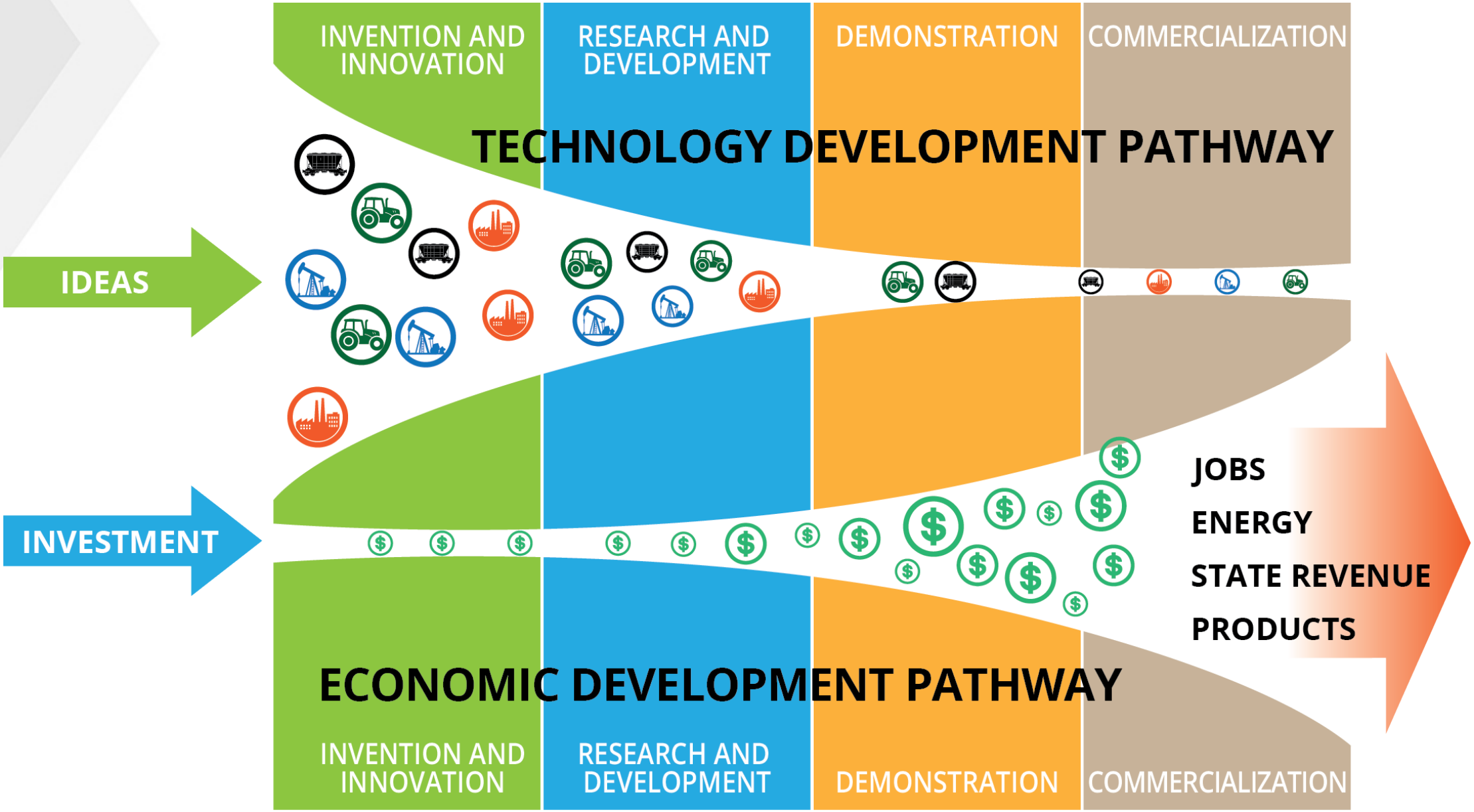
Critical Challenges. Practical Solutions.

State Energy Research Center – 5 years of Progress

Presented to the Interim Energy Development and Transmission Committee

Tom Erickson, EERC SERC Director

June 12, 2024


INVENTION AND INNOVATION
RESEARCH AND DEVELOPMENT
DEMONSTRATION
COMMERCIALIZATION
TECHNOLOGY DEVELOPMENT PATHWAY
IDEAS
INVESTMENT
JOBS
ENERGY
STATE REVENUE
PRODUCTS
ECONOMIC DEVELOPMENT PATHWAY
INVENTION AND INNOVATION
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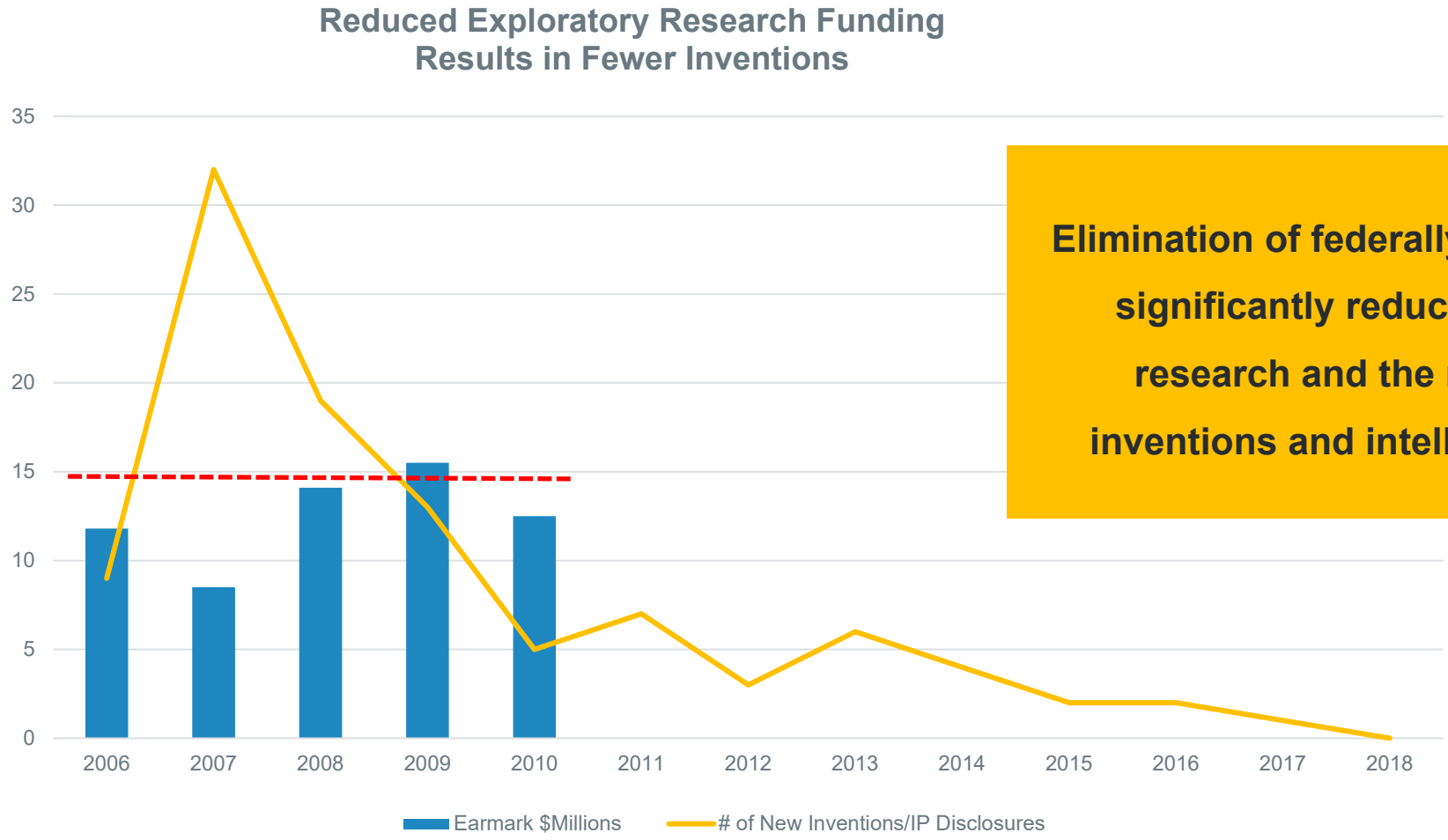
DEMONSTRATION
COMMERCIALIZATION

SIGNIFICANT REDUCTION IN NEW EERC INNOVATION AND INVENTION



Elimination of federally directed funding significantly reduced exploratory research and the resulting new inventions and intellectual property.

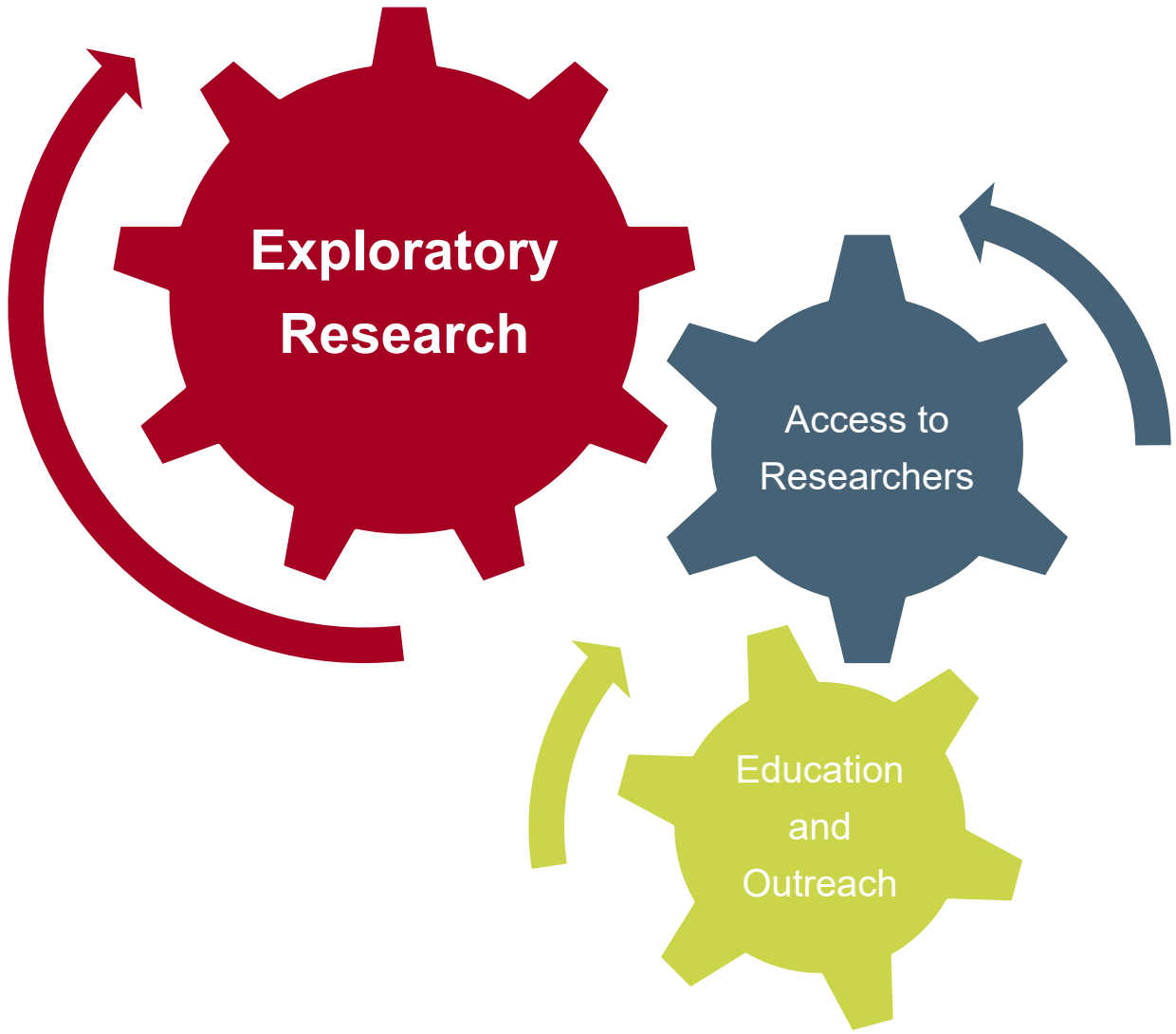
“This funding would support North Dakota through 1) exploratory research, 2) ready access to EERC experts to address critical state needs in a timely manner, and 3) education and outreach throughout the state to advance North Dakota’s critical role.”

Tom Erickson, 2019, Bill 2249 Testimony

“Although the return on investment of this funding may be difficult to quantify, as evidenced by past performance, the benefits of these efforts will be orders of magnitude greater than the investment.”

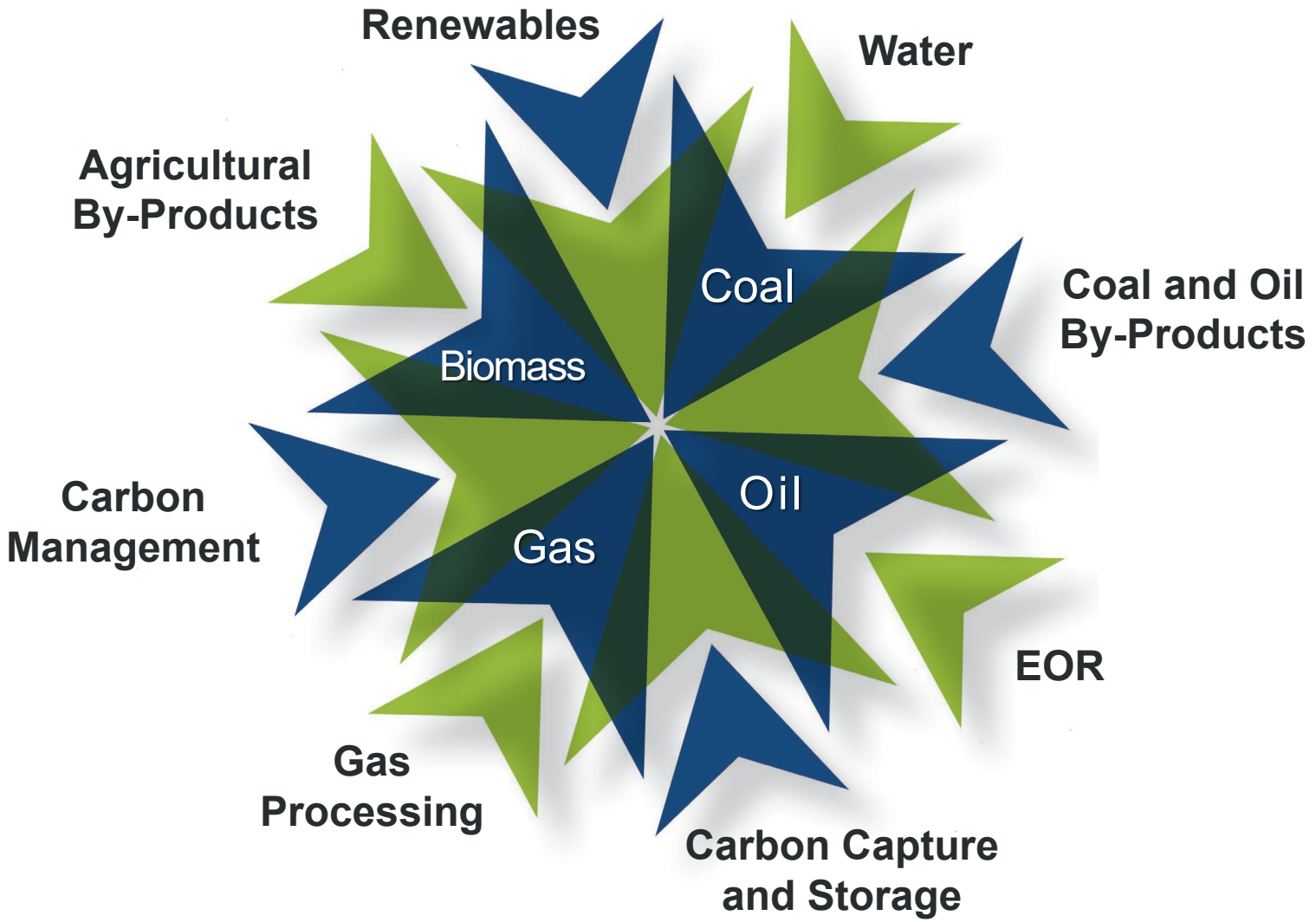
Tom Erickson, 2019, Bill 2249 Testimony

EXPLORATORY RESEARCH



INVENTION AND INNOVATION

Funded nearly 60 projects/strategic initiatives across all North Dakota energy platforms!



RESEARCH AND DEVELOPMENT

SERC exploratory projects lead to larger research and development (R&D) projects, largely funded by the federal government.

- $34 million on proposed follow-on R&D
- $15 million in awarded R&D to date
- $6.7 million in pending awards
- Launched two strategic initiatives:
  - ➢ Enhance Energy Resiliency for North Dakota's Military Installations
  - ➢ Critical and Novel Materials for North Dakota's Energy Growth

DEMONSTRATION

Several SERC-supported technologies have begun demonstration/application testing already.

- One technology in field demonstrations
- One technology nearing field demonstration
- Several technologies being tested for application-specific uses
- Several technologies seeking funding opportunities to advance to demonstration/ specific use evaluations

COMMERCIALIZATION

SERC technologies are being protected and already commercialized to serve North Dakota.

- 11 U.S. Patent applications submitted to date (21 additional continuation, CIP, divisional or foreign applications)
- Six U.S. Patents received to date (five additional continuation or CIP patents received)
- One commercial license finalized
- One commercial license near completion
- Other conversations occurring about licensing opportunities

Story No. 1 – Polar Bear™

INVENTION AND INNOVATION

- SERC award to advance the compressor technology.

RESEARCH AND DEVELOPMENT

- $1,000,000 federal award.
- Significant “in-kind” support from Steffes.
- $2,000,000 federal award.

DEMONSTRATION

- Two manufacturers working on new compressor models.
- First demonstration is in the field.
- Six additional demonstration units ready by end of 2024.

COMMERCIALIZATION

- Multiple patents already received.
- Commercial license with Steffes near completion.

Story No. 2 – Graphene

INVENTION AND INNOVATION

- SERC award to evaluate concept.
- SERC award to explore applications in low-viscosity oil.

RESEARCH AND DEVELOPMENT

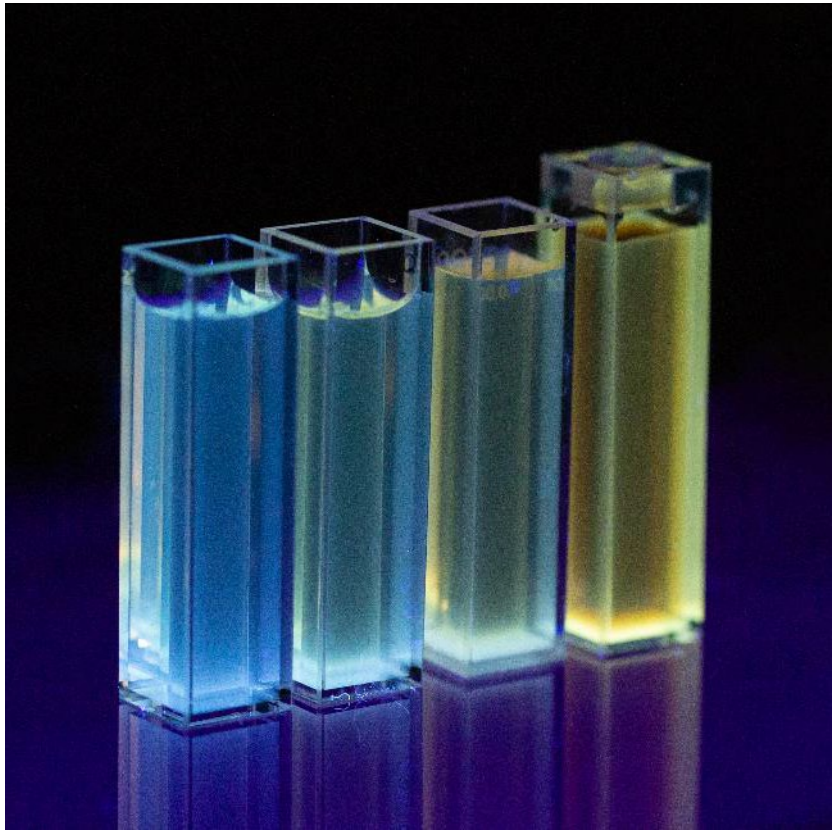
- $930,000 federal award to further research.

DEMONSTRATION

- $1.5 million to investigate for lithium batteries.

COMMERCIALIZATION

- Two patents received, with an additional CIP application in process.



Story No. 3 – Value from North Dakota Brines/CO_2 Capture

INVENTION AND INNOVATION

- SERC award to investigate the topic of North Dakota brines.
- SERC to further develop concept for North Dakota brines.

RESEARCH AND DEVELOPMENT

CO_2 Ocean Capture (direct air capture [DAC]):

- *$500,000 DOE ARPA-E award*
- *$250,000 DOE Award (Phase I)*
- *$900,000 BIRD Foundation award*

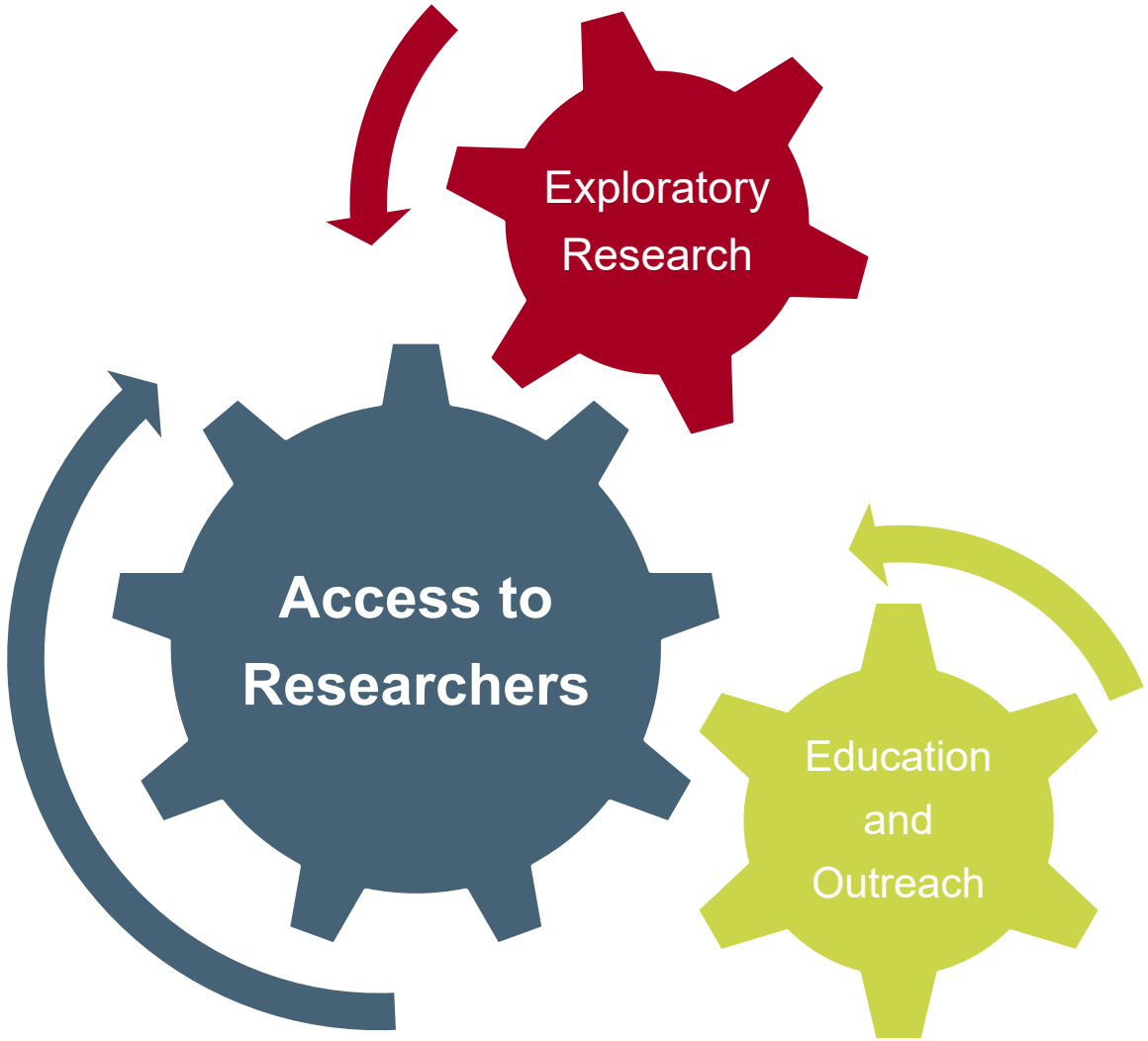
DEMONSTRATION

- *Moving toward first demonstration in Israel.*

COMMERCIALIZATION

- *Three patents received to date – application and disclosures active.*
- *Commercial license with Carbon Blue.*

READY ACCESS TO EERC EXPERTS



SUMMARY OF ACTIVITIES

North Dakota Industrial Commission (NDIC)-chosen projects are focused on serving a critical and timely need for North Dakota.

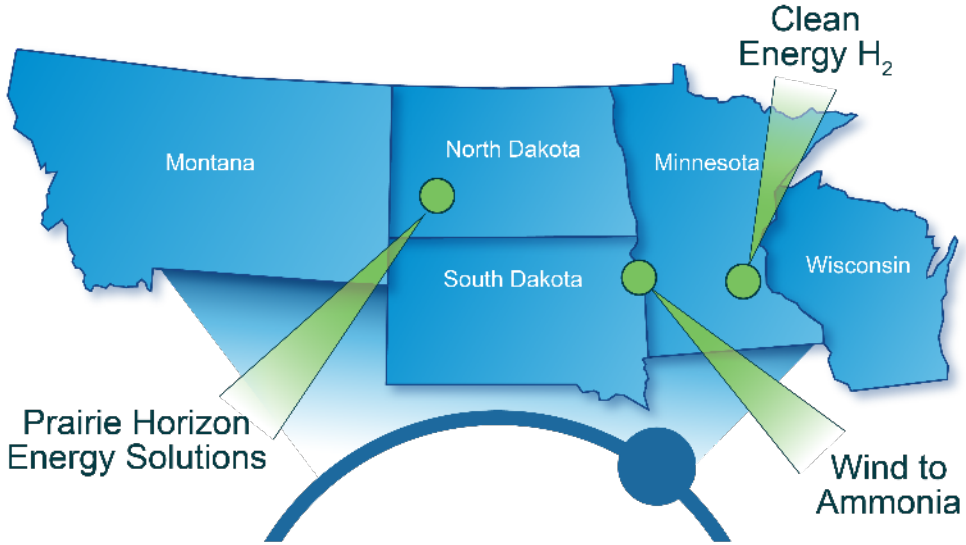
- Proposal for the state of North Dakota was “ghost-written” (transmission grant).
- Two very large North Dakota-centric proposals were written (hydrogen hub and DAC hub).
- Current study to estimate North Dakota tax revenue from potential Bakken EOR.
- Supported North Dakota Transmission Authority’s (NDTA’s) grid resiliency planning.

Story No. 4 – Transmission Grant

- “Ghost-wrote” a proposal to DOE for 5 years of funding to the state to be granted to the transmission industry to enhance the reliability of North Dakota’s grid.
- NDIC awarded a contract for the first 2 years of that program, providing $7,500,000.
- North Dakota Legislature appropriated a 15% match to the program.
- Managed by NDTA, with support from the EERC.

Story No. 5 – Hydrogen Hub

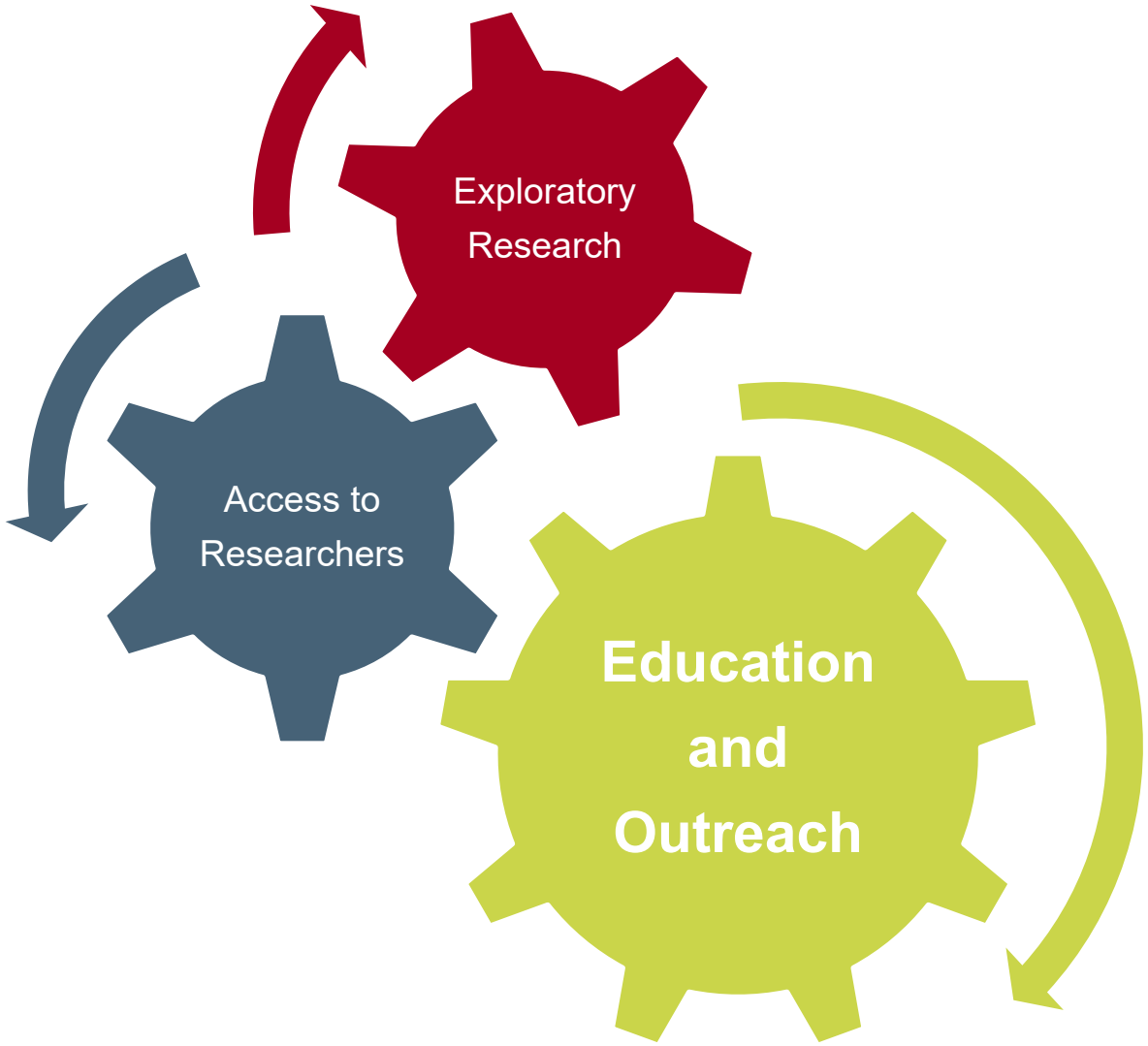
- SERC helped to fund the development of a $1.25 billion proposal to DOE to establish one of the regional hydrogen hubs in North Dakota and adjoining states.
- The EERC's Heartland Hydrogen Hub proposal was announced to receive $925 million.
- Industry providing an additional $4 billion in cost share.
- When complete, one of the main hydrogen production facilities will be located in western North Dakota.



HEARTLAND HYDROGEN HUB

EERC | UND UNIVERSITY OF NORTH DAKOTA | PRAIRIE HORIZON ENERGY SOLUTIONS | MARATHON | TC Energy | Xcel Energy

EDUCATION AND OUTREACH

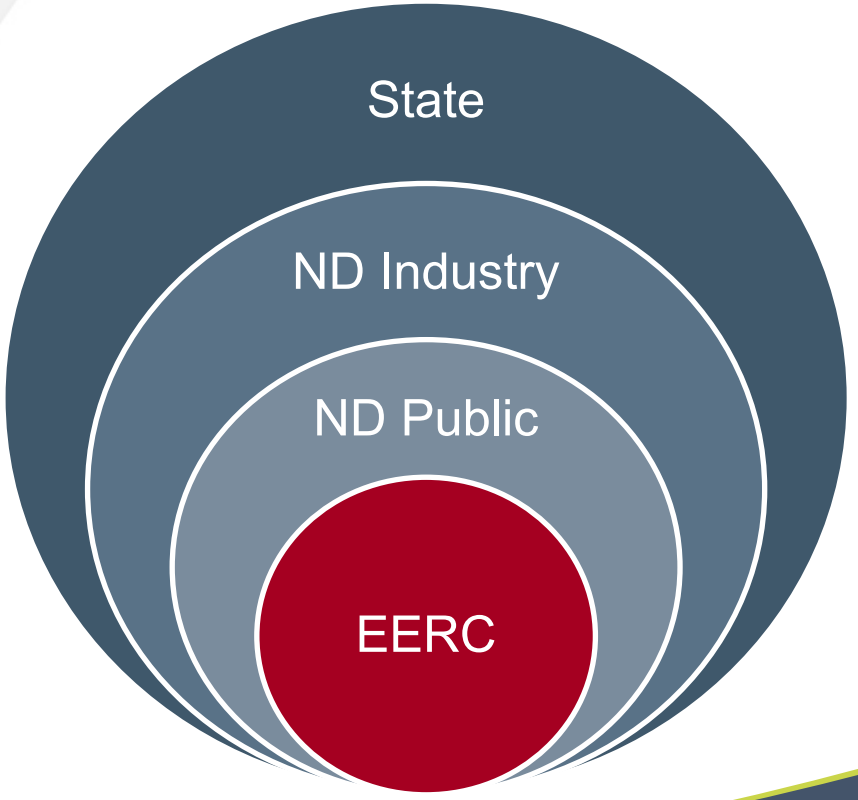


Story No. 6 – Energy Hawks

The Energy Hawks Program provides an opportunity for college students to learn about North Dakota's wide range of energy technologies to enhance their ability to serve North Dakota as employees, leaders, taxpayers, and voters in the future.

- 86 university students from throughout North Dakota.
- Students come from a wide academic background.
- Energy Hawks learn about "all things North Dakota energy."
- Program includes a weeklong tour in western North Dakota visiting with state and industry leaders and touring facilities.
- Students are then tasked with identifying new opportunities.

QUALIFYING AND QUANTIFYING THE IMPACT



2019 2020 2021 2022 2023 2024 and BEYOND!

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THANK YOU

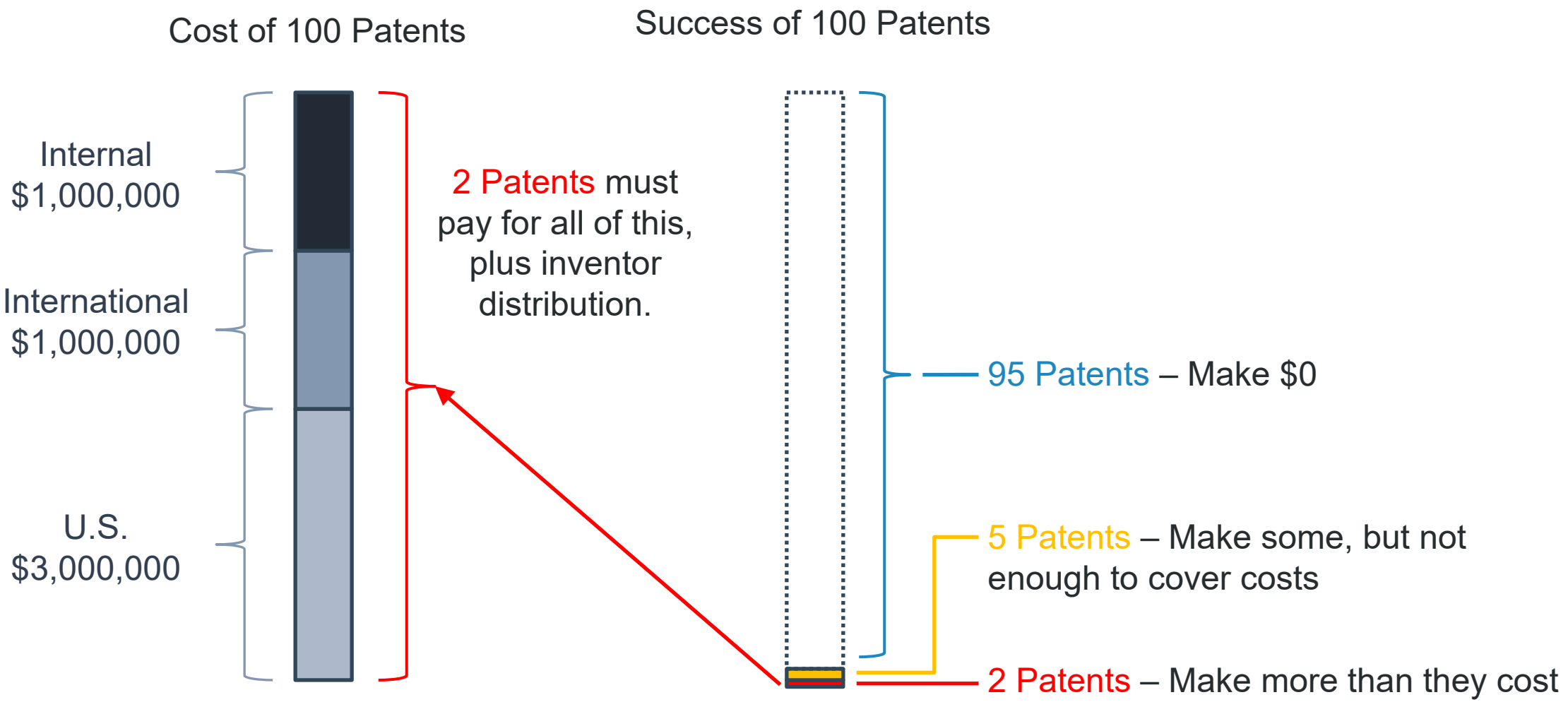
Critical Challenges. Practical Solutions.

Critical Challenges. Practical Solutions.

Energy & Environmental Research Center (EERC)

Back-Up Material

FINANCIAL CHALLENGE OF PATENTING



IP MATURITY

Further development means additional research funding!

IP, when transferred to the EERC Foundation, is typically not fine-tuned for commercial applications; it requires significant further development and demonstration.

Example: Mercury Control

- 2003 – First IP submitted
- 2005 – Core IP created
- 2006–2008 – First license (failed!)
- 2009 – Second license
- approx. 2014 – Royalties finally exceed expenses

10 years of risk

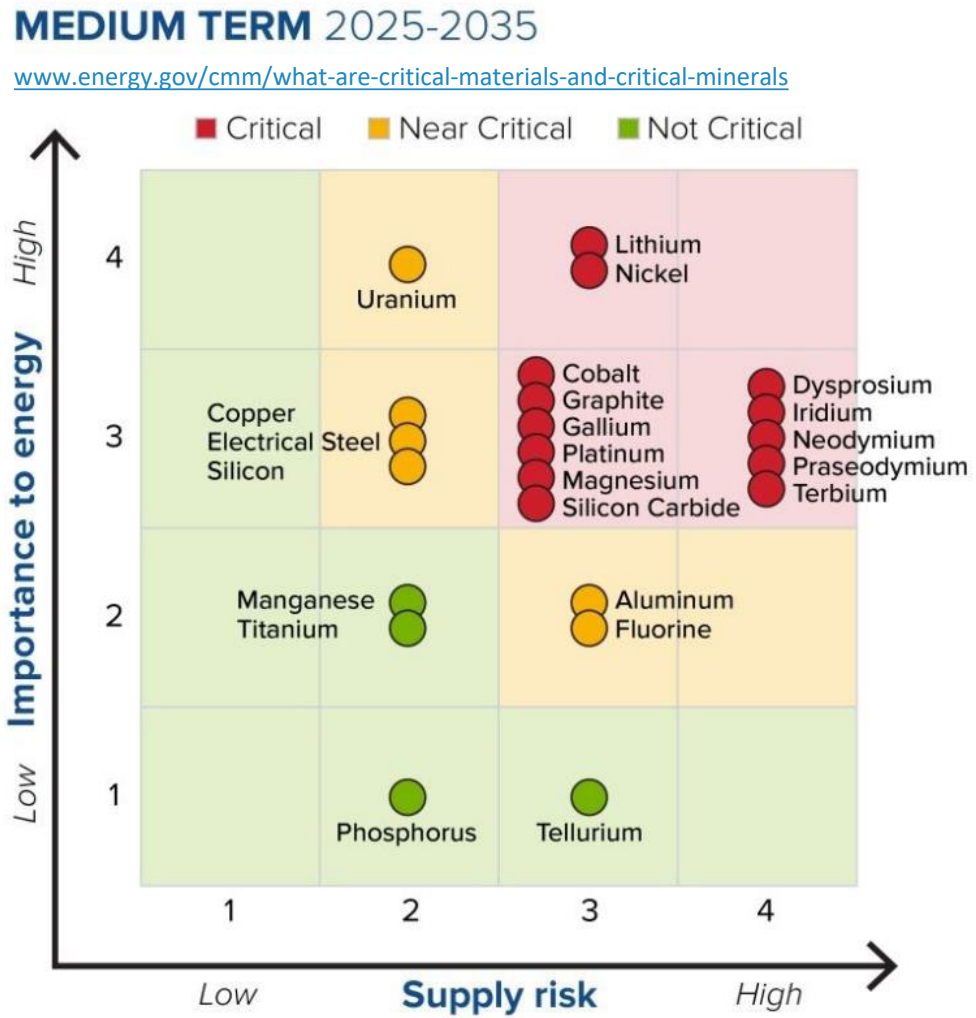
Critical Materials

Funding:

- DOE critical materials list shows focus areas
- Focus on research programs in these areas

Opportunities for EERC:

- Increase capabilities
- Diversify research areas
- Seek new partnerships



Material	Lignite coal	Produced water	Magnet / battery recycle
Li		Y	Y
Ni	Y		Y
Co	Y		Y
Aluminum	Y		Y
Copper	Y		Y
Graphite	Y		Y
Gallium	Y		
Magnesium		Y	
Manganese	Y		Y
Dysprosium	**Y**		Y
Iridium	Y		
Neodymium	Y		Y
Praseodymium	Y		
Terbium	Y		Y

High-Level Goal:

- Generate new opportunities for North Dakota and the EERC using critical material as a framework.

Ongoing SERC Research – REE Recovery from Magnets

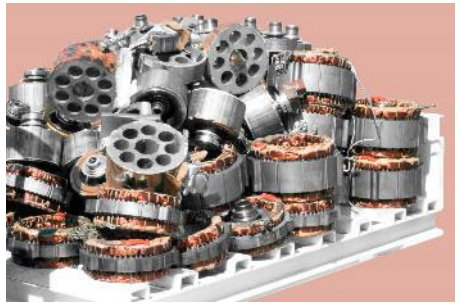
Lignite coals have an affinity for REE adsorption that can be enhanced.

Lignite Coal

Enhanced Coal

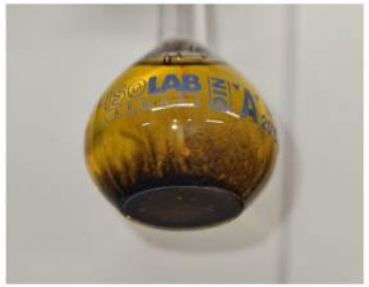
Columnar Chromatography

Solution Recovery



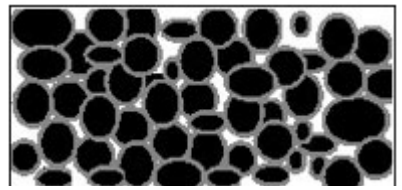
End-of-Life Magnets

Separated Magnet Particles



REE Solution

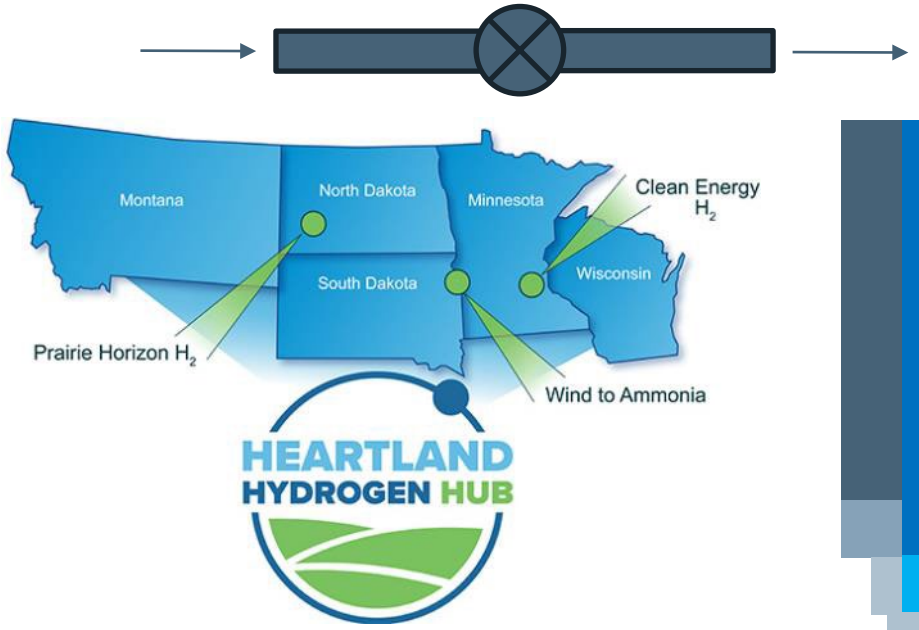
High-REE Concentration Particles



Enhanced lignite coals can be used in existing REE extraction methods.

Ongoing SERC Research – Infrastructure Materials

Multiple infrastructure programs:
- Regional hydrogen hub
- Carbon capture efforts

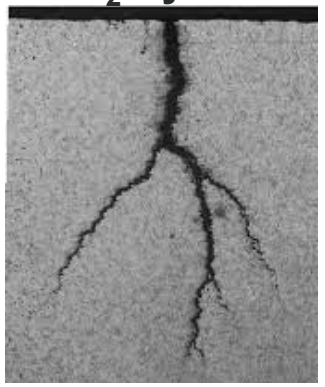


Safe Hydrogen Transport

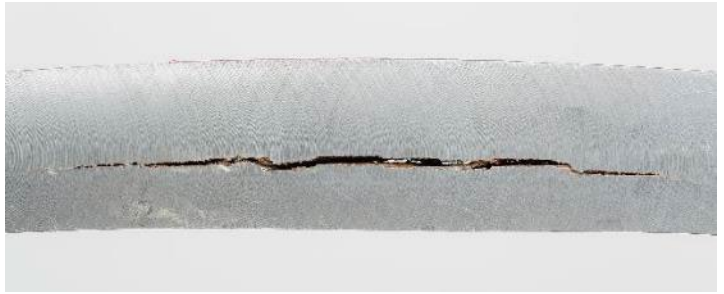
Carbon Capture Wellbores

Fundamental Research to Support Infrastructure Projects

Stress Corrosion Cracking in CO_2 Systems



Hydrogen-Induced Embrittlement Cracking



Study for developing a dynamic corrosion test system at the EERC to simulate pipeline and wellbore conditions.

NORTH DAKOTA ALIGNMENT

Support and Grow North Dakota's Existing DOD Footprint

- GFAFB $270M economic impact in FY19
- Minot AFB $595M economic impact in FY22
- DOD total 1.4% of North Dakota's GDP in FY21

Develop Spin-Off Potential

- E.g., UAS activity has attracted $100M in private investment
- Potential EERC innovation areas
  - Operational energy
  - Advanced materials and domestic critical minerals

Grand Forks AFB

Minot AFB

Cavalier SFS and National Guard Units in Bismarck, Fargo, and Grand Forks

ESTCP ENERGY STORAGE PREPROPOSAL

- Currently pursuing an ESTCP project with the 88th Readiness Division to demonstrate a long-duration, hydrogen-based energy storage system.
- Demonstration would leverage regional activities under the Heartland Hydrogen Hub for the hydrogen supply.
- Applicable to mission-critical facilities in North Dakota that must meet DOD resiliency and/or federal low-carbon energy mandates.
- May become a template for providing uninterruptible power service based on state investments in hydrogen energy.

ESTCP

The Environmental Security Technology Certification Program (ESTCP) is DOD's environmental, resilience, and installation energy and water technology demonstration and validation program.

The 88th Readiness Division is headquartered at Forth Snelling, MN, and Fort McCoy, WI, and it provides base operations support for North Dakota's National Guard facilities.