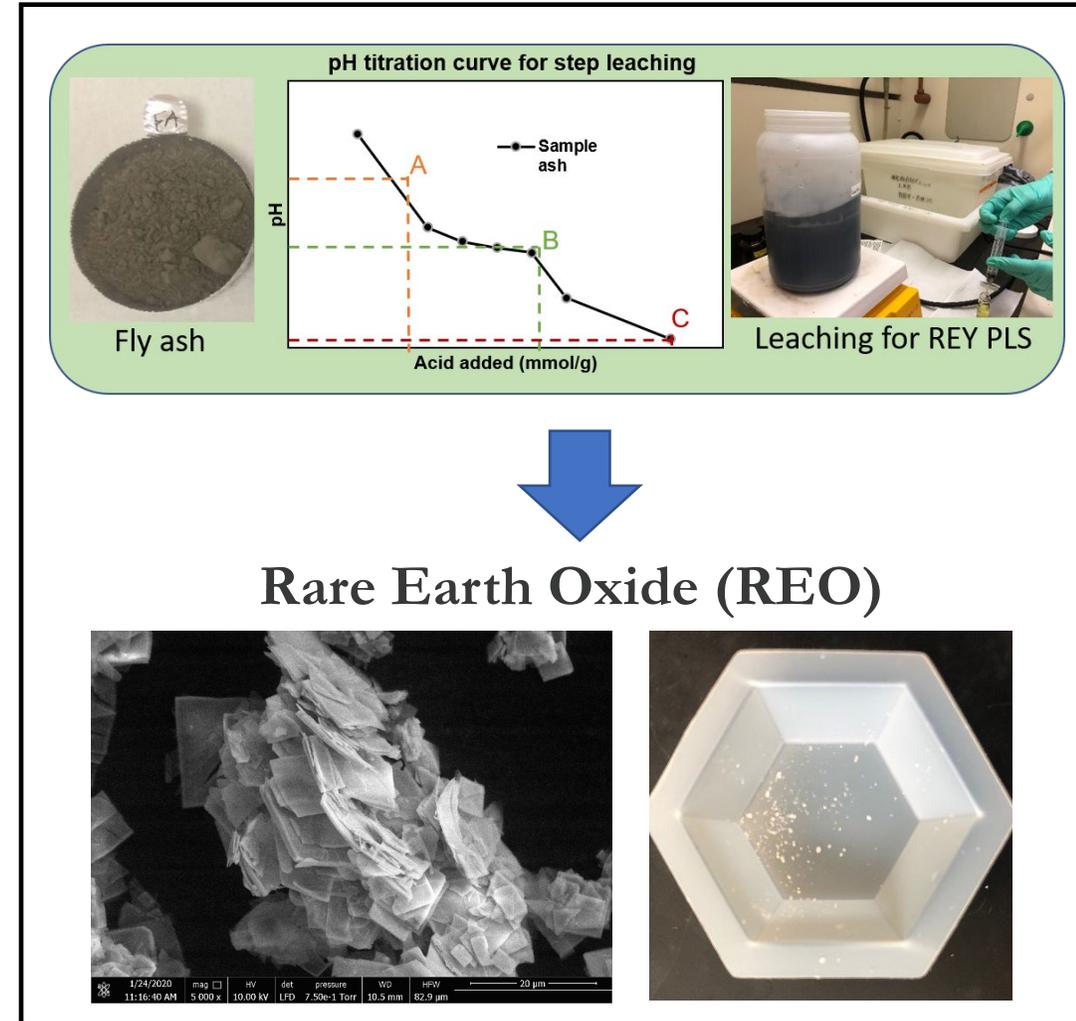


Recovery from Calcium-Rich Ash

Targeting Powder River Basin (PRB) Ashes to Reduce Extraction Steps & Conditions

Targeted Rare Earth Extraction (TREE)*

- ✓ Waste product that doesn't need to be mined
- ✓ No grinding and no pre-treatment required
- ✓ Step-leaching at ambient conditions
- ✓ No heating or elevated pressure required
- ✓ Mild acids (90% acid reduction compared to industrial use) and effective REE recovery (80-100% recovery rate)
- ✓ Reduced solvent consumption for subsequent REE purification and separation
- ✓ Wastes with mild pHs and minimal radioactive materials (Th and U)



Bridging the “Valley of Death”

US DOE Technology Commercialization Fund (TCF)

- Designed to increase the number of energy technologies developed at **DOE’s national labs** that graduate to commercial development and achieve commercial success.
- The fund also enhances DOE’s technology transitions system with an enterprising and competitive approach to **lab-industry partnerships**.
- Through the TCF, the applied program offices and national laboratories can pursue a strategic, forward-looking, competitive approach to commercializing technologies from lab-industry collaborations.
- 50% Cost share between DOE and partners

From Bench to Pilot: \$1.6 million TCF Project

NETL works with Wyoming partners committed to technology maturation:

- University of Wyoming School of Energy Resources
- Campbell County
- City of Gillette

State, Campbell County pursue rare earth opportunities

By Greg Johnson, Gillette News Record | Via Wyoming News Exchange Jul 5, 2020 [Comments](#) [OPEN ACCESS](#)

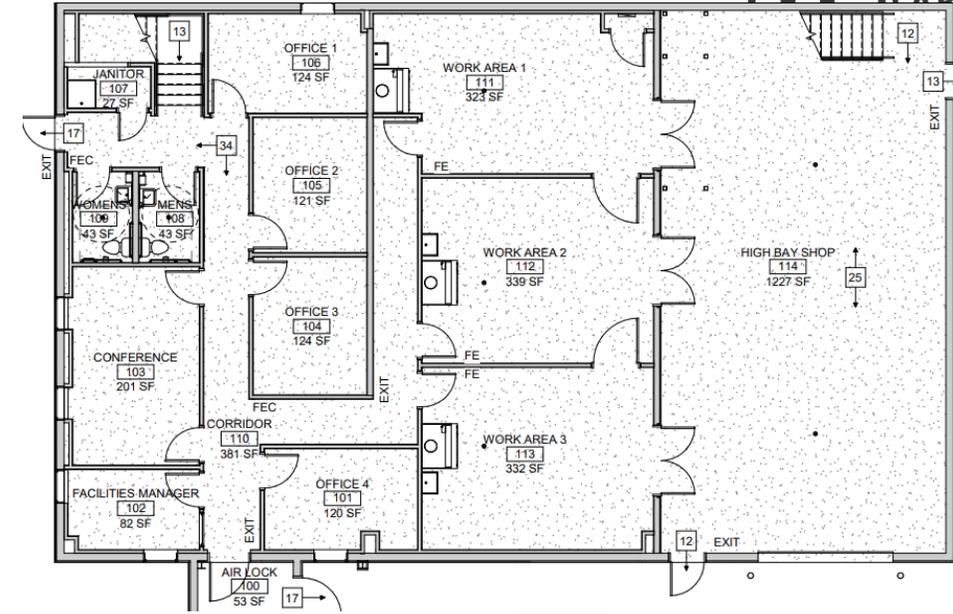
Rare Earth Elements Project Receives Federal Funding

NEWS DIRECTOR | Article Updated: June 23, 2020 | COMMENTS OFF

[Share on Facebook](#) [Tweet this!](#) [G+](#) [in](#) [@](#) [t](#) [v](#) [digg](#) [vk](#) [m](#)

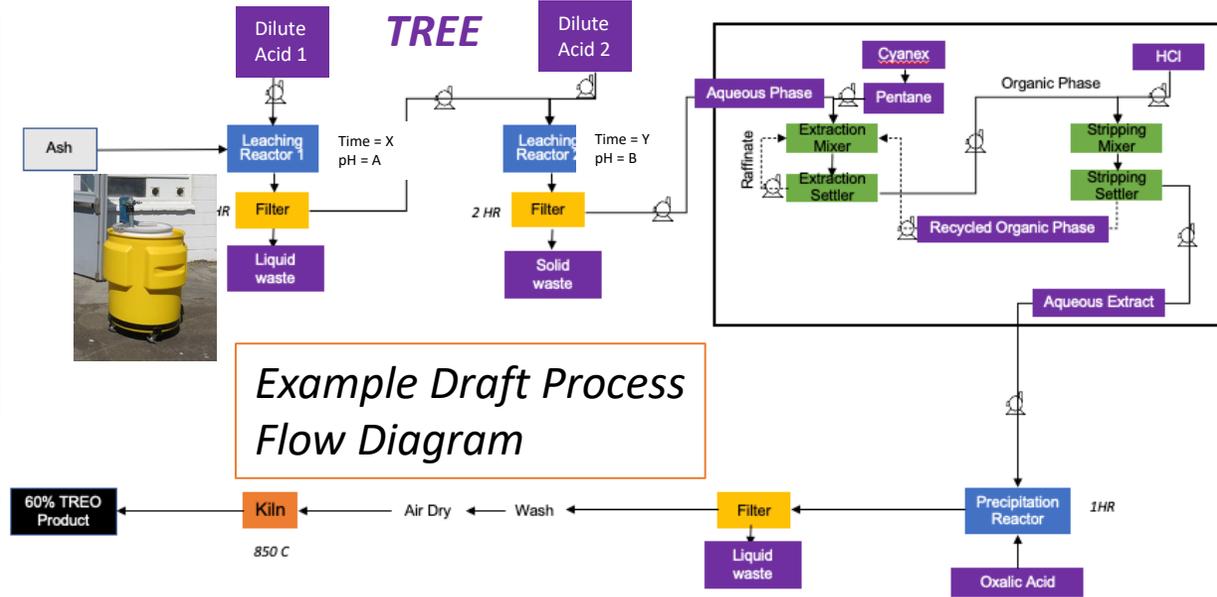


Wyoming Innovation Center



Ribbon cutting – June 14, 2022

[SER Participates in Wyoming Innovation Center Ribbon Cutting Ceremony and Meets with Key Stakeholders in Gillette \(uwyo.edu\)](https://www.uwyo.edu)



REE Recovery from PRB Coal Wastes: Pilot at WIC

TCF-20-21358



VISIT US AT: www.NETL.DOE.gov



@NETL_DOE



@NETL_DOE



@NationalEnergyTechnologyLaboratory

CONTACT:

Christina Lopano & Tom Tarka
Christina.Lopano@netl.doe.gov

Thomas.Tarka@netl.doe.gov



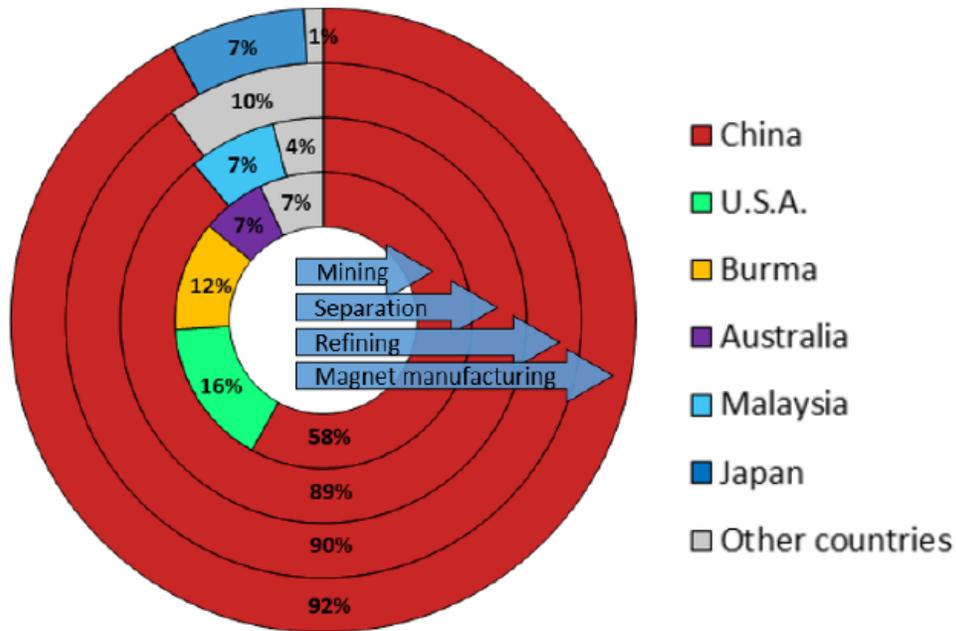


U.S. DEPARTMENT OF
ENERGY

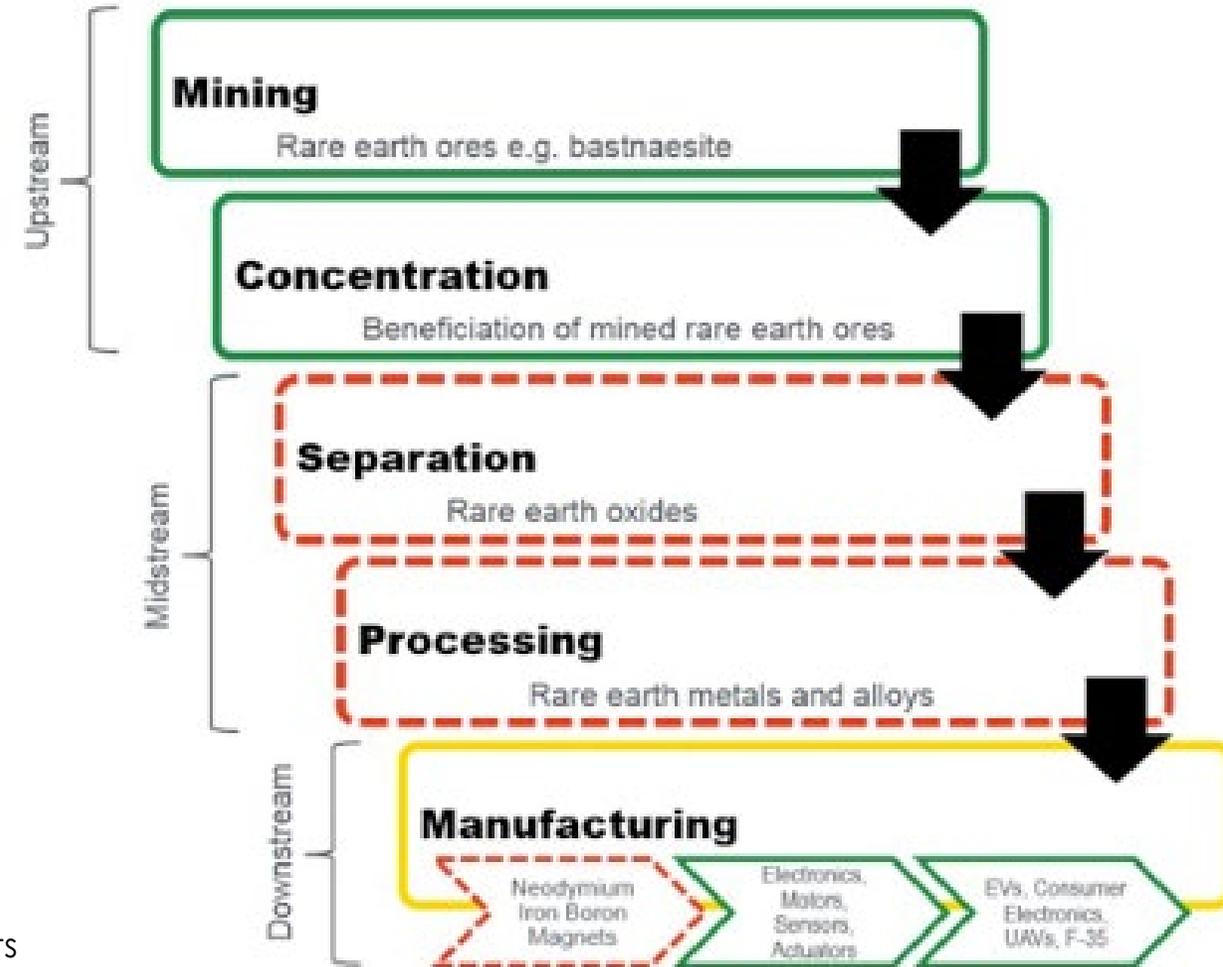
Understanding the REE Supply Chain

Challenge: Gaps in Domestic Supply Chain

- Up- and Mid-Stream capabilities concentrated in 1-3 countries
- Lack of midstream capabilities area a gap that limits growth of upstream supply & downstream manufacturing



Gaps in the domestic supply chain are shown in red.



Geographic concentration of supply chain stages for sintered NdFeB magnets

Commercialization Pathways: Pilot Projects

Producing High Purity MREO & CM (Co, Mn, Ni, etc.) from Coal-Based Sources






- Separating MREO concentrate from **lignite**
- August 2022 Pilot Facility Construction Complete
- October 2022 Pilot Facility start-up of Testing

| 2018 | 2019 | 2020 | 2021 |
|----------------------------|--------------------------|------|------|
| 5 – 10 g 5 – 15% purity | 500 g 30 – 85% purity | 2020 | 2021 |
| Under Construction | | | |




- Small-Scale Pilot plant cumulatively produced > 1 kg mixed rare earths on an oxide basis from **post combustion coal ash** by 2021. Ended March 2022.

| 2018 | 2019 | 2020 | 2021 |
|--------------------------|-------------------------|-------------------------|-------------------------|
| 0.004 kg ≥ 10% purity | .057 kg ≥ 14% purity | 0.41 kg ≥ 67% purity | 0.67 kg ≥ 91% purity |



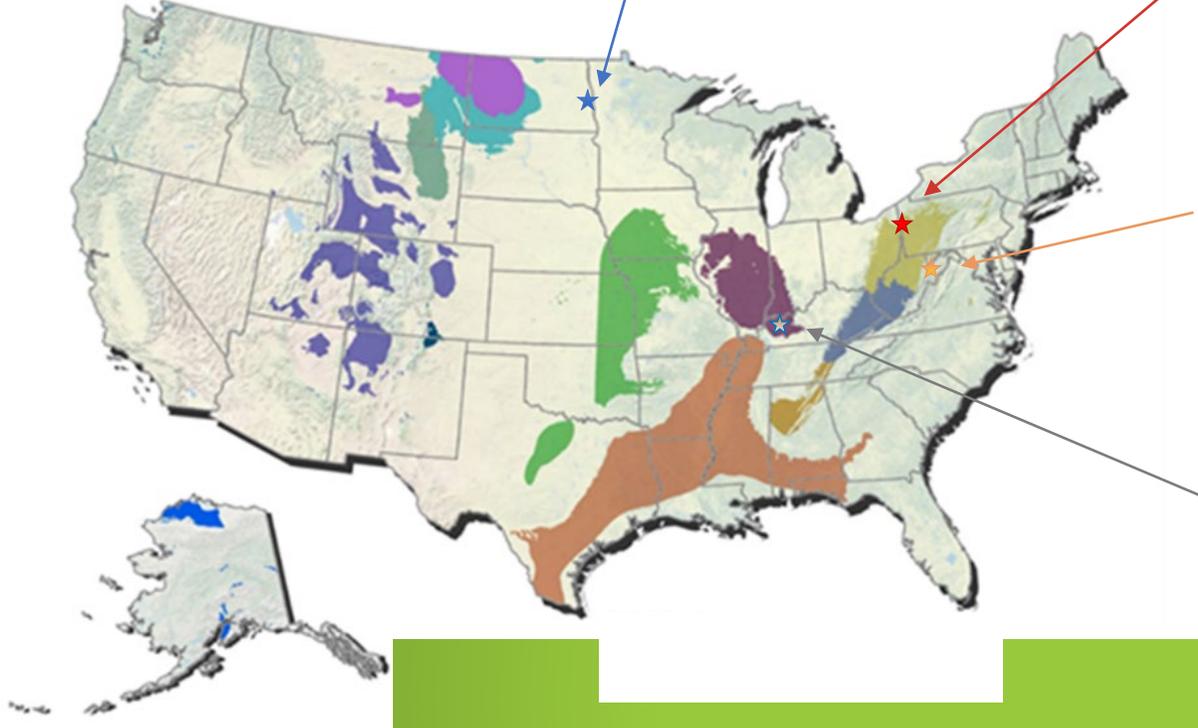

- Produced REE pre-concentrates from **AMD and sludge materials** with ~100% REE recovery, 45% is HREEs

| 2018 | 2019 | 2020 | 2021 |
|-------------------------|------|--|------|
| 44 g 95 – 99% purity | | Field Pilot-Scale Under Construction to start up June 2022 | |




- Pilot plant operation started in Q4 FY21. Produced quantities MREOs in its *modular* pilot-scale facility from **coal refuse materials**

| 2018 | 2019 | 2020 | 2021 | 2022 (Q1) |
|----------------------|------------------------|-----------------------|--------------------------------------|--|
| 0.6 kg 80% purity | 1.5 kg > 90% purity | 0.41 kg 98% purity | 0.4 kg >50% purity & 4 kg 0.5% | 0.72 kg >95% REE & 0.3 kg (8% Co, 30% Ni) & 0.27 kg (22% Mn) |



Panelists

- **Cindy Edwards**, Economic Development Administration
- **Dr. Holly Krutka**, University of Wyoming School of Energy Resources
- **Dr. Christina Lopano**, Research and Innovation Center, National Energy Technology Laboratory



Upcoming

- NETL visit to Morgantown, WV & Pittsburgh, PA this december
- NARUC Annual Meeting & Education Conference in New Orleans, November 13-16, 2022
- Check www.naruc.org/cpi for information on upcoming activities



Thank you!

Visit www.naruc.org/cpi for additional resources

Contact Kiera Zitelman (kzitelman@naruc.org) and Kathryn Kline (kkline@naruc.org) with questions

