



Energy & Environmental Research Center (EERC)

WHY DO CRITICAL MINERAL BUSINESS IN THE BASIN? OUR STRENGTHS, OUR ASSETS, OUR NEEDS

January 11, 2023

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**NORTH AMERICAN
COAL
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PRESENTERS

Jason Laumb, Director
Advanced Energy Systems, EERC

David Flynn, Research Director
Institute for Policy & Business Analytics
Nistler College of Business & Public Administration

Webinar Series Events

Last Year



Critical Minerals: What, How, Why All the Hype?
September 21, 2022



Today's Critical Mineral Technologies and How to Move Forward
November 30, 2022

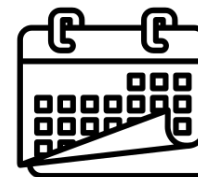
www.undeerc.org/wb-corecm
(or scan the QR code)



Today



Why Do Critical Mineral Business in the Williston Basin? Our Strengths, Our Assets, Our Needs
January 11, 2023



Securing the Williston Basin's Critical Mineral Future: Findings and Next Steps

Defining Critical Minerals



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)

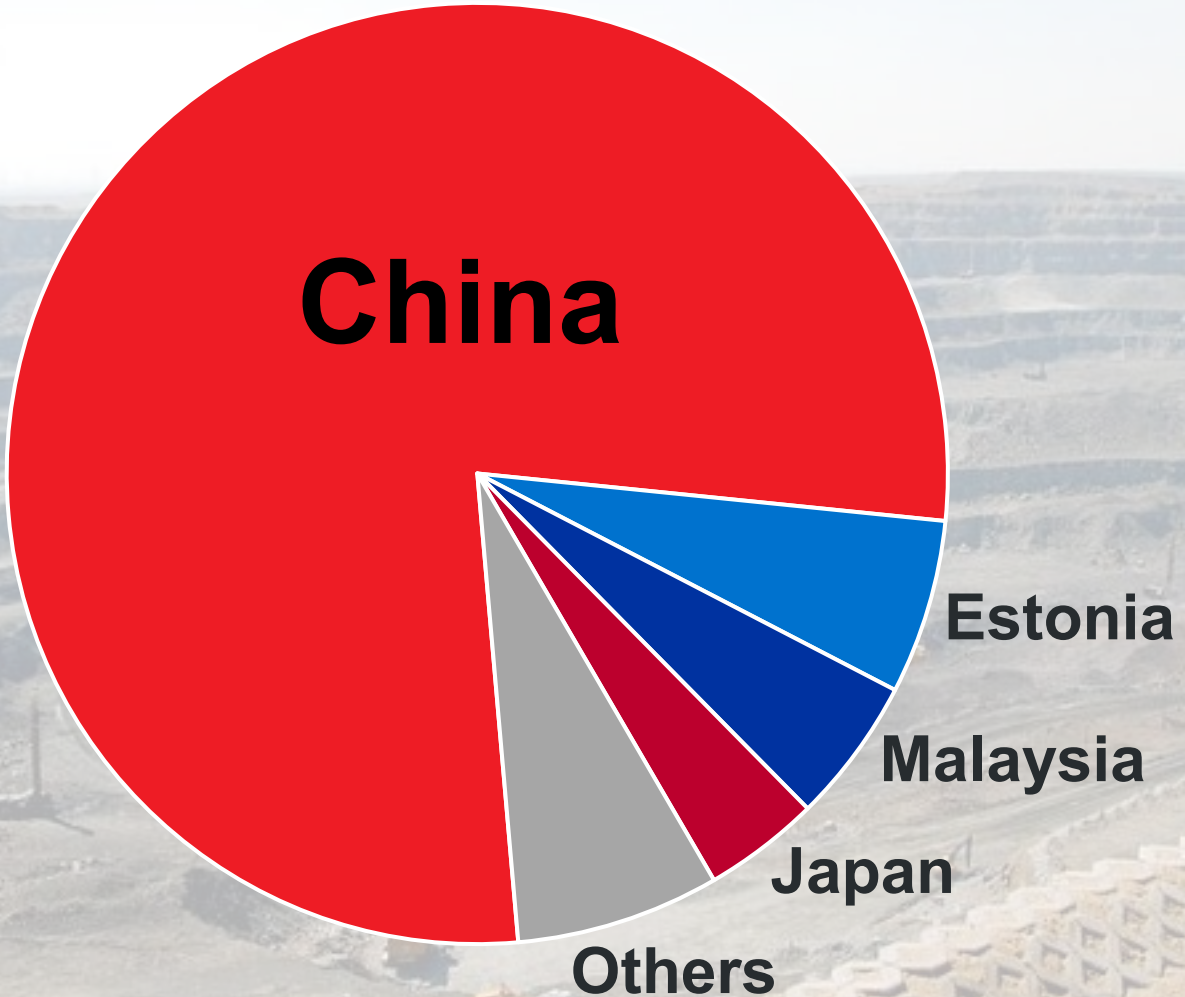
- Catch-all term for the critical minerals that are not REEs
- No other common factor

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

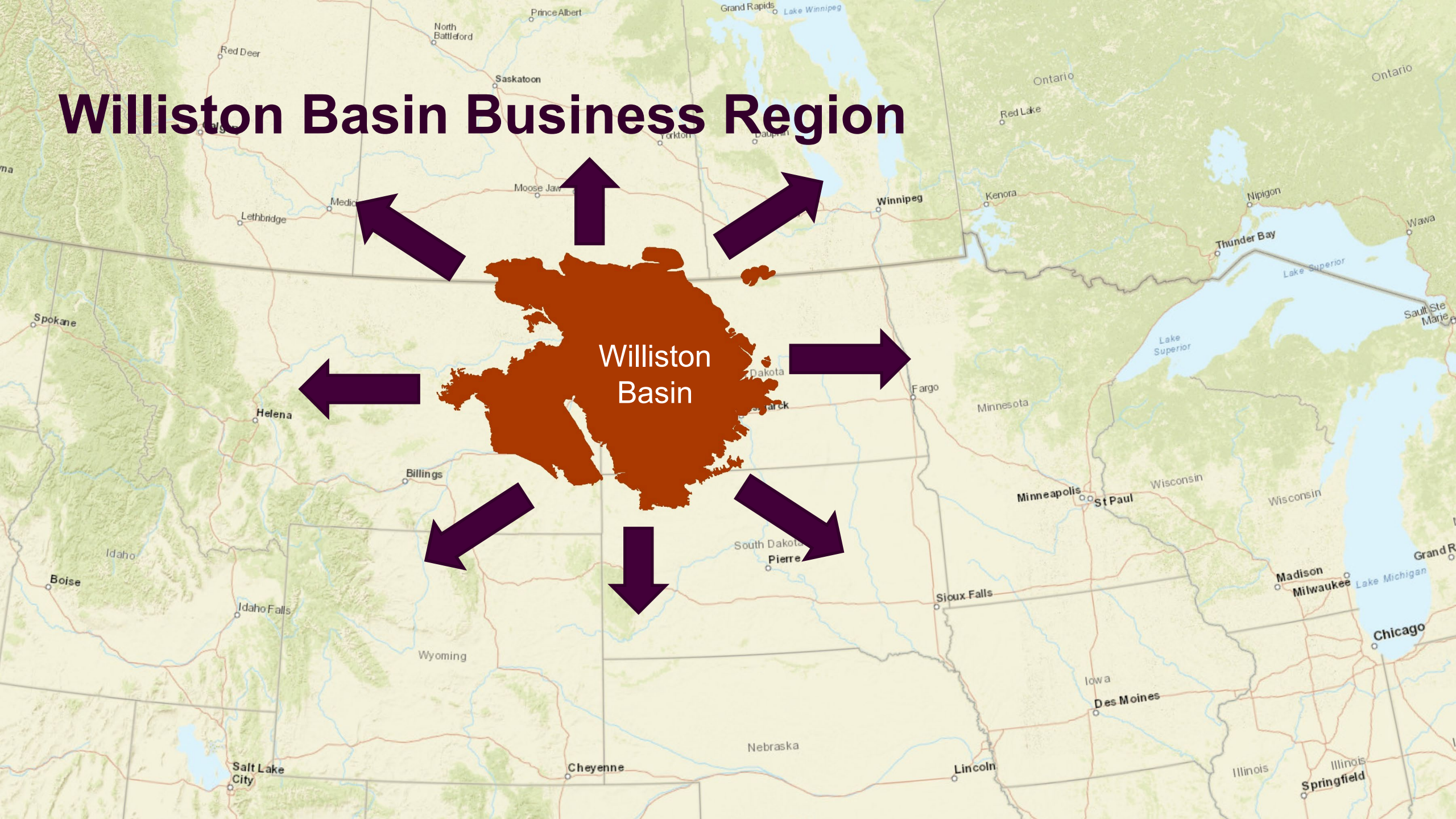


U.S. REE Suppliers

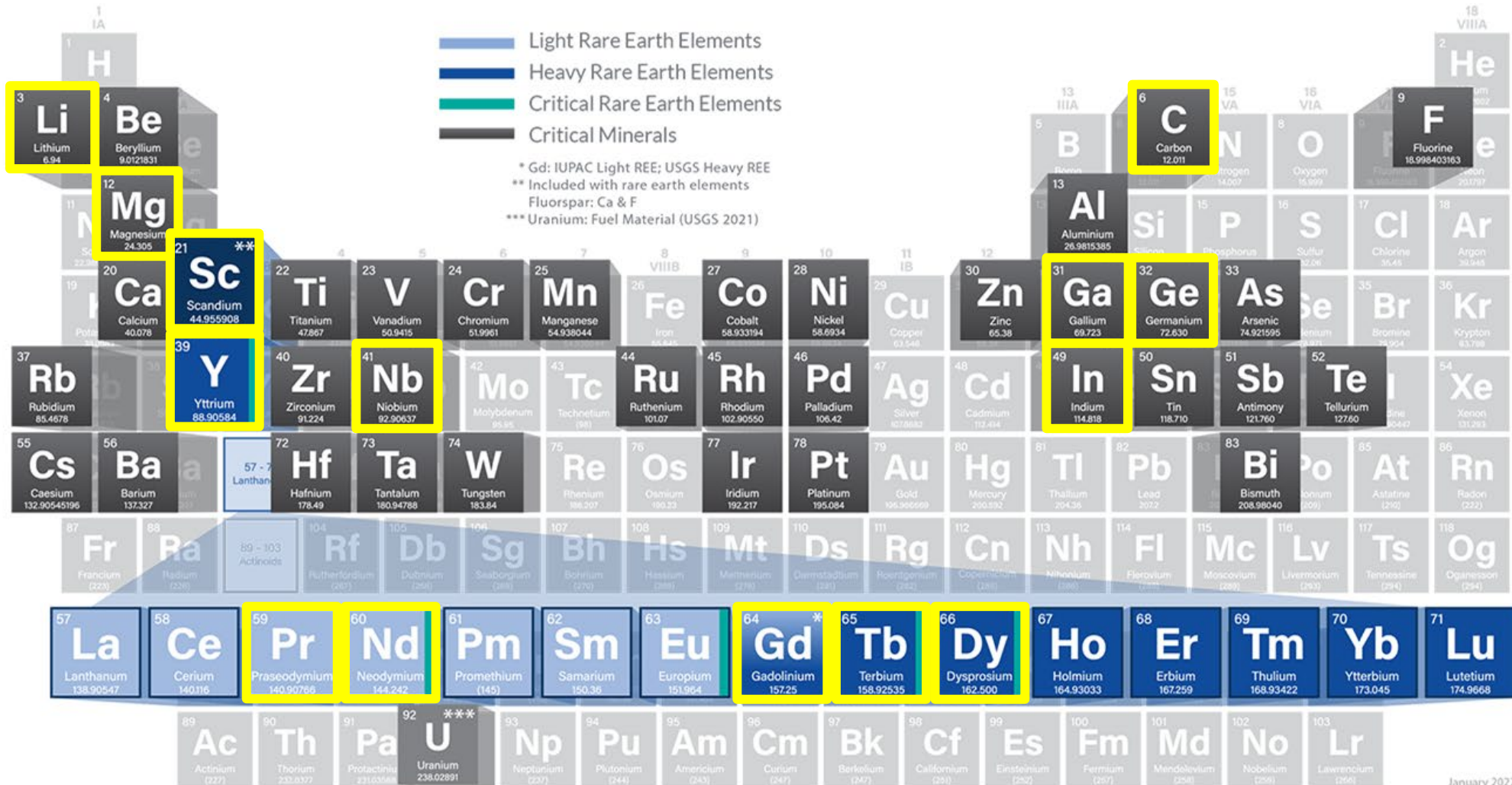
More than 80% of U.S. critical minerals are imported.



Williston Basin Business Region



Elements with Greatest Potential to Contribute to the Williston Basin Market



Developing New Sources and Innovative Ways to Extract CMs and REEs



Existing Lignite Coal Mines



Produced Water



ND Shales: Pierre, Niobrara, Upper and Lower Bakken



Deep Unminable Coal Seams by In Situ Extraction

How Do We Move Forward?

Evaluate technologies with:

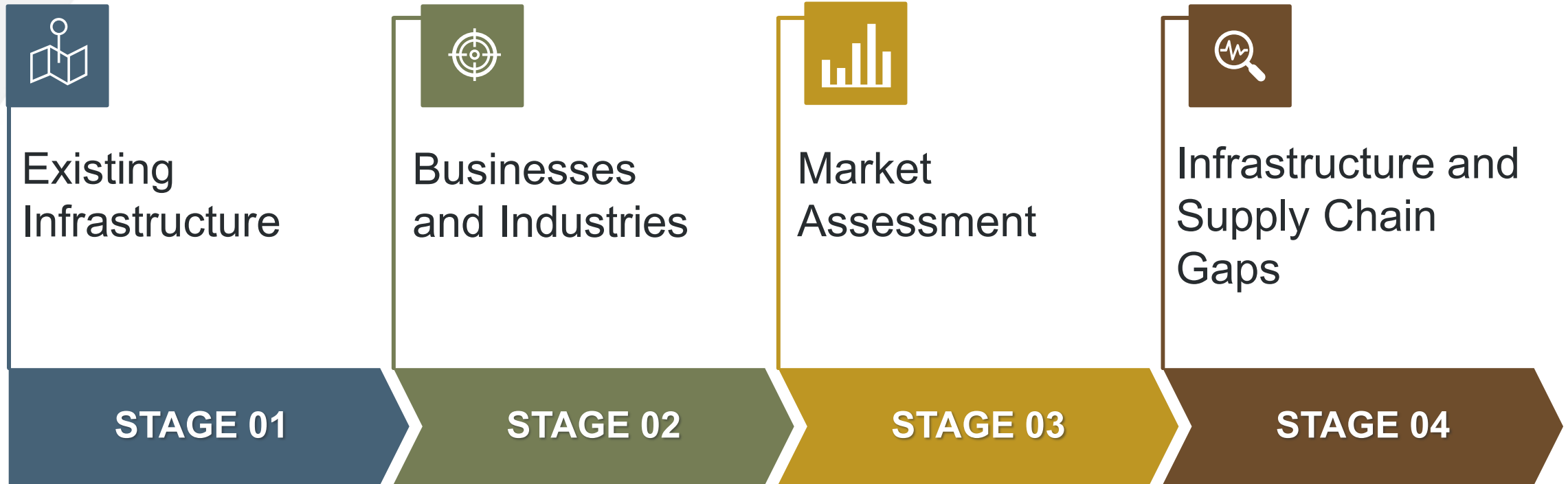
- Ore and reserve in mind
- Current technology scale
- Market needs



JASON LAUMB

Director, Advanced Energy Systems
Energy & Environmental Research Center
University of North Dakota

Business Boundary Timeline and Team

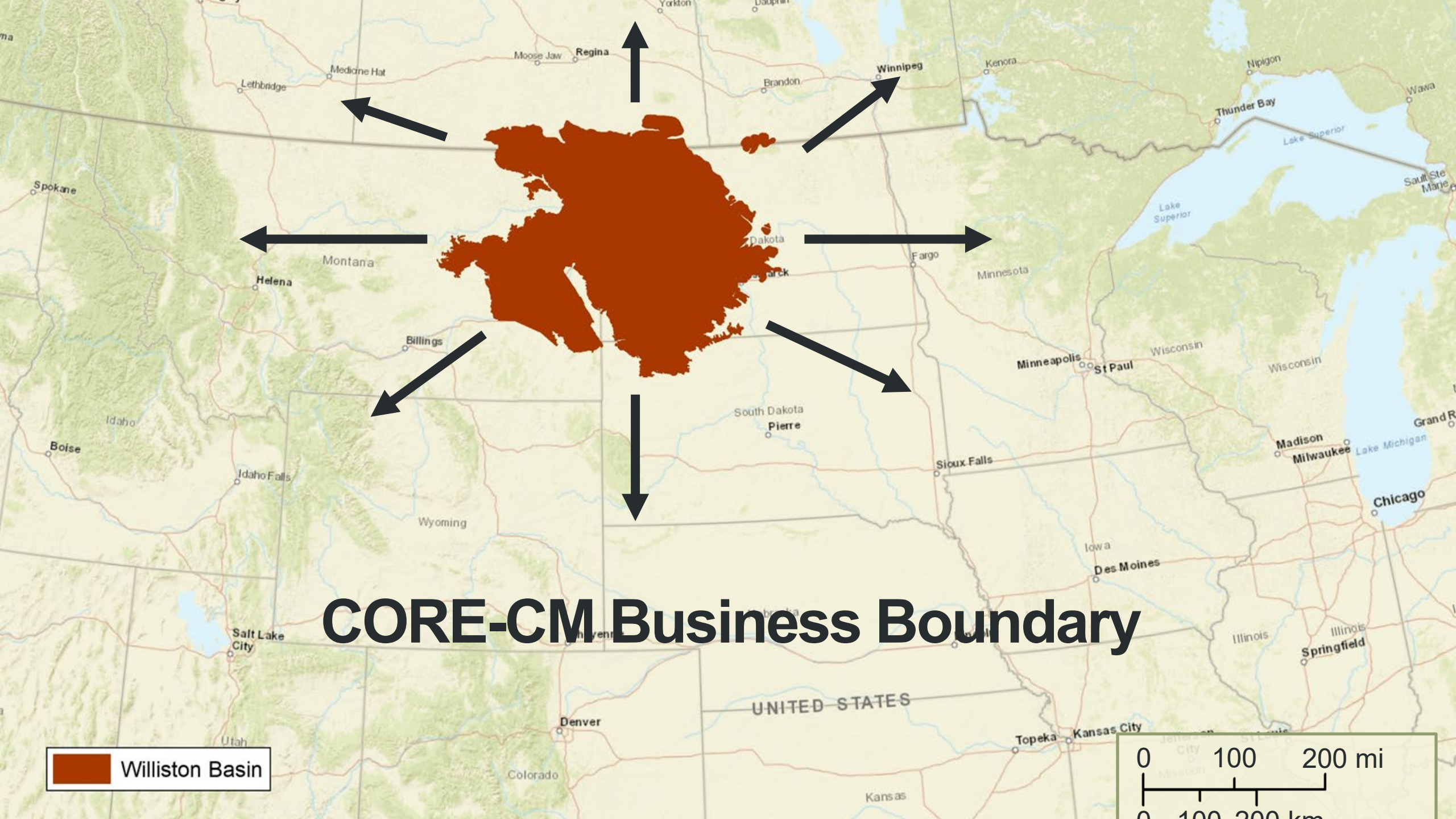


Jason Laumb,
Angie Morgan, and others

David Flynn
UND Nistler School

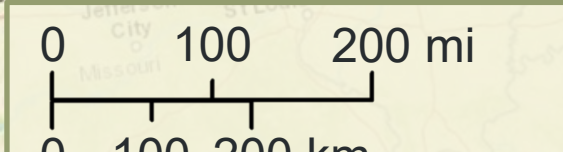
Dean Bangsund
Ag Economics





CORE-CM Business Boundary

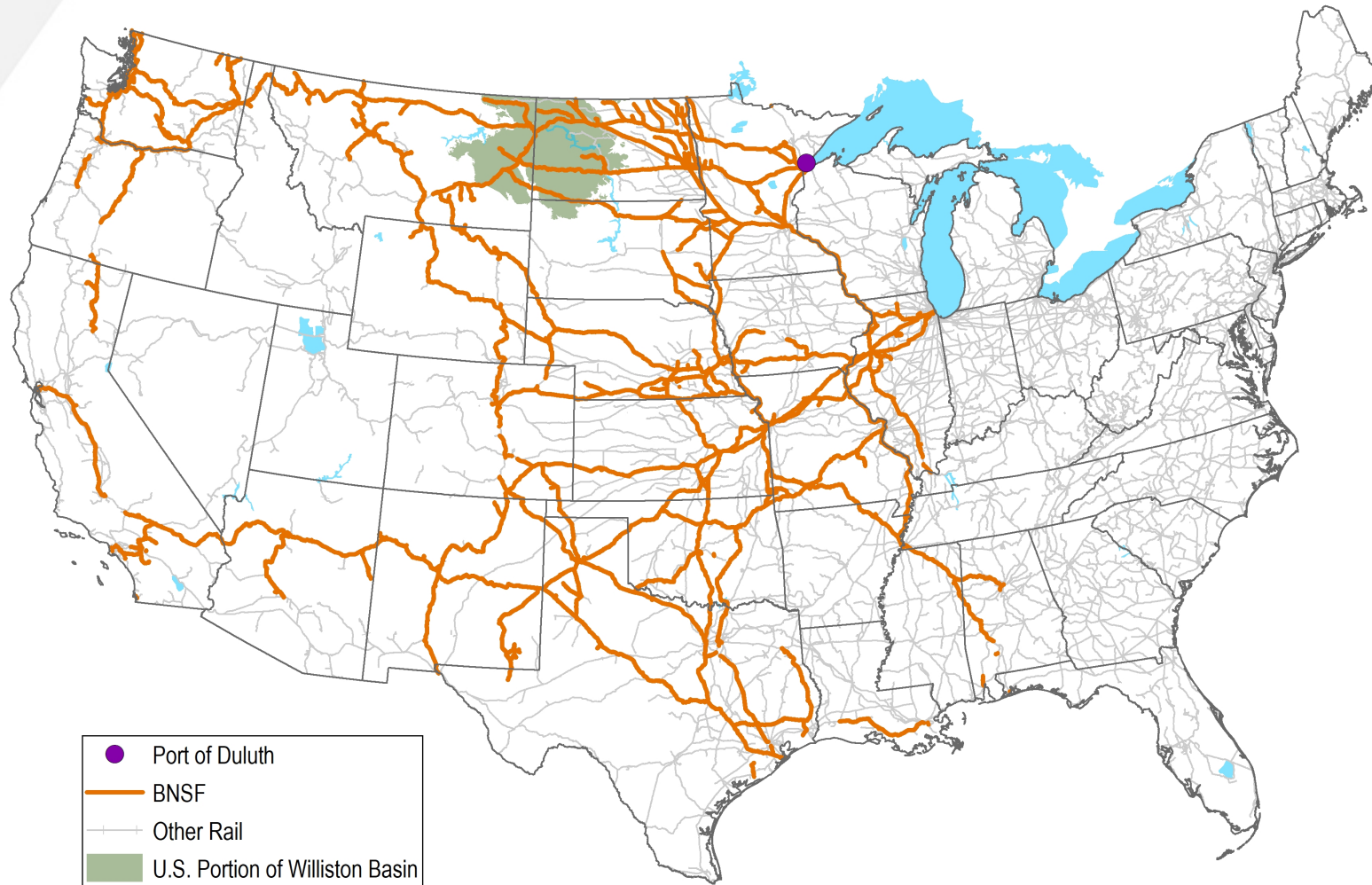
 Williston Basin



Strategy – Our Strengths, Our Opportunities

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

Advantageous Transportation Infrastructure



- Rail
- Truck
- Port in Duluth

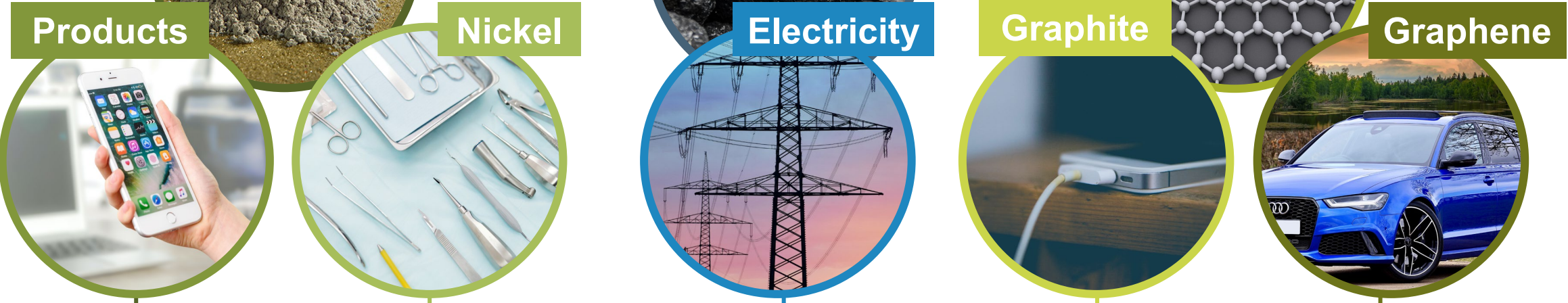


Strategy – Our Products

Raw REEs/CM?

Final Products?

- Magnets
- Aggregate
- Computer components
- Graphite/graphene
- Batteries



**Smart Phones
Military Equipment
Farming**

**Medical
Equipment
Kitchenware**

**Power Plants
Power Lines
Homes/Businesses**

**Phone
Batteries
Car Batteries**

**Water Filters
Body Armor
Automotive
Equipment**



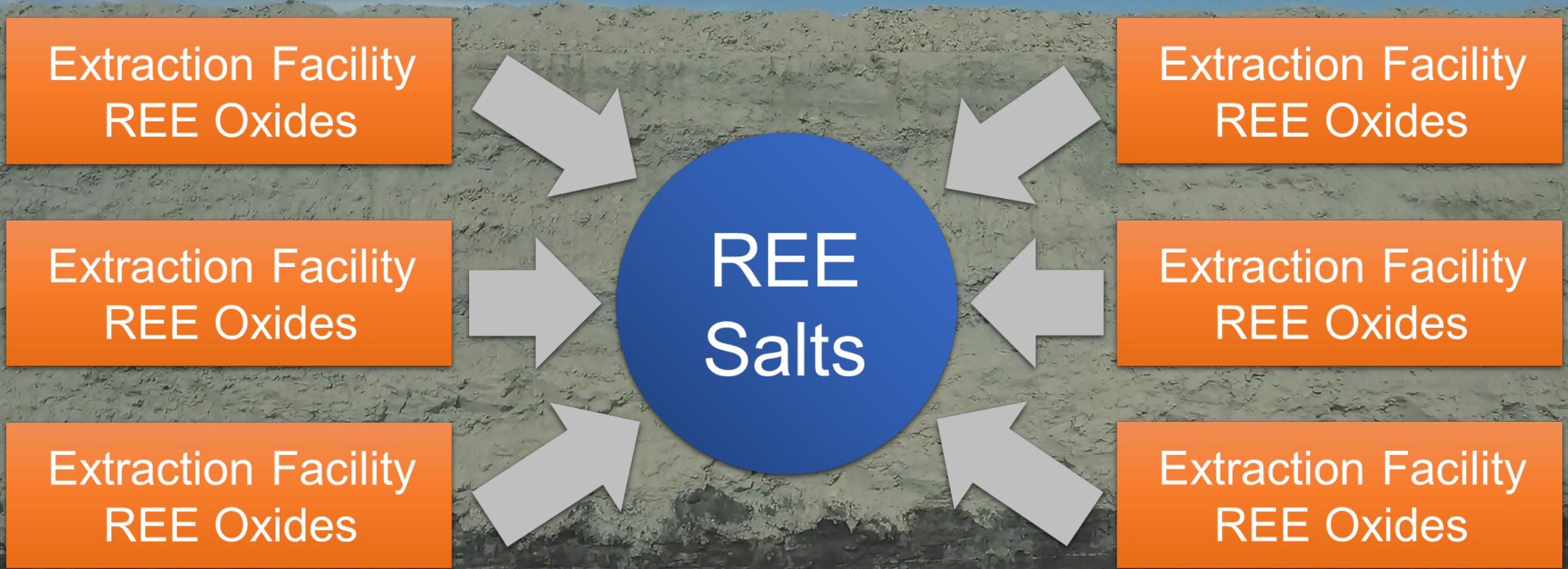
Critical Challenges. Practical Solutions.

Strategy – Our Needs



- **Additional infrastructure and resources**
- **Ideas to spur economic growth**
- **Logistical needs to fill supply chain gaps**

Extraction to Concentrate – Hub and Spoke

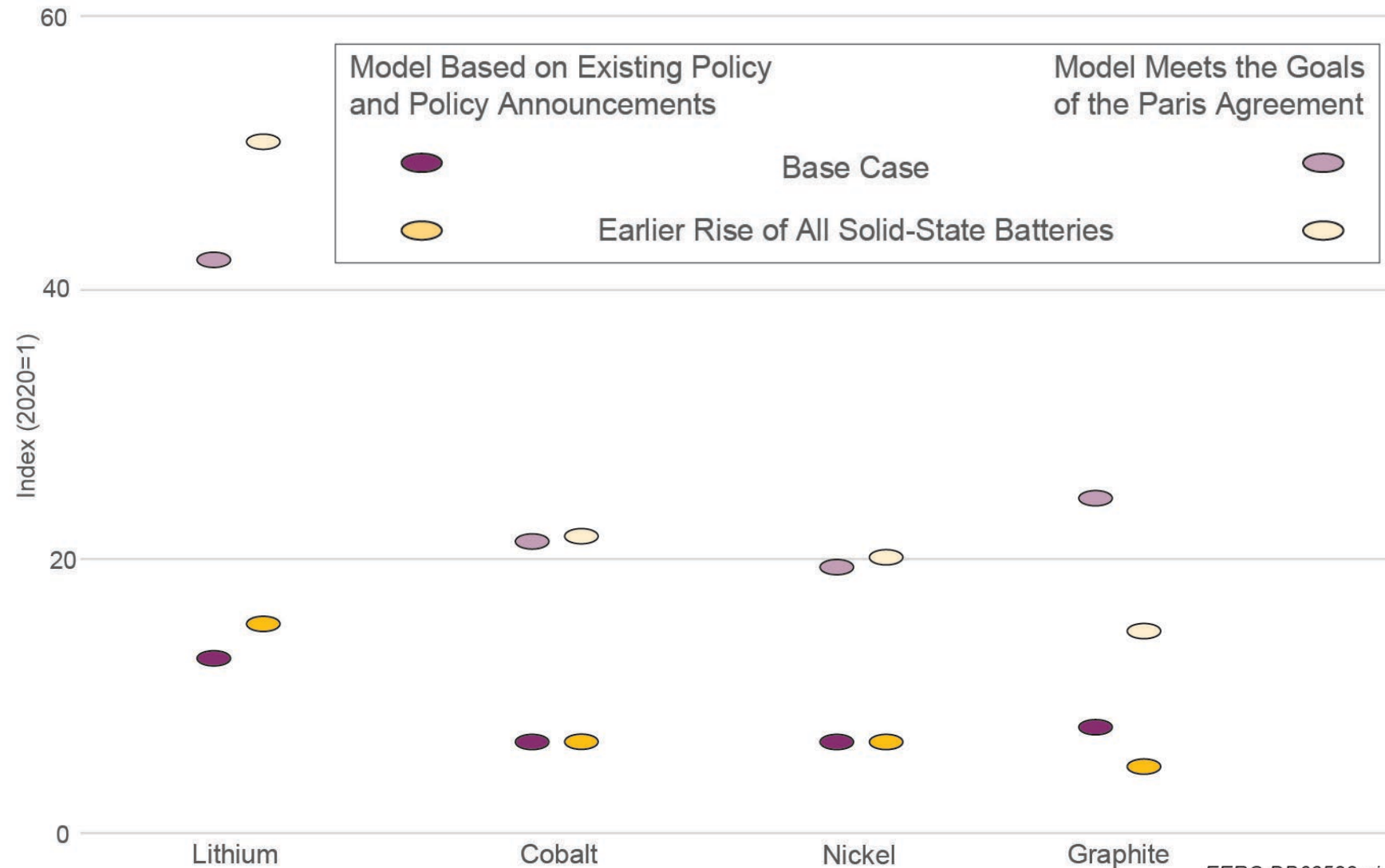


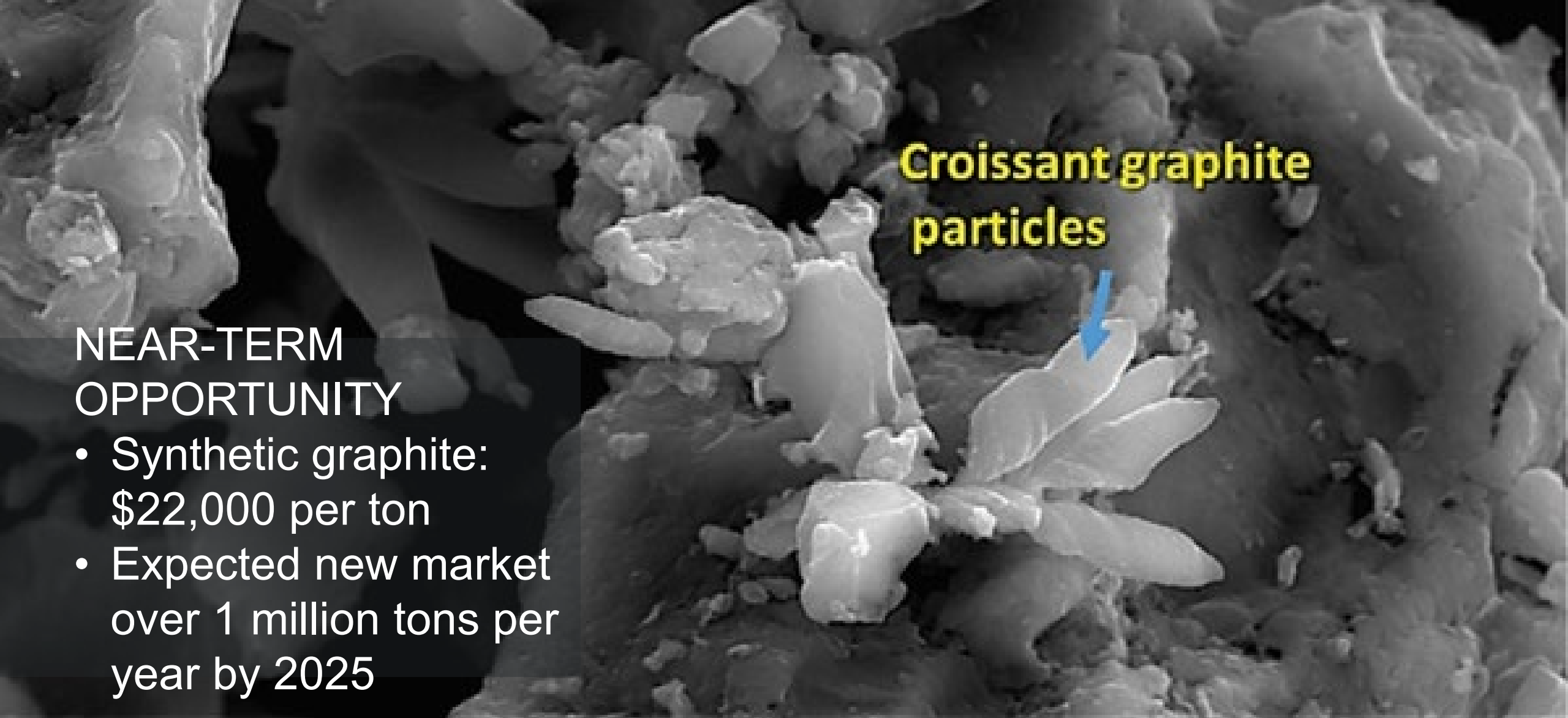
International Energy Agency 2040 Demand Scenarios

Production increasing

- Meet climate goals
- Meet computer and electrification needs

Production for some elements will need to increase by many times the current rate.





Croissant graphite particles

NEAR-TERM OPPORTUNITY

- Synthetic graphite: \$22,000 per ton
- Expected new market over 1 million tons per year by 2025

9 μ m

MAG: 3000x HV: 15 kV WD: 9.8 mm Px: 41.5 nm

Recycling

- Magnet elements are near-term target:
 - Neodymium
 - Praseodymium
 - Dysprosium
 - Terbium
- Turbine motors
- MRI machines
- Hard drives



Image Credit: Mart Production/Pexels

Barriers: Limited Market Penetration and Price Control



Market Assessment

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

DAVID FLYNN

Research Director
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University of North Dakota

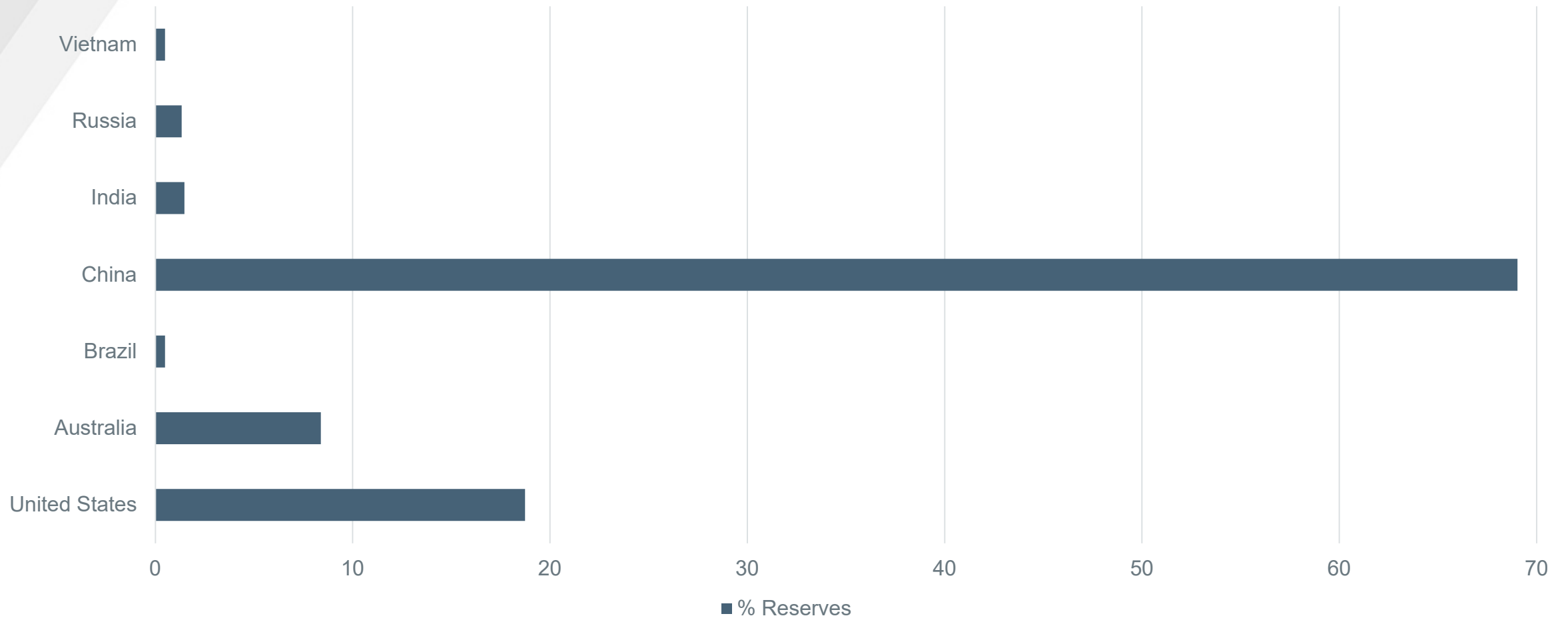
Opportunities Exist to Enter



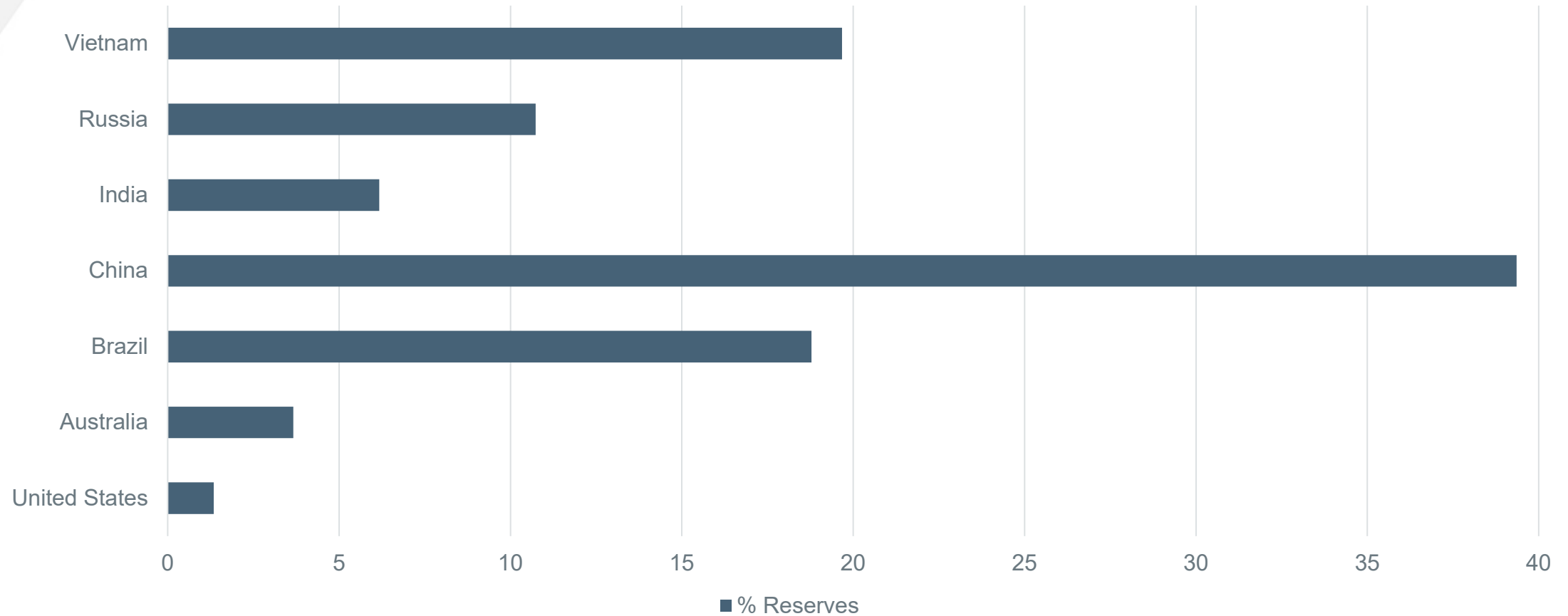
Photo: Mo Eid

- Most research suggests the cost structure of firms in the supply chain and the nature of demand do not favor monopoly.
- This depends crucially on access to infrastructure:
 - Transportation
 - Energy
 - Water
 - Labor
- Production and reserves are currently highly concentrated globally.

2020 Annual Production of Rare-Earth Elements



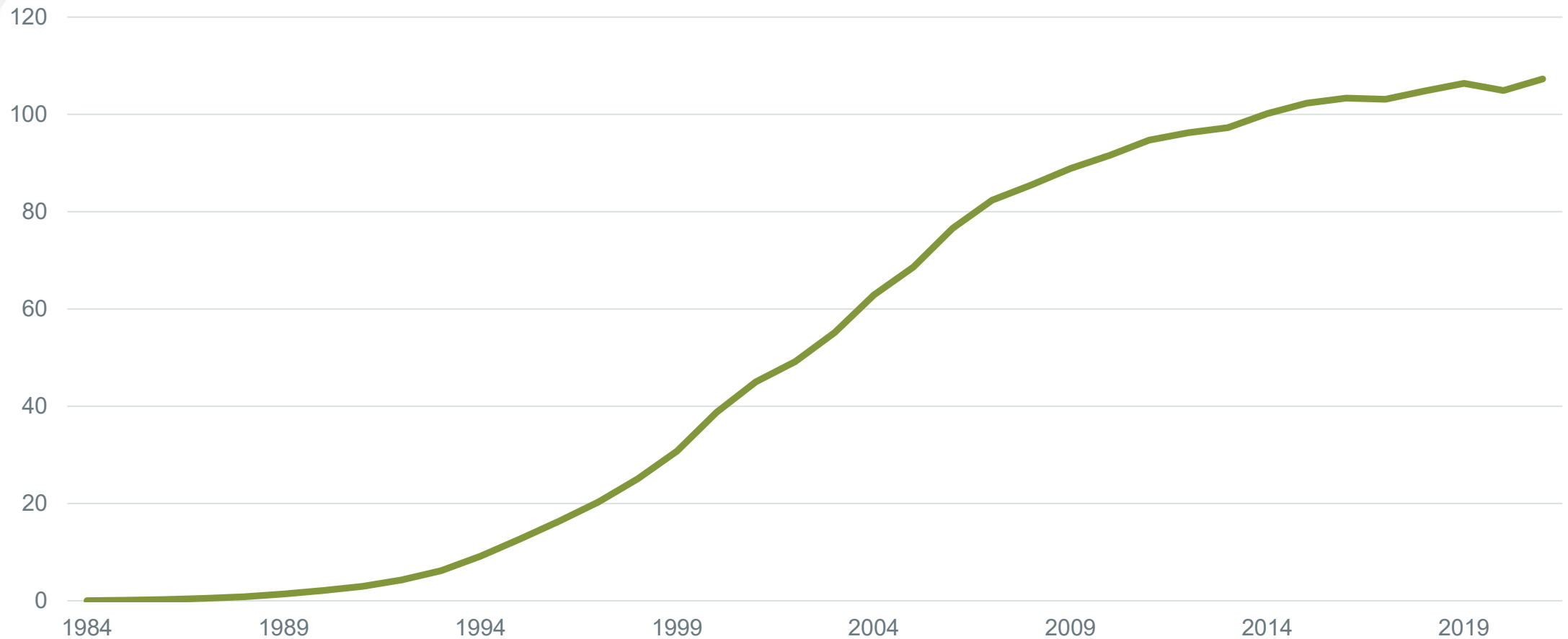
2020 Annual Reserves of Rare-Earth Elements





Demand for products using rare-earth elements is high.

Cellular Subscriptions per 100 People



Price Factors Are Vital to Business Growth

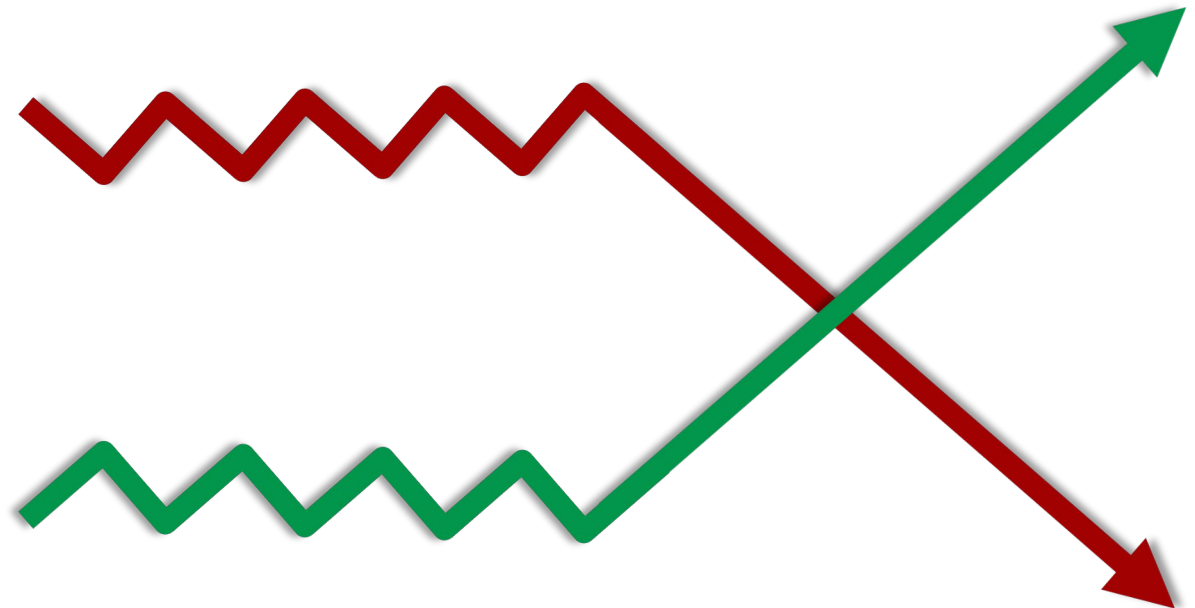
- Within extractive industries, the price level is an important factor determining firm entry, exit, and profitability.
- Equally important from the perspective of risk mitigation is the variability of prices and the inflation rate.
- These prices displayed significant volatility over the last several years.



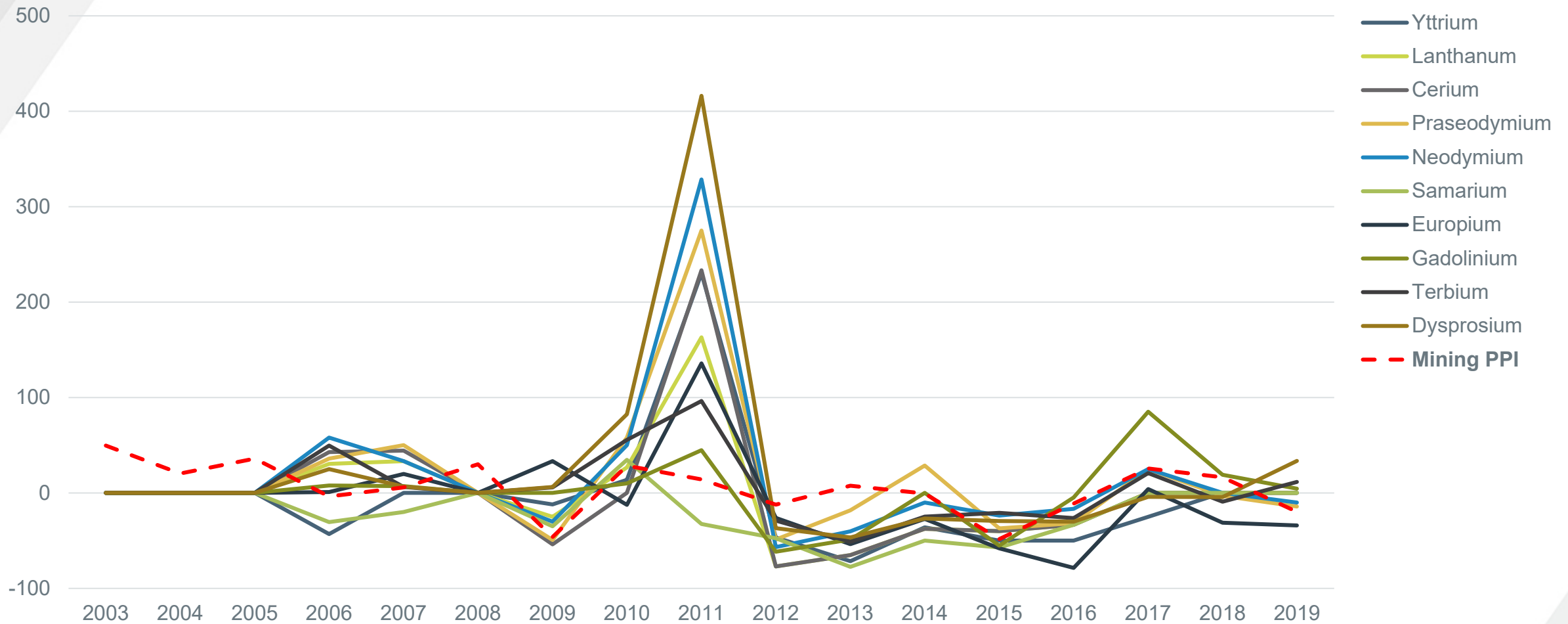
Photo: Alpha Trade Zone

Understanding Price Fluctuations

- Right now, there is no singular price series for rare earths.
 - Mining Producer Price Index shown as something that might be comparable
- Not all the rare earths move the same, although overall the pattern is pretty clear.

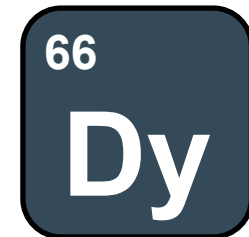
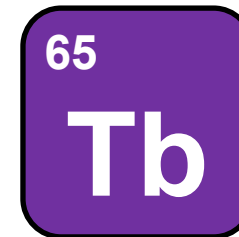
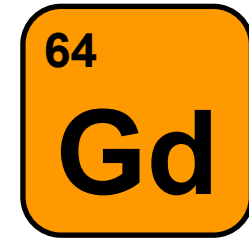
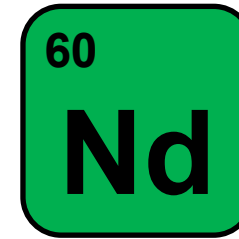
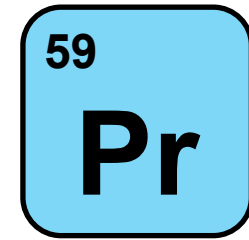
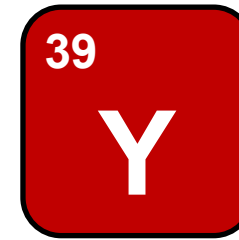


Rare-Earth Inflation and Mining PPI

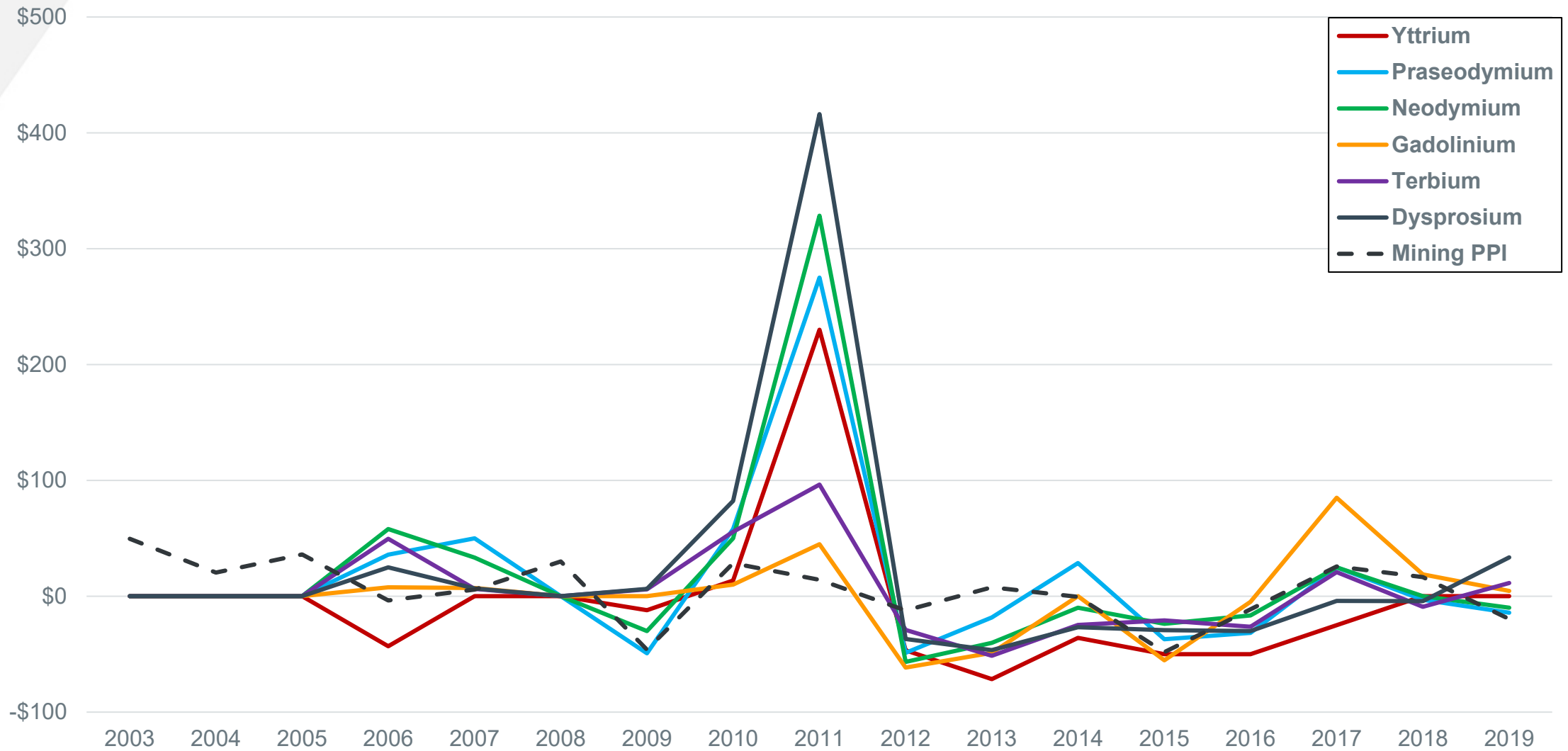


Not All Rare Earths Are Created Equal

- At different times, the demand, supply, and innovation factors influence price fluctuations.
- We highlight a few of the current key ones right now.
- Notice they experienced some of the highest inflation volatility.



Select Rare Earths



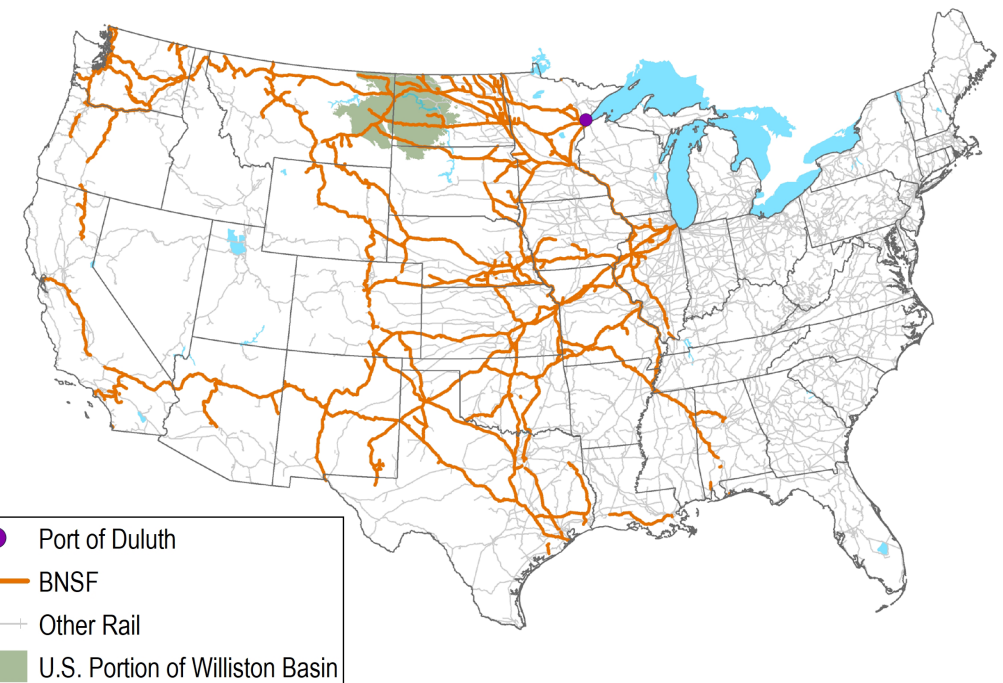
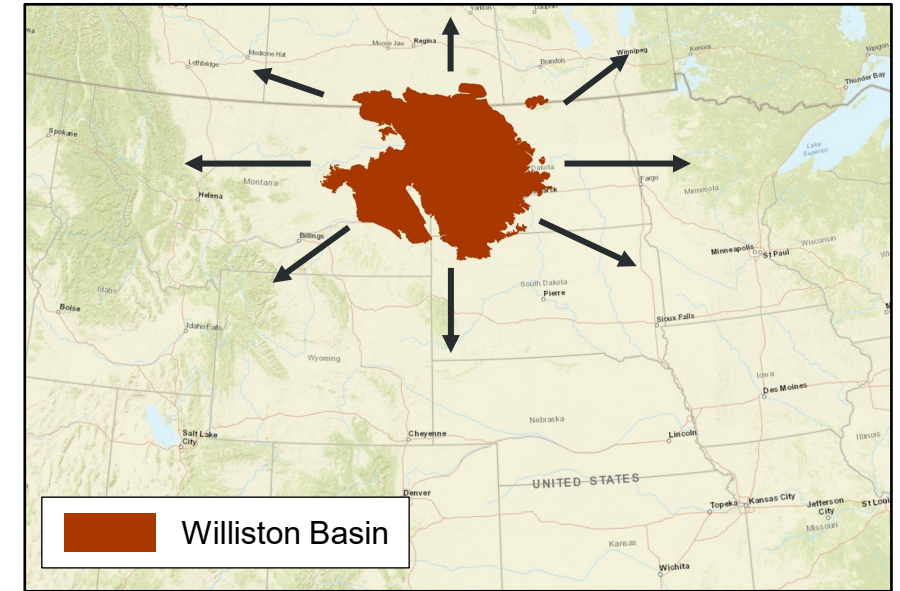
What Is Unknown?

- Innovation is difficult to predict; equally difficult to determine are the economic consequences of any innovation.
- Broader economic circumstances and policy, such as interest rates, matter and can impact the benefit-cost calculations at the firms.
- Is the U.S. government going to engage in policy actions to support the industry?
 - National security and interest
 - Economic security



Williston Basin as a Business Hub

- Williston Basin possesses natural risk mitigation attributes:
 - Transportation
 - Water availability
 - Energy
- These factors contribute to the protection of capital investment.





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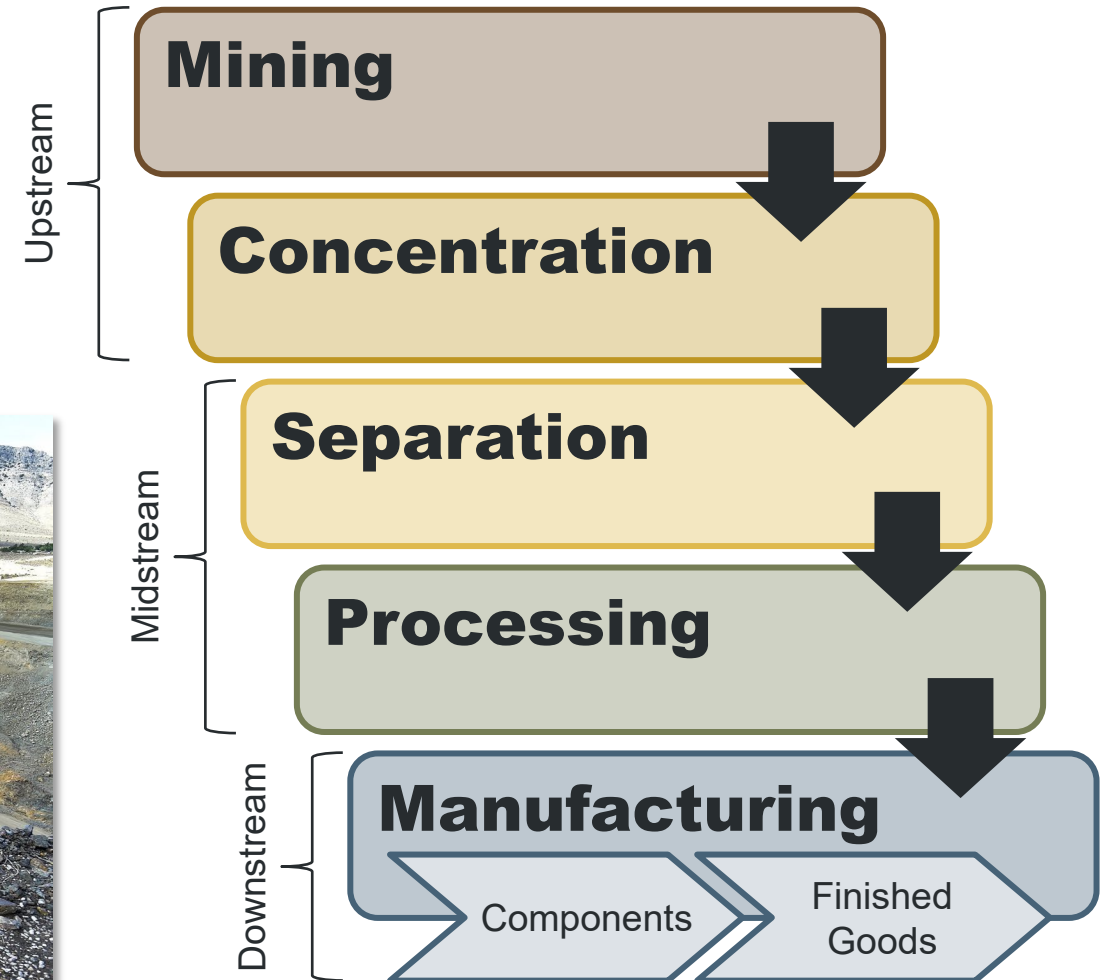
A wide-angle photograph of a university campus at sunset. The sun is low on the horizon, casting a warm glow over the scene. In the foreground, there are large trees with some yellowing leaves. In the background, several multi-story brick buildings and a parking lot with many cars are visible under a clear sky.

THANK YOU

Critical Challenges. Practical Solutions.

Key Findings

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



Key Takeaways

1

Critical mineral users and markets are influenced globally.

2

Hub-and-spoke development.

3

Key market barrier is the buyer.





Jason Laumb
Director of Advanced Energy Systems Initiatives
jlaumb@undeerc.org
701.777.5114 (phone)

A wide-angle photograph of a university campus at sunset. The sun is low on the left, casting a warm glow over the scene. In the foreground, there is a green lawn. In the middle ground, there are several multi-story brick buildings and a parking lot filled with cars. Trees with yellowing leaves are visible on the left and right sides. The sky is a mix of blue and orange.

THANK YOU

Critical Challenges. Practical Solutions.

Carbon Ore, Rare Earth, and Critical Minerals Initiative (CORE-CM)

U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL)-Led Program

- Catalyze economic growth.
- Job creation in energy communities.
- Energy communities not to be left behind.
- Domestic production of REEs and CMs.
- Strengthen our national economy and security.



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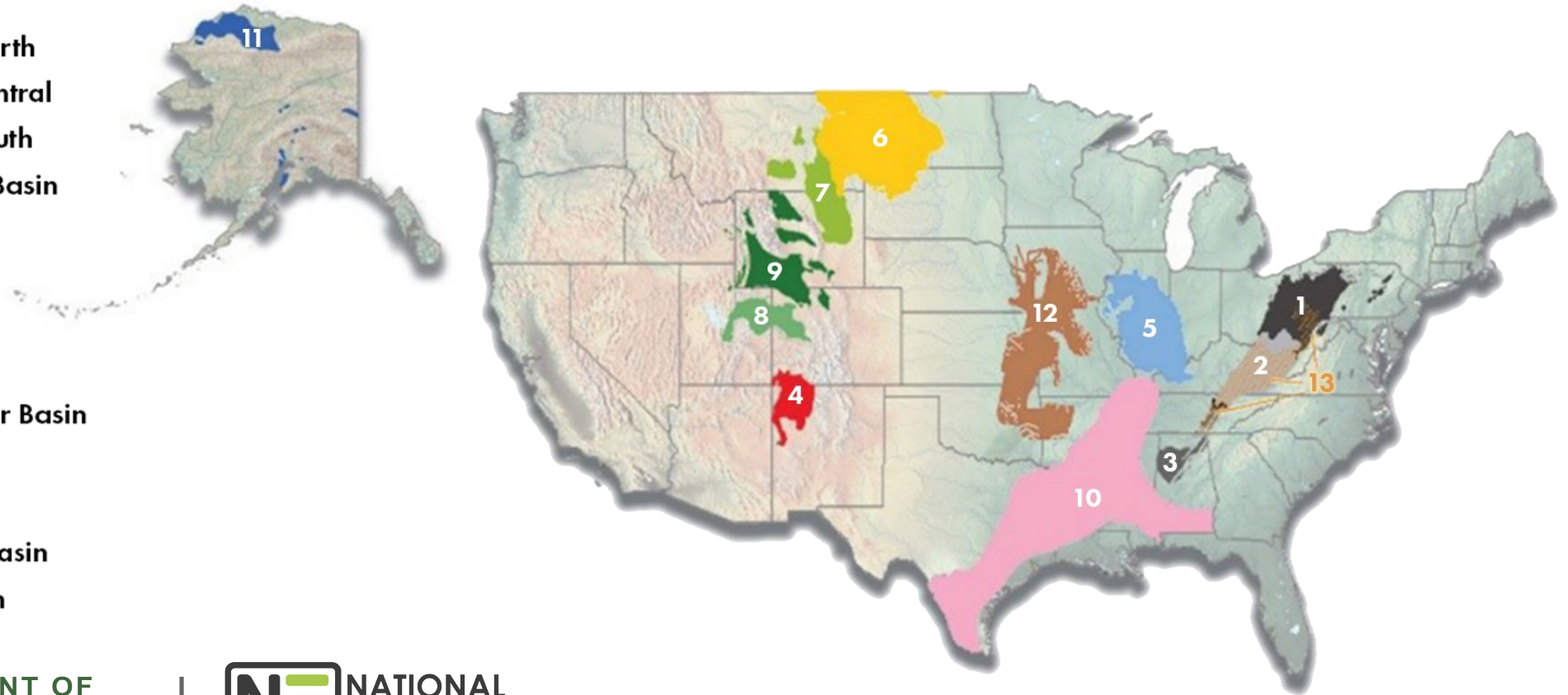


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13 CORE-CM Initiative Teams

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



UND Energy & Environmental Research Center
UND Institute for Energy Studies
UND Nistler College of Business & Public Administration
Pacific Northwest National Laboratory
North Dakota State University
Montana Tech University
Critical Materials Institute (Ames)
Basin Electric Cooperative
BNI Energy
Current Lighting Solutions
General Atomics
Illinois Geological Survey CORE-CM Team
Lignite Energy Council
Minnkota Power Cooperative

NDIC Lignite Research Program
North American Coal
North Dakota Department of Commerce
North Dakota Geological Survey
North Dakota Governor's Office
Northrup Grumman
Semplastics
South Dakota Geological Survey
U.S. Geological Survey
University of Alaska CORE-CM Team
University of Utah CORE-CM Team
Western Dakota Energy Association
Wyoming School of Energy Resources CORE-CM Team

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ACKNOWLEDGMENT

This material is based upon work supported by the U.S. Department of Energy National Energy Technology Laboratory under Award No. DE-FC26-05NT42592.

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Securing the Williston Basin's Critical Mineral Future: Findings and Next Steps

Because of recent and unexpected new opportunities for the Williston Basin CORE-CM Initiative, we are postponing the fourth webinar until we can fully incorporate our findings into an update.

Visit us online!

- Learn more about the Williston Basin CORE-CM Initiative.
- Listen to past webinars and presentations.

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Questions?





EERC



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Critical Challenges. Practical Solutions.