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Critical Challenges. Practical Solutions.

Energy & Environmental Research Center (EERC)

CRITICAL MINERALS: CREATING JOBS IN THE WILLISTON BASIN

September 6, 2023

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Webinar Series Events

Critical Minerals: What, How, Why All the Hype?

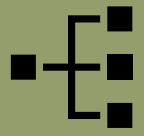
9.21.2022

Today's Critical Mineral Technologies and How to Move Forward

11.30.2022

Why Do Critical Mineral Business in the Williston Basin? Our Strengths, Our Assets, Our Needs

1.11.2023



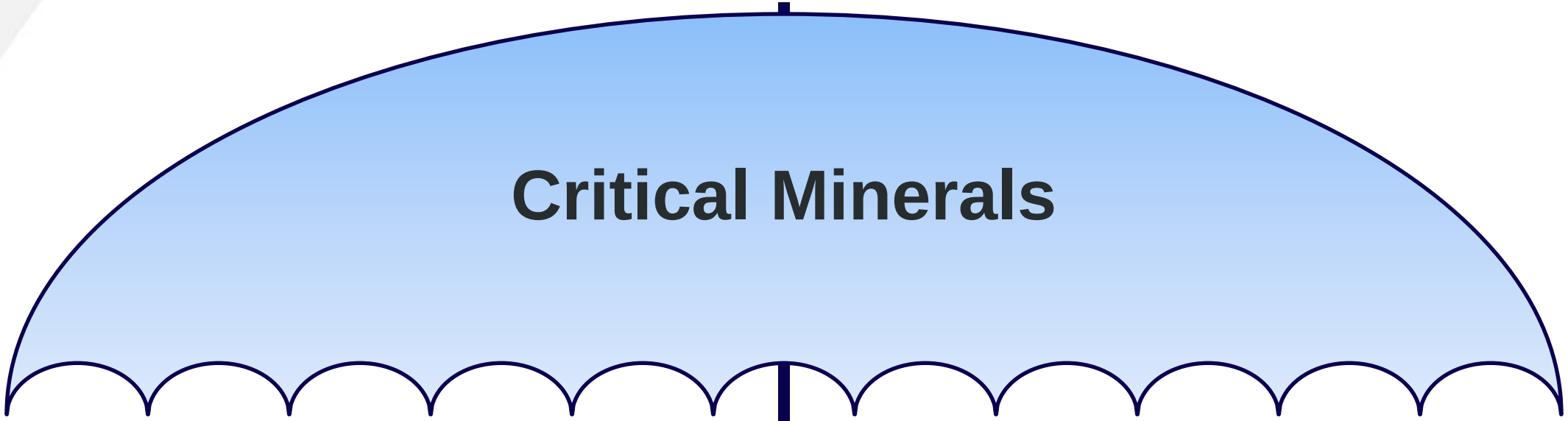
Critical Minerals from Lignite: The Process and Products

5.25.2023

Critical Minerals: Creating Jobs in the Williston Basin

Today

Defining Critical Minerals



Rare-Earth Elements (REEs)

- Not rare but found together
- Chemically similar and difficult to separate
- Each with a different use

Critical Minerals (CMs)

- Catch-all term for the critical minerals that are not REEs
- No other common factor

Critical Minerals Play a Vital Role in Our Modern Economy and National Security

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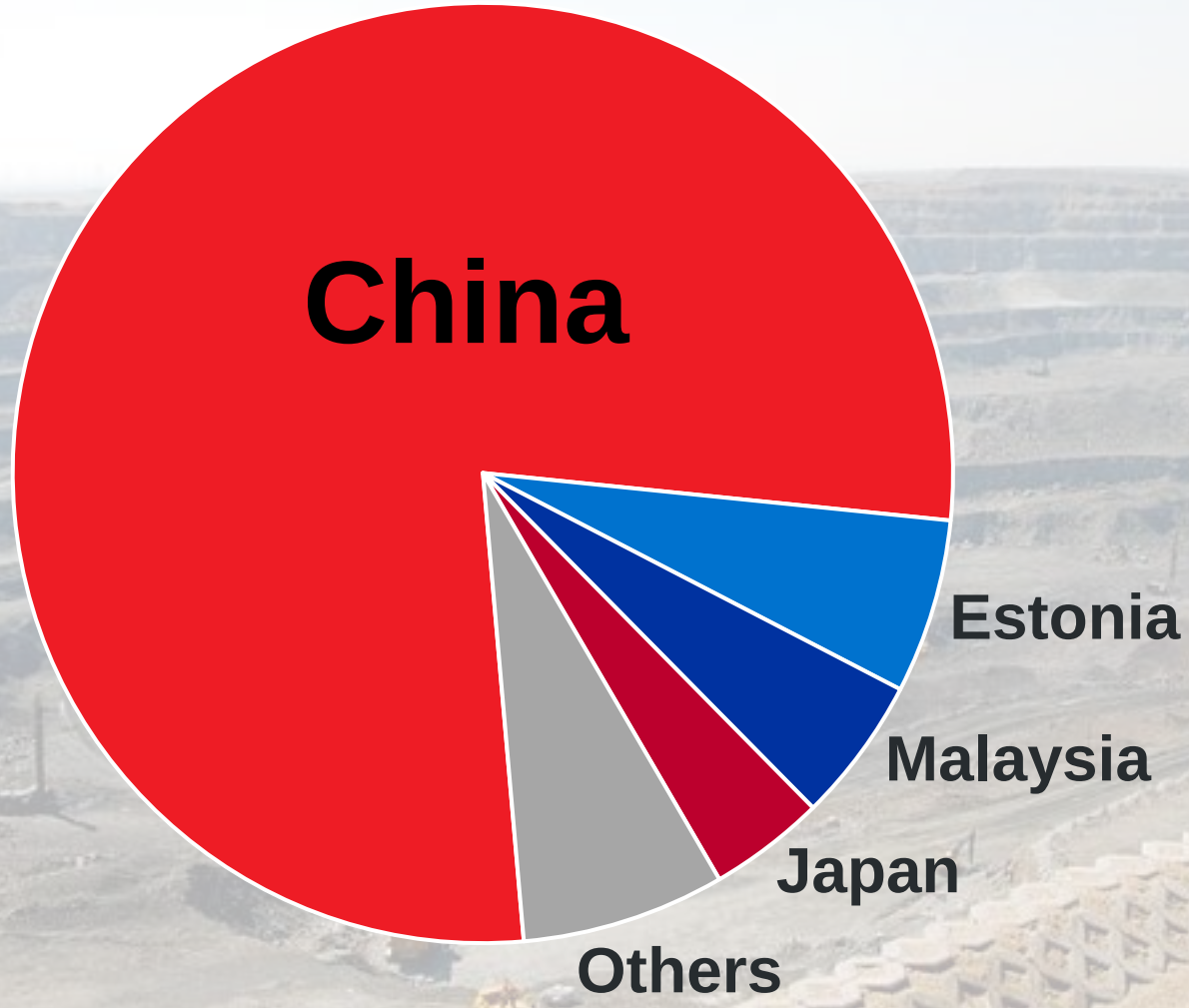
Critical Challenges. Practical Solutions.

U.S. REE Suppliers

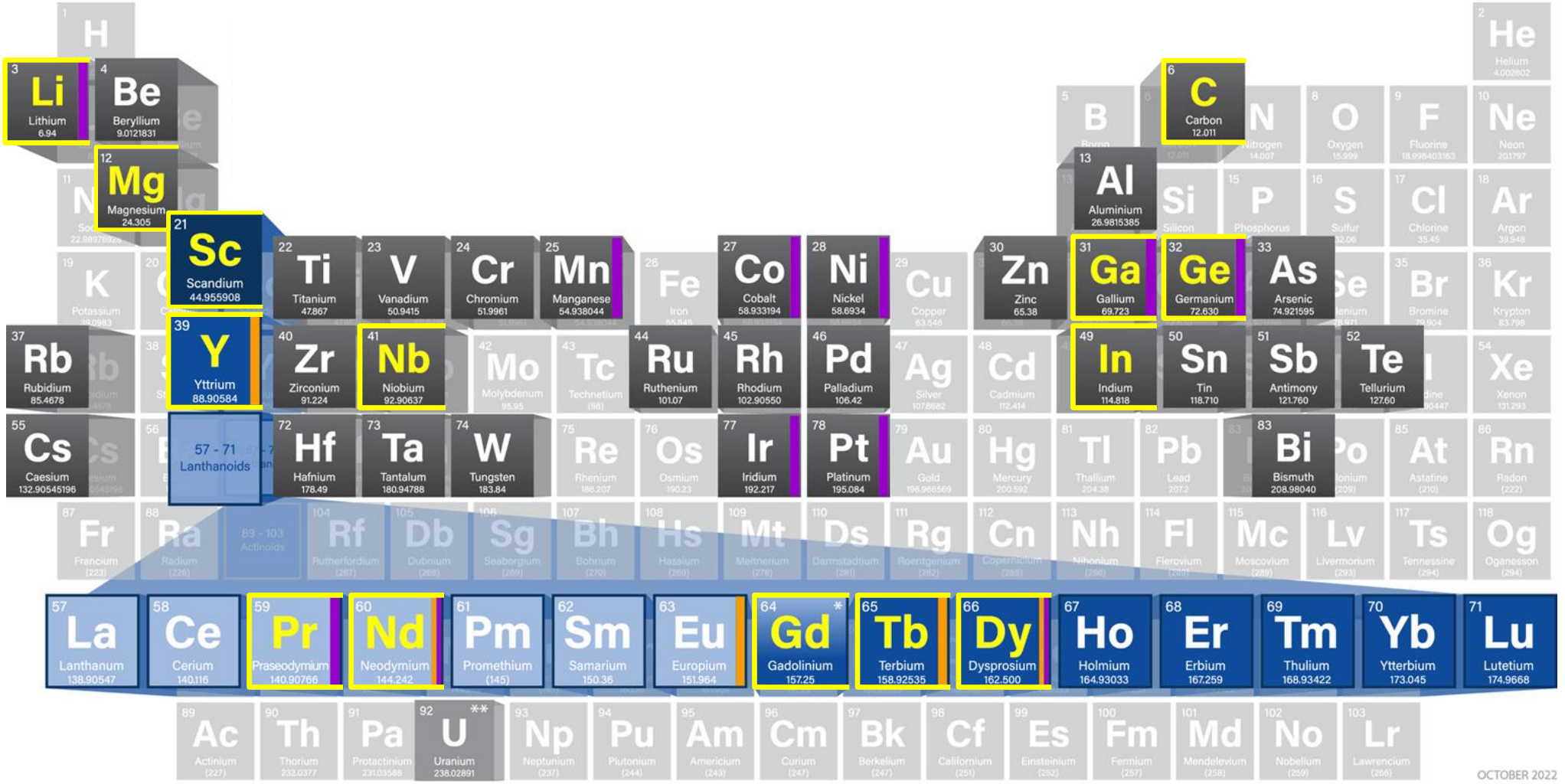
More than 80% of U.S. critical minerals are imported.



Elements with Greatest Potential to Contribute to the Williston Basin Market

Legend

- CM
- Light REE
- Heavy REE
- Critical REE
- Critical for Clean Energy Supply Chains
- Fuel Material
- C — Williston Basin Market Potential

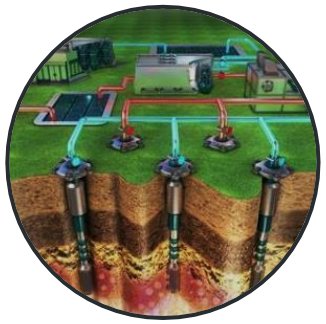


OCTOBER 2022

Developing New Sources and Innovative Ways to Extract CMs and REEs

ND Shales: Pierre, Niobrara, Upper and Lower Bakken

Deep Unminable Coal Seams by In Situ Extraction



Existing Lignite Coal Mines

Coal Ash

Produced Water

Developing New Sources and Innovative Ways to Extract CMs and REEs

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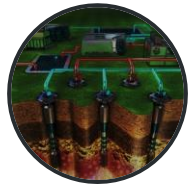

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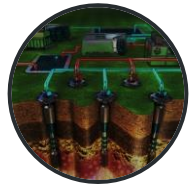

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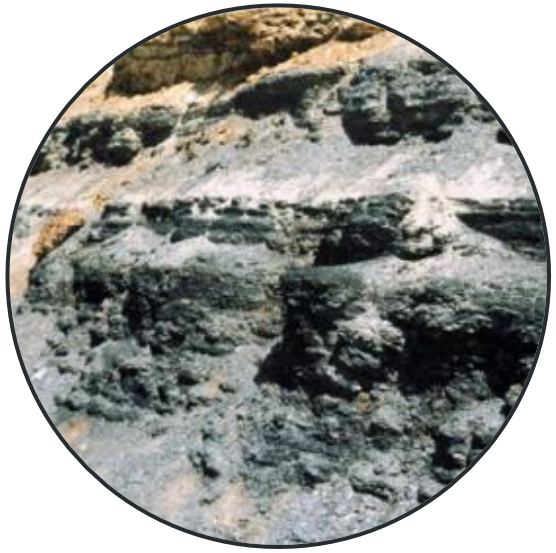

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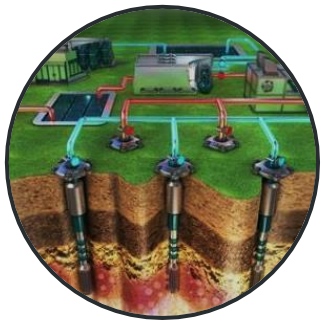

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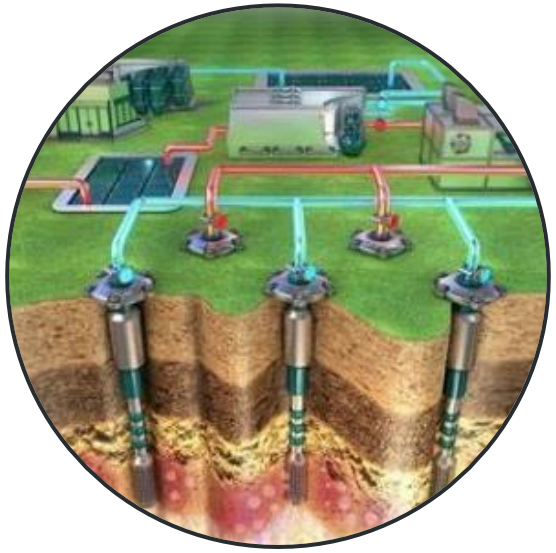


Existing Lignite Coal Mines

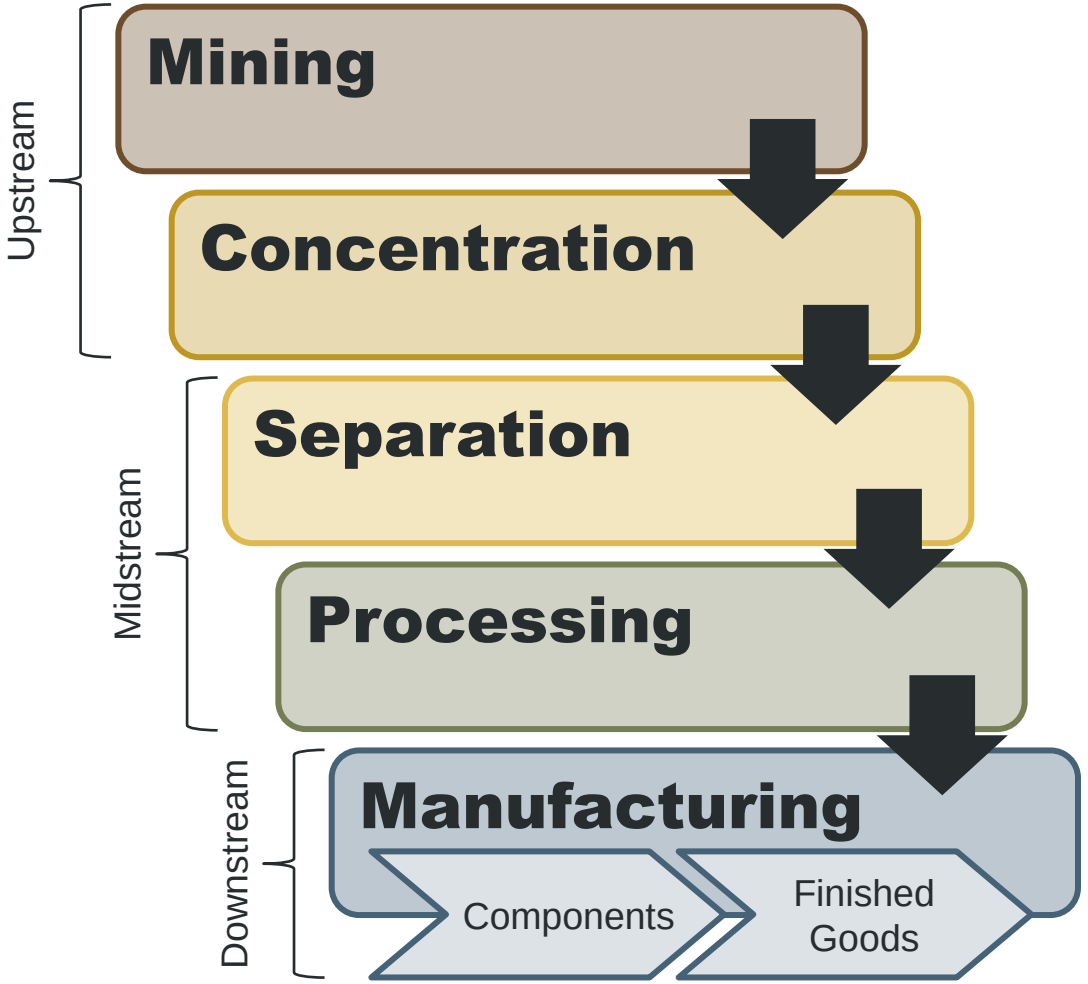
Coal Ash

Business Findings and Takeaways

Regional industries

- End users of final products
- Defining business model

Mountain Pass REE Mine, California



Summary of the Process for CM Production

Many steps—and handoff points—from mined lignite to products.

Different purities and processing methods.

Many companies in many locations.

Shipping solids is easy over long distances.

Anytime a solid is produced, this could be another business.

CREATING JOBS IN THE WILLISTON BASIN

Dean Bangsund
Research Scientist
Department of Agribusiness and Applied Economics
North Dakota State University

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CORE-CM WILLISTON BASIN

Outline

01 Measuring industry employment

02 Critical mineral opportunities in North Dakota

03 Potential statewide employment

04 Workforce

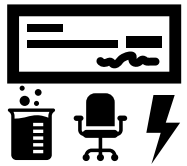
Three Kinds of Economic Activity Measured

Direct

The first round of change in the economy (adding a job, increasing sales, etc.)

I've gotten a new job at the EERC!

Indirect



What happens as an effect works its way through the economy

The EERC's new expenses include not just my salary but also the electricity I use, office supplies, equipment, etc.

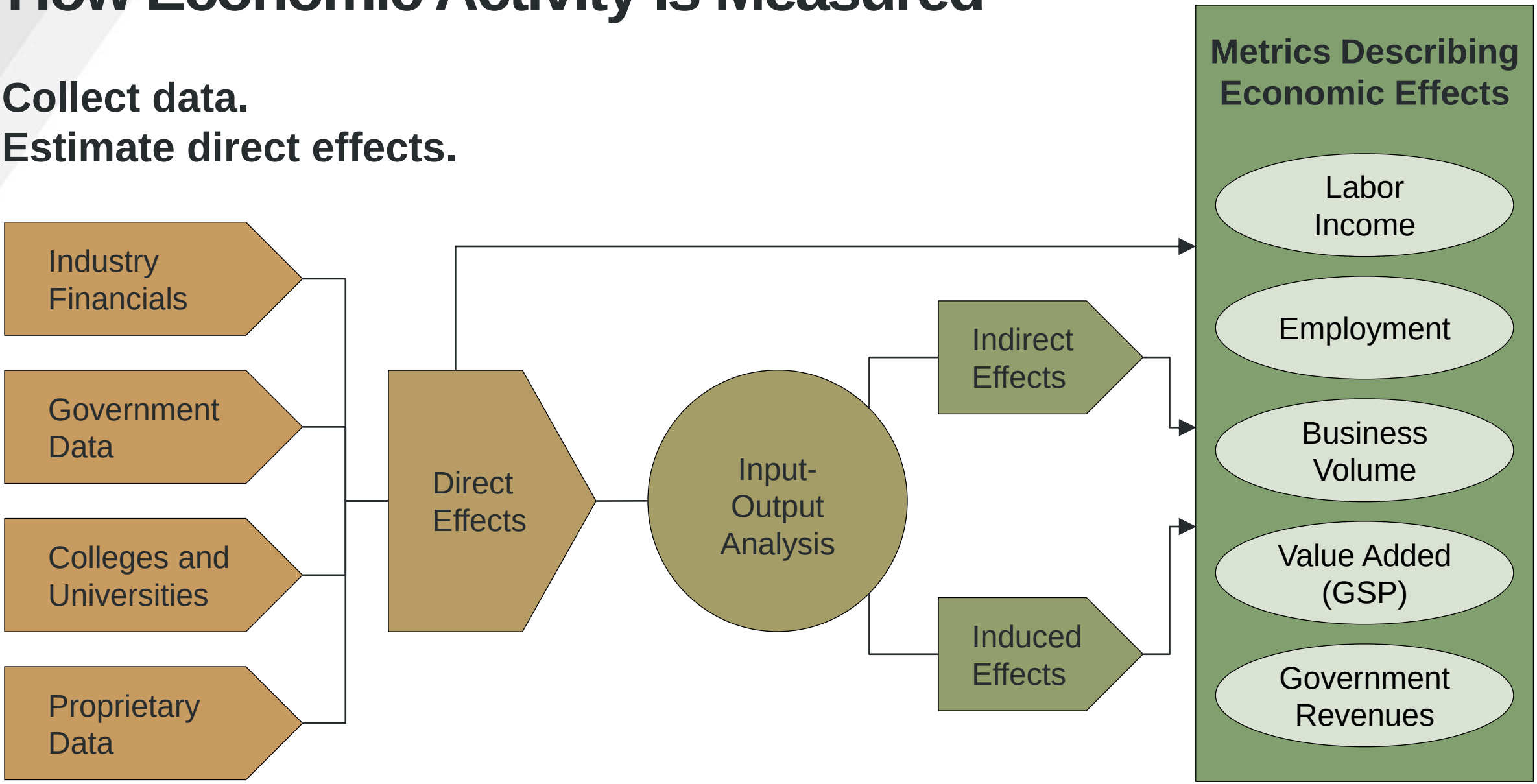
Induced

How consumers affect businesses

I can buy more groceries. The grocery store receives an increase in income.

How Economic Activity Is Measured

Collect data.
Estimate direct effects.



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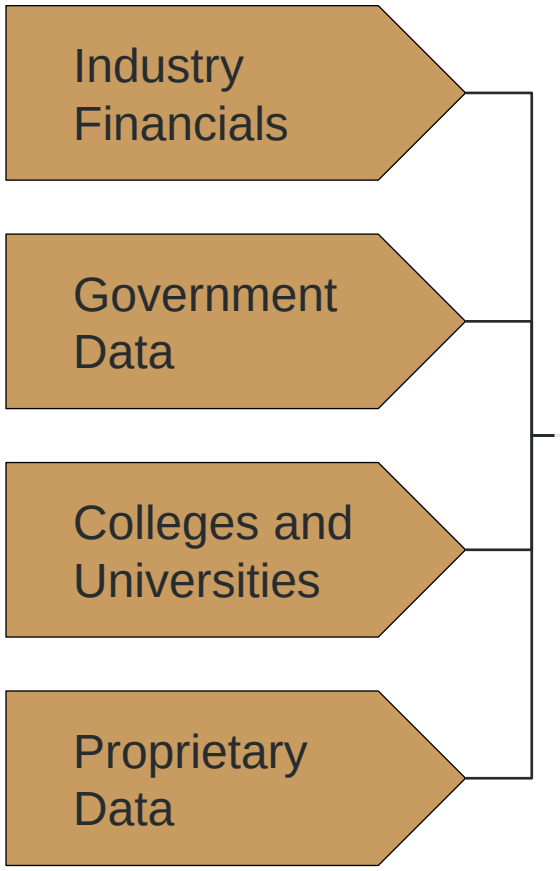
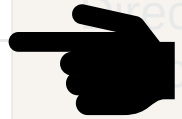




This is 75%–80% of the work.

Indirect Economic Effects: Business-to-Business Transactions

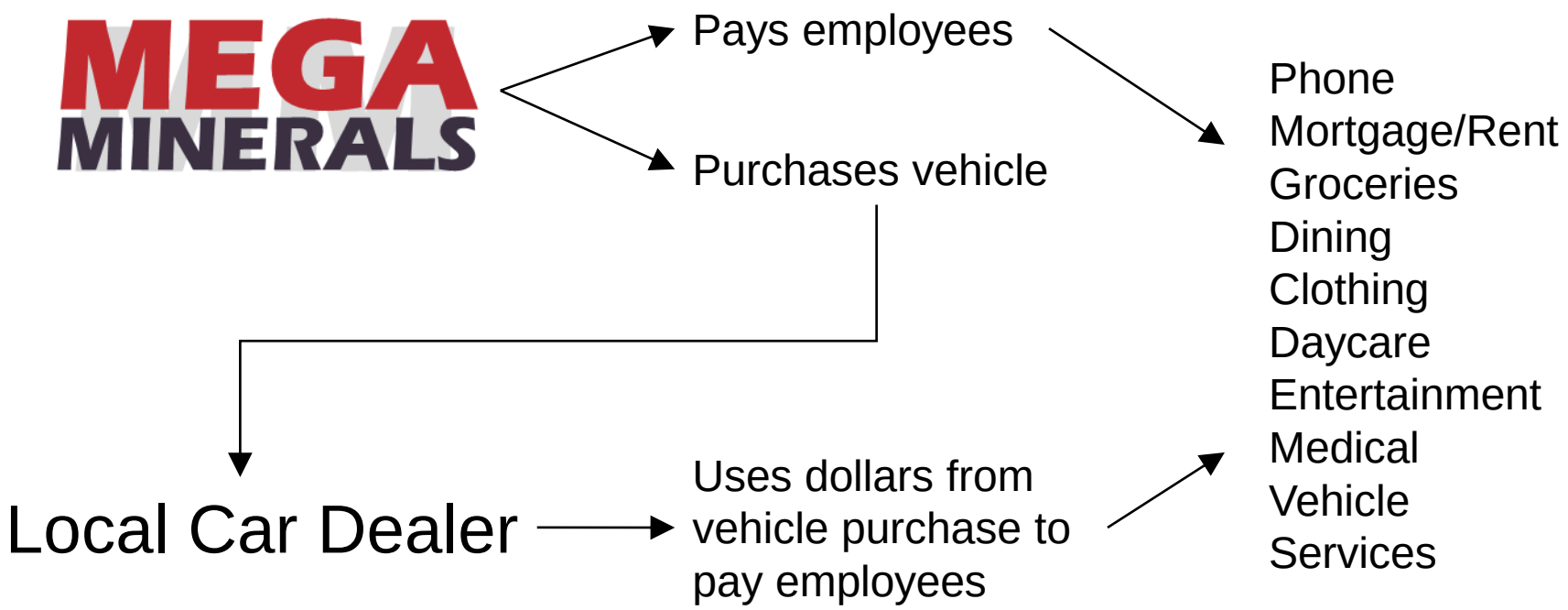
MEGA MINERALS

Local Car Dealer

Replace inventory
(manufacturing/transportation)
Interest
(banking and finance)
Advertising
(business services)
Electricity
(utilities)
Phone bill
(communication)
Office supplies
(retail trade)
Building upkeep
(construction)
Yard maintenance
(services)

Each of these in turn can affect multiple additional economic sectors.

Induced Economic Effects: Consumer-to-Business Transactions



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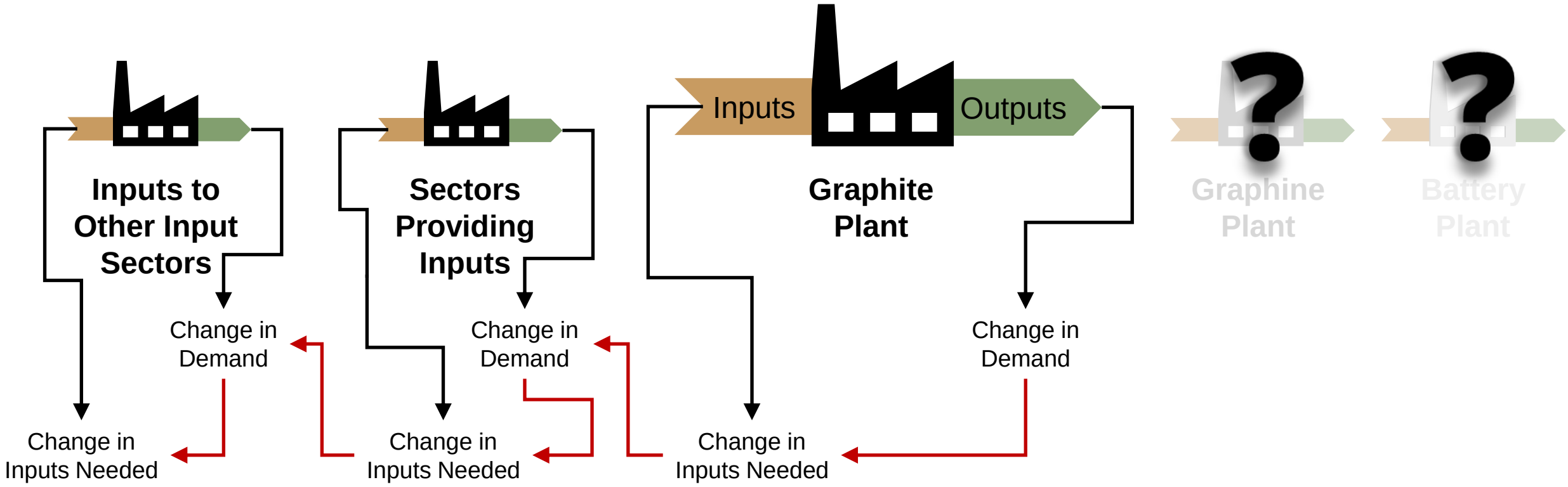
Limited to Backward Linkages

Backward Linkages	**Focus of Analysis**	Forward Linkages



Limited to Backward Linkages

Mining and Extraction Rock Ore	X	Geologic limitations
Processing Ore	✓	Talon metals (nickel ore from MN)
Primary Extraction Lignite Coal (mined)	✓	UND College of Engineering and Mines Research Institute
Secondary Processing (extending primary extraction)	✓	UND College of Engineering and Mines Research Institute
In Situ Mining Lignite Coal	✓	Coal seams accessible with mineable REEs
Primary Extraction Fly Ash	?	Fly ash is produced; is it feasible to use as feedstock?
Graphite/Graphene Manufacturing	✓	Extension of available lignite coal to serve as feedstock

Constraints Ignored

- Permitting
- Markets and trade
- Policy
- Technology
- Business economics
- Private investment

Lignite Industry Aspects Ignored

- Effects on existing lignite mining operations
- Implications tied to future viability of coal-fired power plants

Opportunities in North Dakota

Opportunities	Direct Jobs	Scope	Guidance
Processing Ore	150	One operation	Beulah Job Development Authority
Primary Extraction Lignite Coal (mined)	100–150	One or two operations	UND College of Engineering and Mines Research Institute
Secondary Processing (linked to primary extraction)	60–80	One or two operations	UND College of Engineering and Mines Research Institute
In Situ Mining Lignite Coal	40–60	One primary extraction operation	In Situ Operations for Uranium in NE and WY (when operating)
Graphite/Graphene Manufacturing	130	One operation, multiple activities	Anovion Technologies Alabama Graphite Products

Payroll? Production Inputs?

Analysis traditionally would acquire data from industry partners.

A paucity of data necessitates using the **North American Industry Classification System** (NAICS) codes to select U.S. economic sectors for proxy data.

NAICS Codes

Payroll, 2021 average compensation rate/job/sector

Production inputs:

How much?

Ratios of input purchases to employment per sector.

Where purchased?

Applied modified national average spending patterns to N.D. economy using low (20%) and high (80%) scenarios for in-state sourcing of inputs.

Clarification

If an input purchase is required from an economic sector that does not exist in the N.D. economy, employment will be zero in either scenario.

Opportunities in North Dakota: Payroll and Production Inputs

Opportunities	Payroll	Production Inputs	NAICS
Processing Rock Ore	$17,700,000	$97,650,000	212230 331410
Primary Extraction Lignite Coal (mined)	$14,190,000	$39,710,000	212290
Secondary Processing (extending primary extraction)	$7,700,000	$89,460,000	331410
In Situ Mining Lignite Coal	$5,850,000	$15,525,000	212290
Graphite/Graphene Manufacturing	$14,040,000	$35,620,000	327992 335991

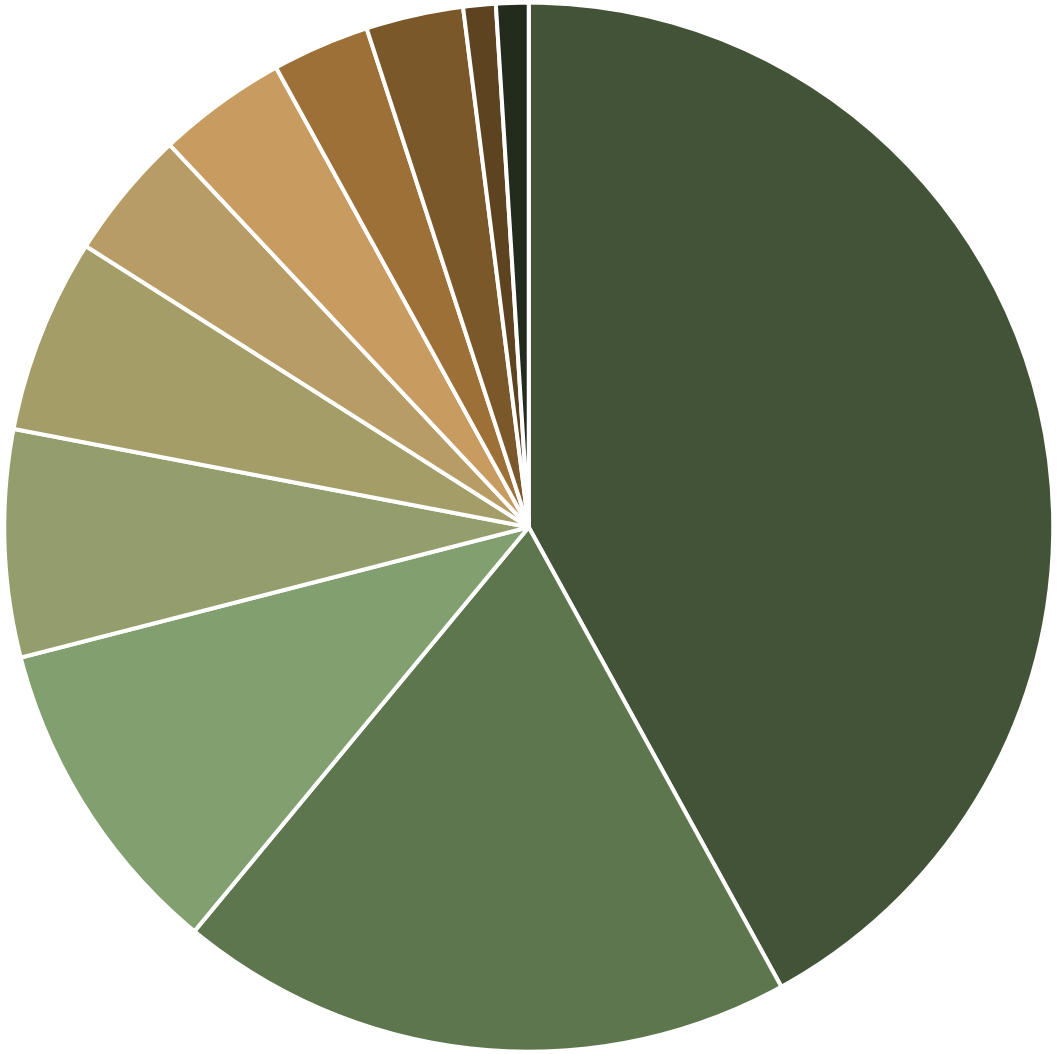
Potential Statewide Employment

	Direct Jobs	Jobs from Purchases of Production Inputs				Direct Payroll	Direct, Indirect, Induced	
		Indirect		Induced		Induced		
	—	Low	High	Low	High	—	Low	High
Processing Nickel Ore	150	96	383	28	110	66	339	709
Primary Extraction Lignite Coal	110	30	120	9	36	53	202	319
Secondary Processing Lignite Coal	70	35	140	10	39	29	144	278
In Situ Lignite Coal	45	10	40	3	11	22	80	118
Graphite/Graphene	130	30	120	9	35	52	221	336

Does North Dakota Produce the Types of Production Inputs Required for CORE-CM Opportunities?

National Production Functions for Selected CORE-CM Opportunities (NAICS equivalent)					
	All Economic Sectors*			Only Manufacturing Sectors	
	Total	Number Not Available in ND		Total	Number Not Available in ND
Processing Nickel Ore (212230)	117	30		56	23
Primary Extraction Mined Lignite Coal and In Situ Lignite (212290)	105	21		36	14
Secondary Processing Mined Lignite Coal (331410)	101	19		29	13
Graphite/Graphene (327992)	106	18		32	12
Graphite/Graphene (335991)	84	18		32	17
*National and North Dakota's economies based on 546 economic sectors.					

Direct Labor Workforce Requirements



NAICS Classifications:

- 212230 (copper, nickel, lead, and zinc mining)
- 212290 (other metal ore mining)

Occupations

42%	Construction and extraction
19%	Installation, maintenance, and repair
10%	Production
7%	Transportation and material moving
6%	Architecture and engineering
4%	Life, physical, and social science
4%	Management
3%	Office and administrative support
3%	Business and financial operations
1%	Protective service
1%	Computer and mathematical

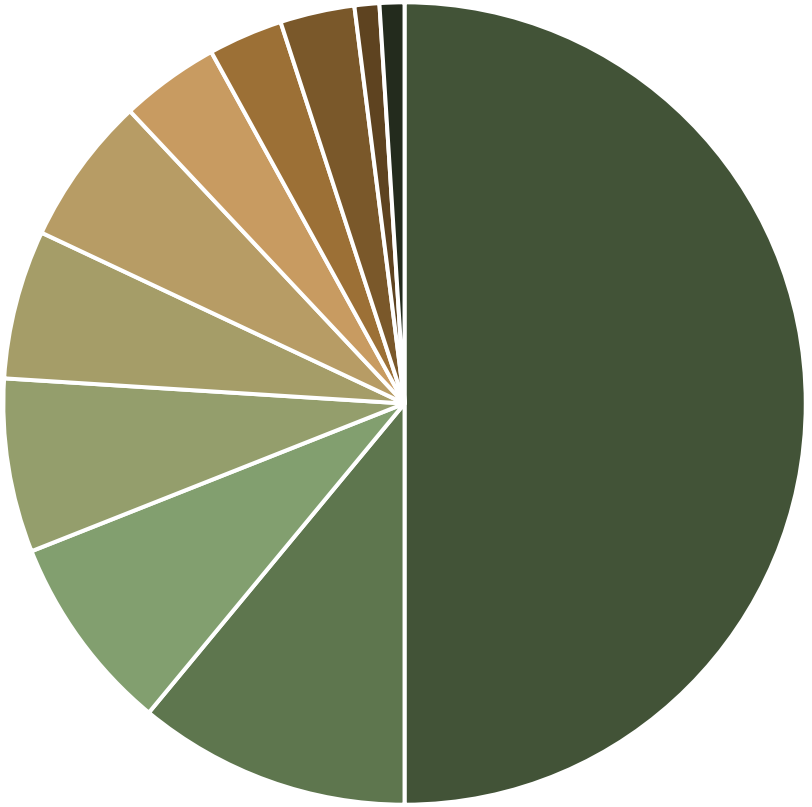
Direct Labor Workforce Requirements

NAICS Classifications:

- 335991 (carbon and graphite product manufacturing
- 331410 (nonferrous metal smelting and refining [excluding aluminum])
- 327992 (ground or treated mineral and earth manufacturing)

Occupations

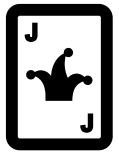
50%	■	Production
11%	■	Transportation and material moving
8%	■	Office and administrative support
7%	■	Management
6%	■	Architecture and engineering
6%	■	Installation, maintenance, and repair
4%	■	Business and financial operations
3%	■	Sales and related
3%	■	Construction and extraction
1%	■	Computer and mathematical
1%	■	Life, physical, and social science
0.2%	–	Protective service *(not shown)*
0.2%	–	Arts, design, entertainment, sports, and media *(not shown)*
0.02%	–	Legal *(not shown)*



CORE-CM Employment

Biggest variable/unknown: how well will North Dakota supply what the new projects (industry) require for production inputs.

Least variable: anticipated high-paying jobs will generate employment growth from induced economic output.



Potential wildcard: the link between the existing lignite industry and a critical minerals industry.

Food for thought: the presence of critical mineral projects creates new/expanded product development (forward linkages to other industries).

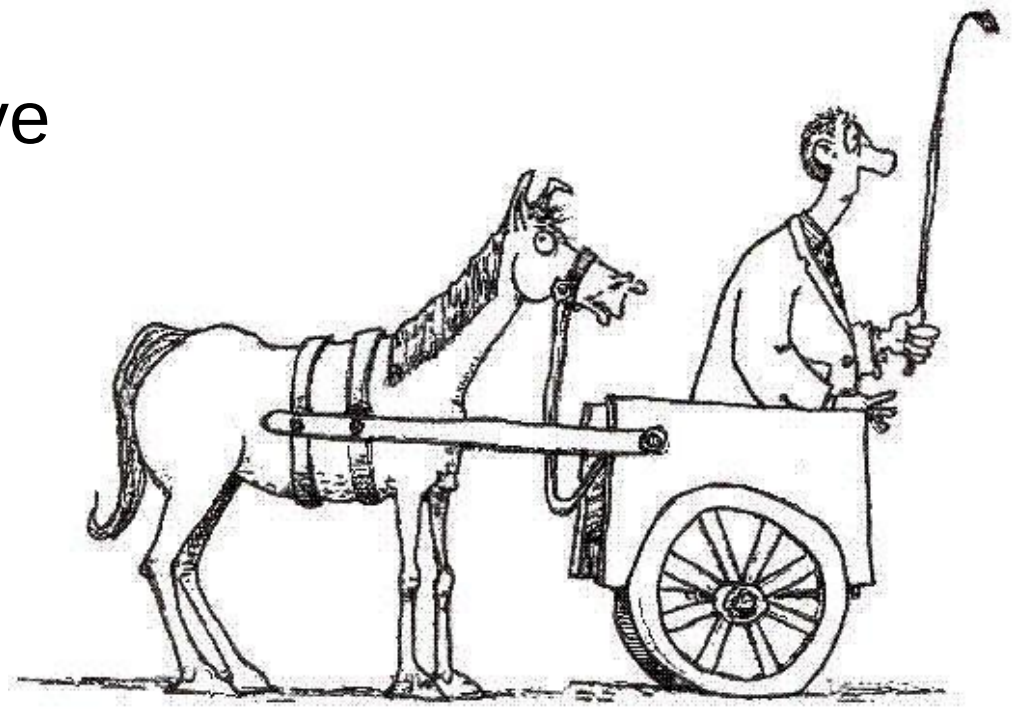
Takeaways

Opportunity is real

Unlikely to be transformative at the state level

Likely to be important at the local level

Avoid unrealistic thinking



North Dakota icon by Marco Livolsi

Contact Information

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Carbon Ore, Rare Earth, and Critical Minerals Initiative (CORE-CM) led by DOE NETL

Catalyze economic growth

Job creation in energy communities

Energy communities not to be left behind

Domestic production of REEs and CMs

Strengthen our national economy and security

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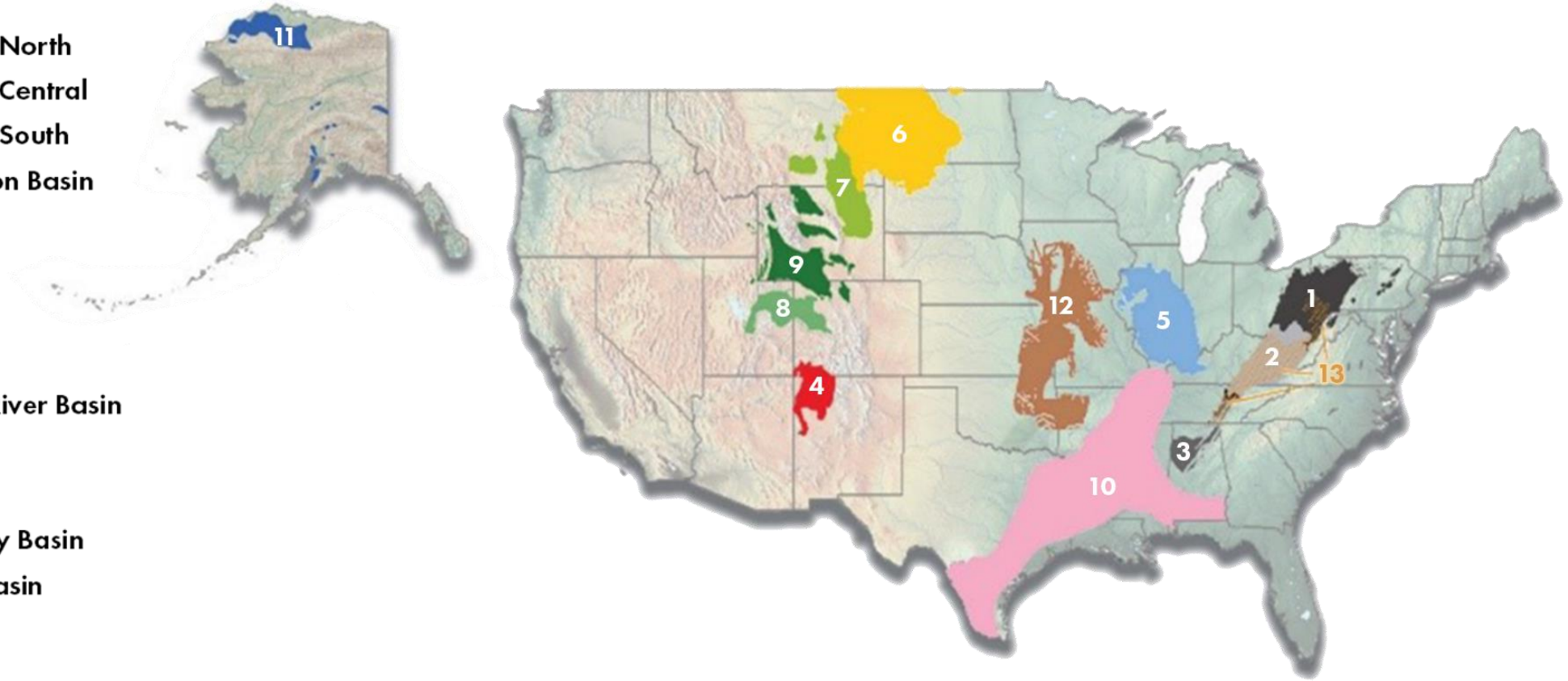
13 CORE-CM Initiative Teams

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



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Source: NETL

Williston Basin CORE-CM Project Team

Project Team

UND Energy & Environmental Research Center
UND College of Engineering & Mines Research Institute
UND Nistler College of Business & Public Administration
Pacific Northwest National Laboratory
North Dakota State University
Montana Tech University

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Minnkota Power Cooperative
North American Coal
Critical Materials Institute (Ames)
Current Lighting Solutions

CORE-CM
WILLISTON BASIN

In Collaboration With

Lignite Energy Council
North Dakota Department of Commerce
North Dakota Governor's Office
Semplastics
Western Dakota Energy Association
North Dakota Geological Survey
South Dakota Geological Survey
Illinois Geological Survey CORE-CM Team
University of Alaska CORE-CM Team
University of Utah CORE-CM Team
Wyoming School of Energy Resources CORE-CM Team

ACKNOWLEDGMENT

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October—Bismarck

Keynote Speaker:

Dr. Jessica Mullen

U.S. Department of Energy

National Energy Technology Laboratory

Opening Reception

Monday, October 9, 2023

5:30–7:30 p.m.

Stonehome Brewing Company

1601 North 12th Street

Symposium

Tuesday, October 10, 2023

9:00 a.m. – 4:00 p.m.

North Dakota's Gateway to Science

1600 Canary Avenue

Scan QR code or visit crees-wb-2023.eventbrite.com

Coming in 2024

Learning More

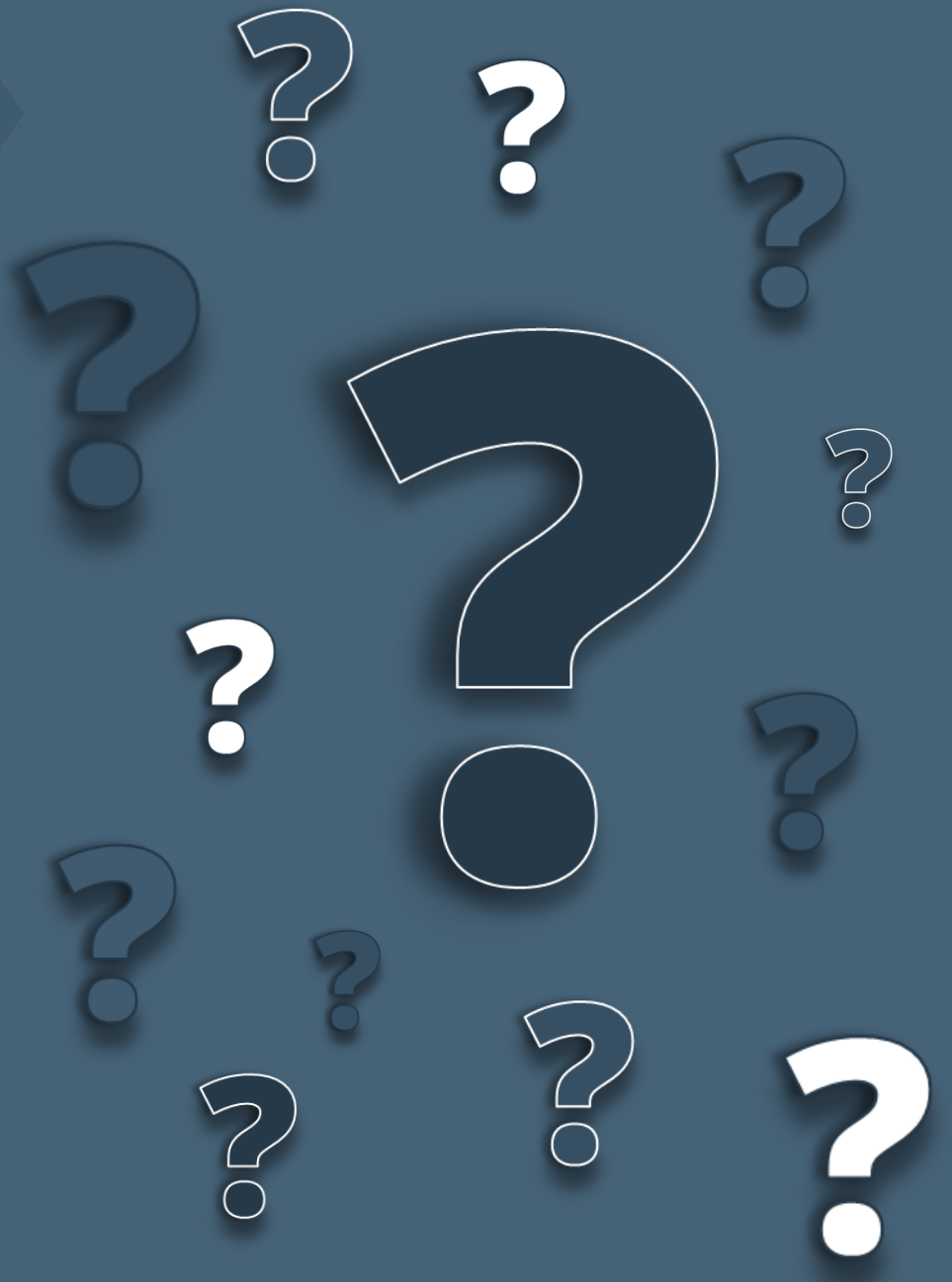
Visit the Williston Basin CORE-CM website:
undeerc.org/research/projects/wb-corecm.html

Information about the project

Information about critical minerals

Revisit past webinars

Any questions?



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