Transforming our Nation's Energy Future — North Dakota's Carbon Management Solutions

Lignite Energy Council Fall Conference

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ALLETE Clean Energy

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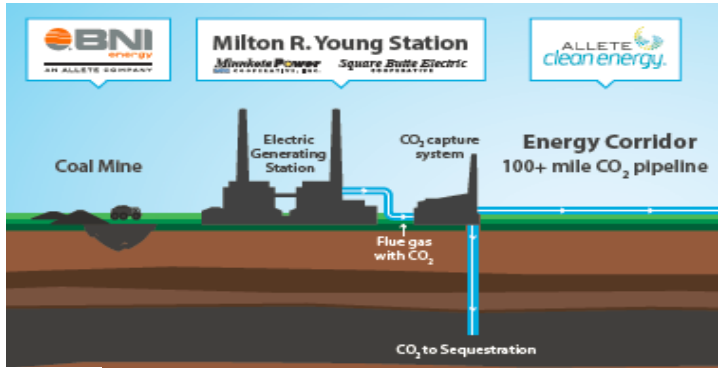
ALLETE Carbon Solutions Strategy

Existing Plant Solutions

Project Tundra



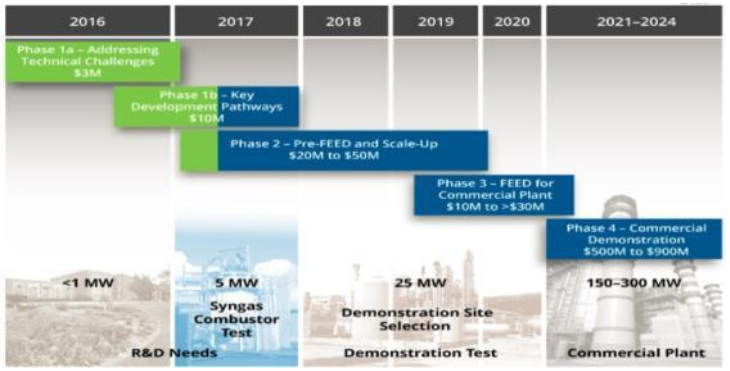
CO_2 Utilization & Storage Solutions

PCOR & CarbonSAFE

EOR Partners

New/Replacement Solutions

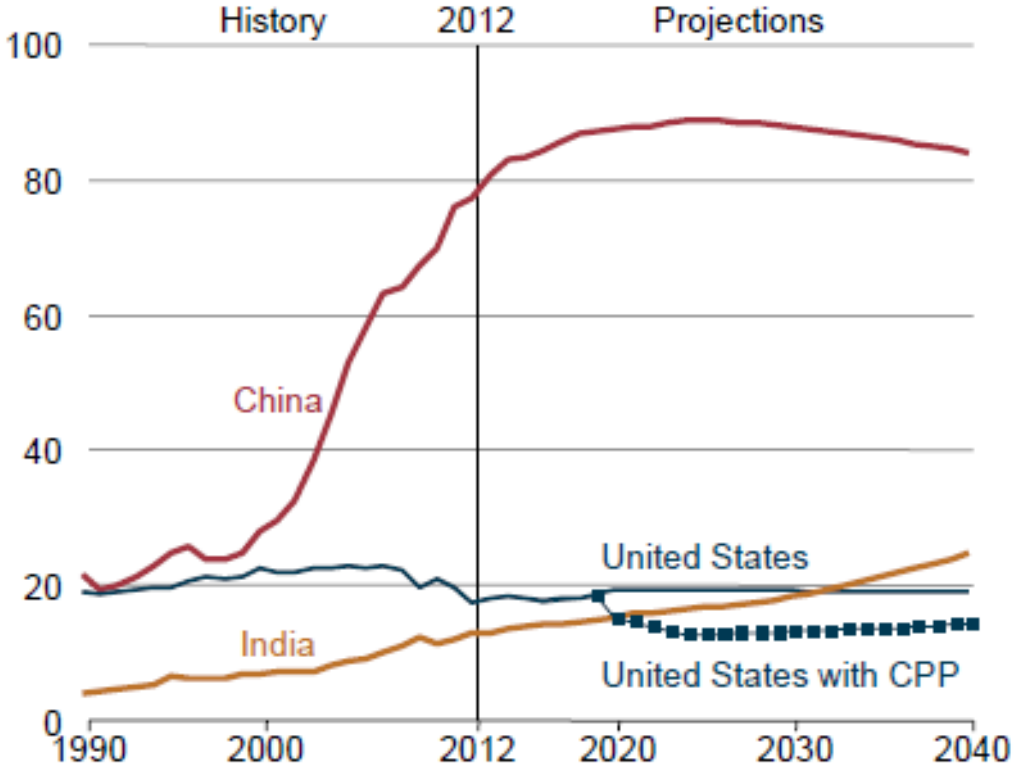
Allam Cycle



Coal is … KING

- #1 fuel for electric generation in the World.
- #1 fuel for electric generation in the United States…..

Figure ES-5. Coal consumption in China, India, and the United States, 1990–2040 (quadrillion Btu)



Note: Dotted line for U.S. coal consumption shows projected effect of the U.S. Clean Power Plan.

U.S. Energy Information Administration | Annual Energy Outlook 2016

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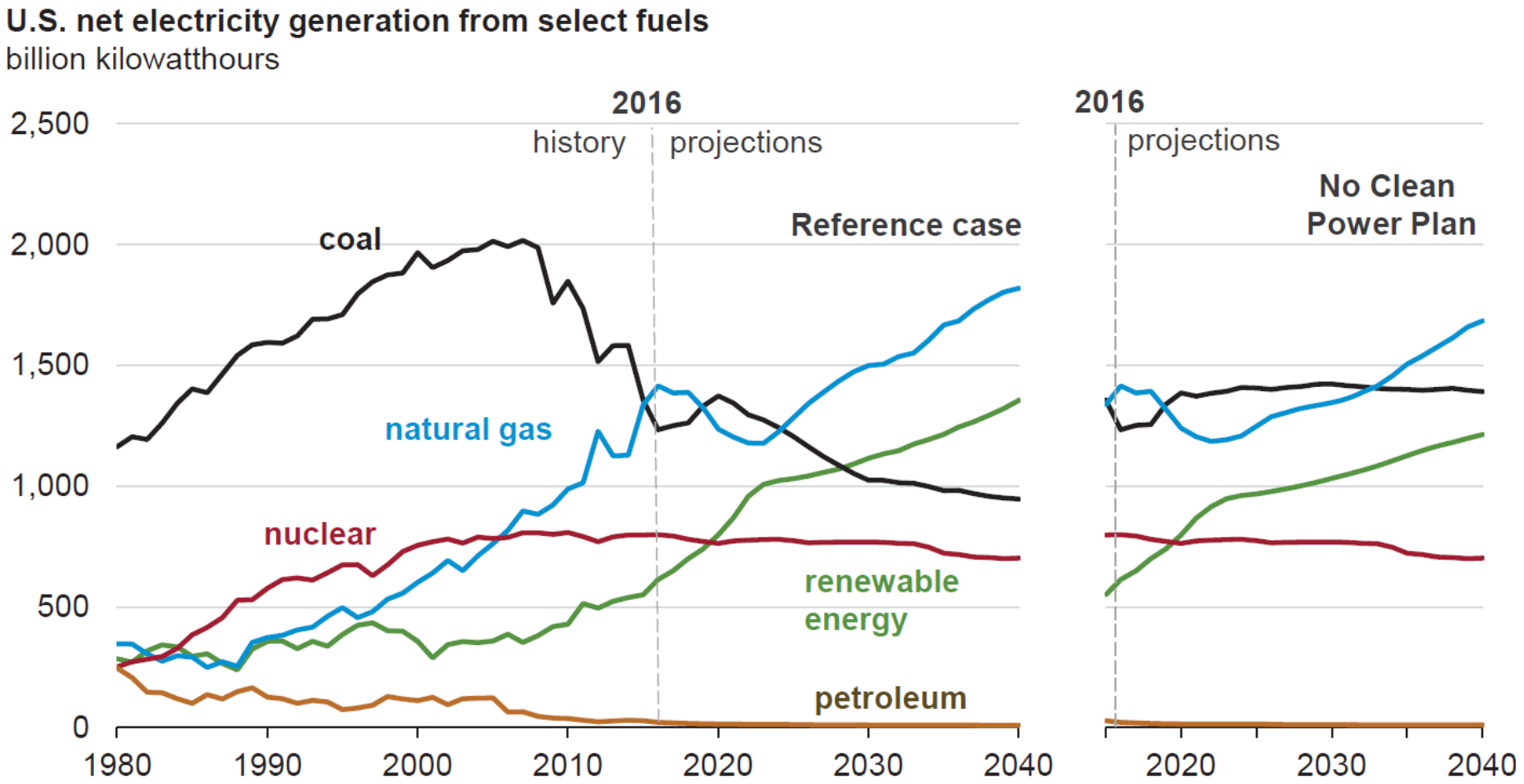
Until….it is Not



Energy Industry Challenges – Why are we Here?

- Low-cost, reliable, coal-fired generation is challenged in today's regulatory environment.
- Natural gas use for generation is growing, but has variability in pricing and is also challenged under long-term environmental regulations.
- Renewable generation options are expanding, but intermittency is challenging.

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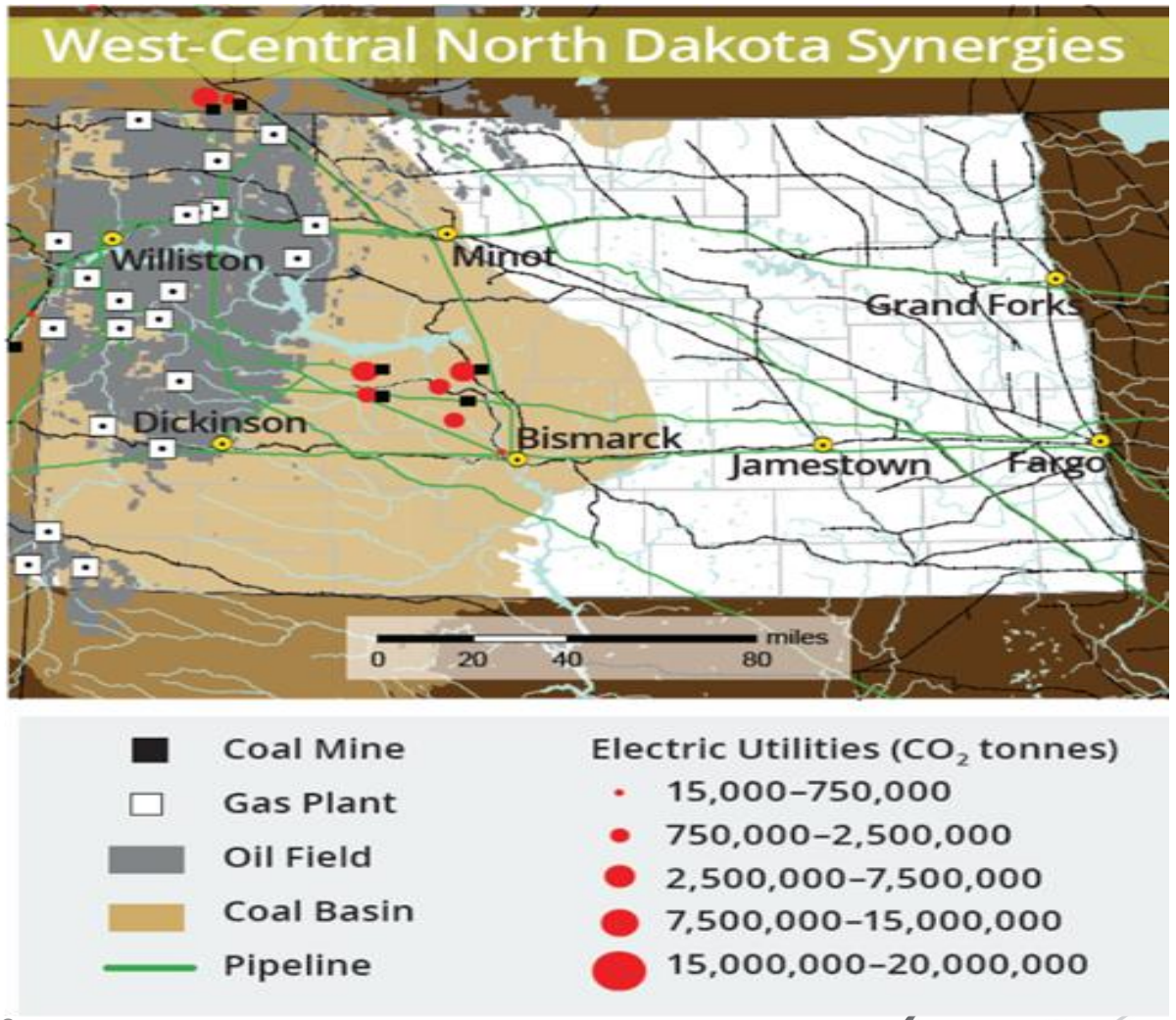
Energy Industry Challenges –Why are we Here?

Carbon Solutions are Strategic to Industry

- Demonstrates truly “all of the above” energy strategy.
- Allows utilization of the most abundant fuel in the U.S. – Coal.
- Allows a continued platform for U.S. Energy Security & Dominance – Utilization of coal resources and access to unavailable oil reserves with captured CO_2.
- Maintains viability of existing fleet without stranded investment.
- Provides a solution for carbon globally.



Energy Industry Challenges – Why are we Here?

According to recent EIA data, there is a long-lasting supply of coal and gas in the U.S.:

- Based on U.S. coal production in 2016, the U.S. estimated recoverable coal reserves would last about 350 years (280 years for 2015 data).
- Based on U.S. natural gas usage in 2015, the U.S. estimated recoverable gas reserves would last about 86 years (90 years for 2014 data).

Source: www.eia.gov

Energy Industry Challenges – Why are we Here?

We need an all-of-the-above strategy that offers a platform for meeting the nation's energy needs while providing a solution to our carbon challenge.

Our Vision:

An integrated energy and carbon solution that allows the utility industry to continue to use our nation's most abundant fuel, while providing the foundation for the beneficial use of the CO_2 produced at these facilities.

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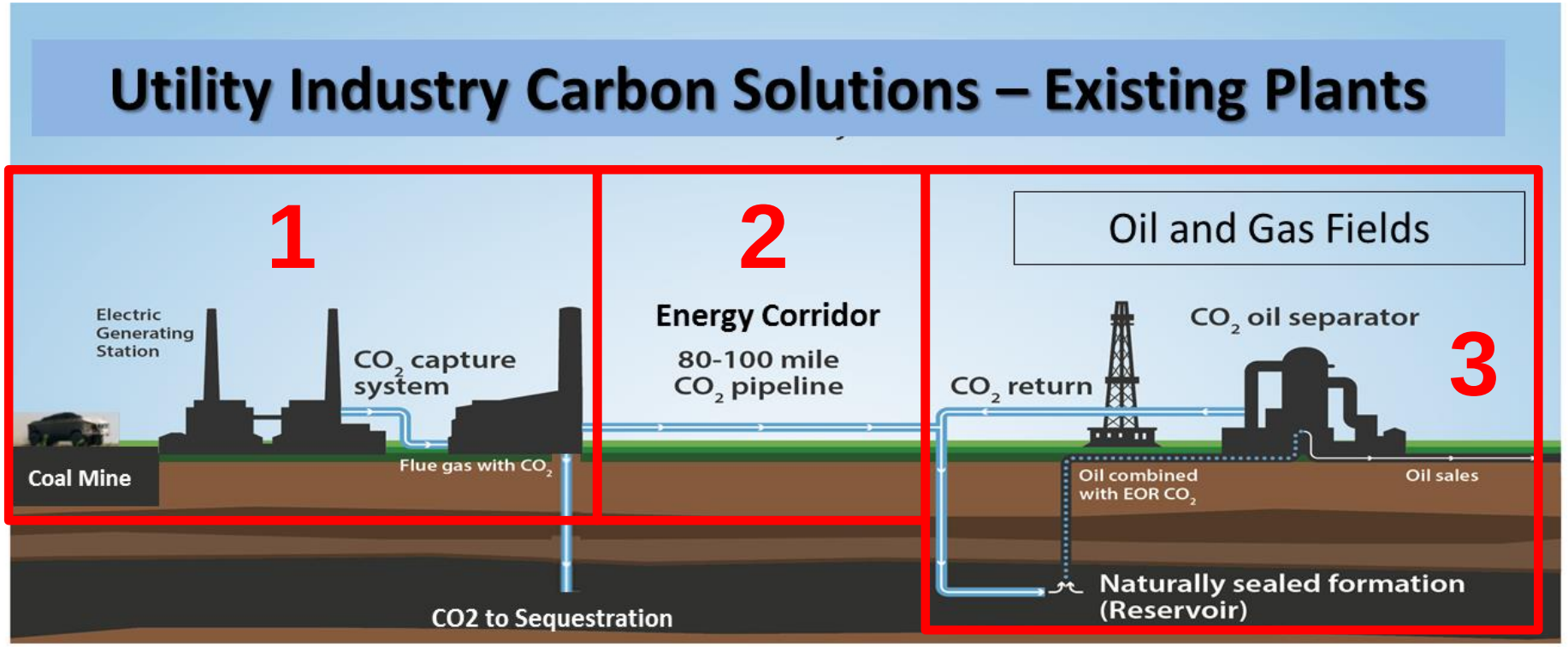
An Integrated Solution: How it Looks



Coal-fired power plant with carbon capture technology providing beneficial CO_2 for enhanced oil recovery or to be stored in geologic sequestration.

An Integrated Solution: How it Works

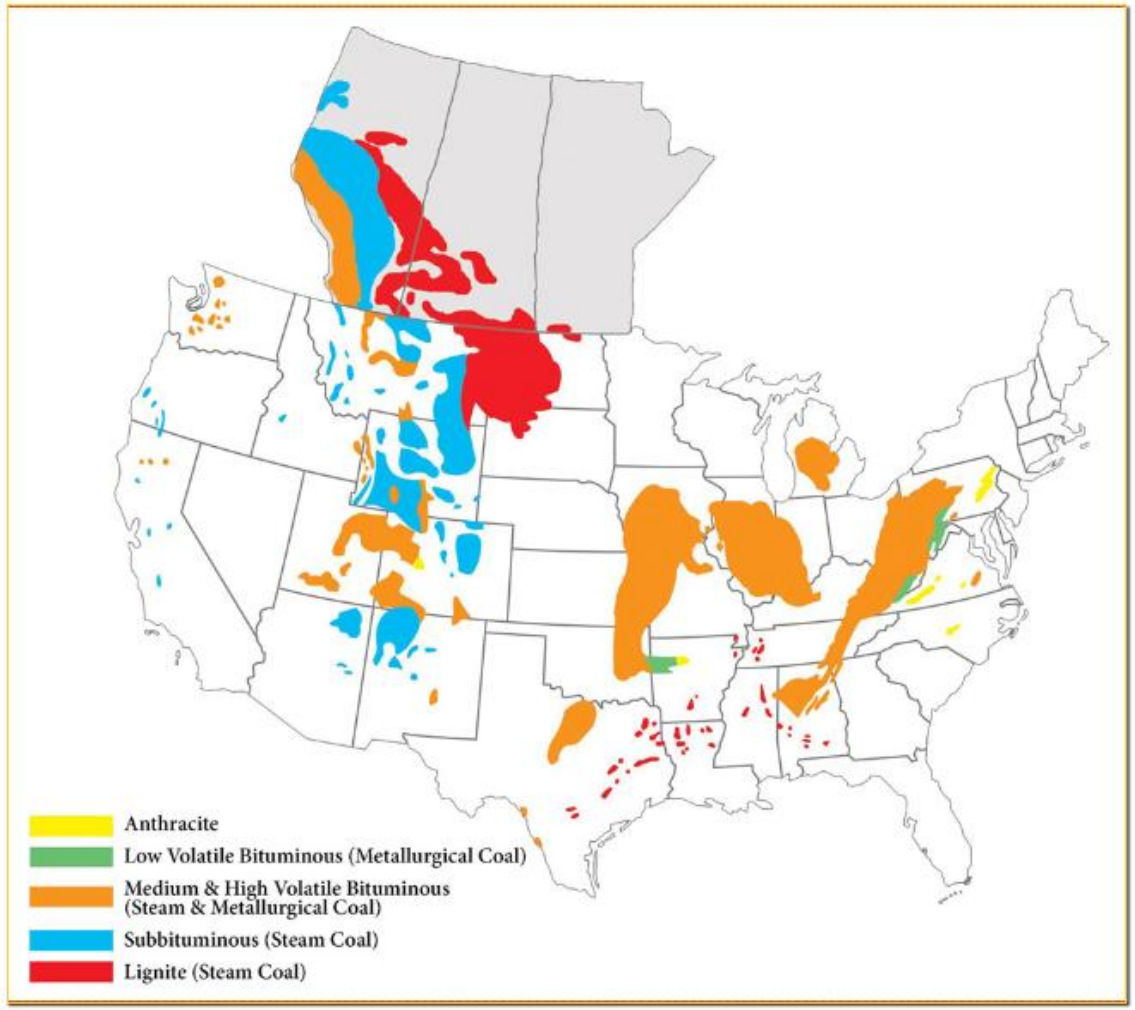
This type of integrated solution requires four key components:

1. The technology to enable the CO_2 capture.
2. The infrastructure to transport the CO_2.
3. The oil reserves and sequestration sites to utilize and store the CO_2.
4. Dedicated utility partners with strong State and Federal support.

An Integrated Solution: How it Works

North Dakota is rich in the key components to build this integrated platform, and we are developing this integrated energy and carbon solution **right now**!

- 25 billion tons of recoverable lignite coal
- 8 Lignite-fired power plants
- Numerous potential locations for CO_2 storage (EOR and deep saline)
- >250 MMBBI oil from conventional fields
- ~4000 MMBBI potential from the Bakken Petroleum System



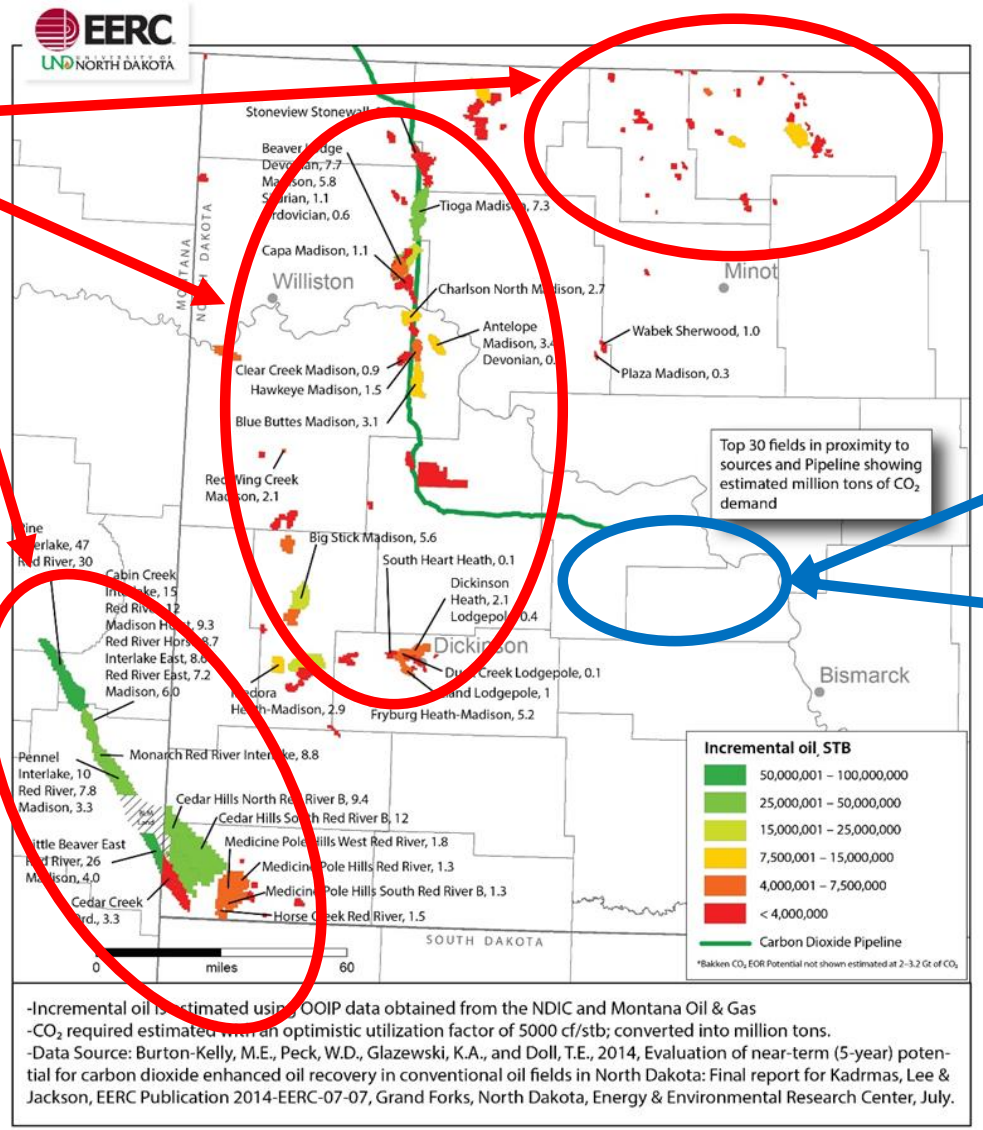
Lignite Coal Map and Legend: North Dakota's supply of lignite coal is enough to last more than 800 years.

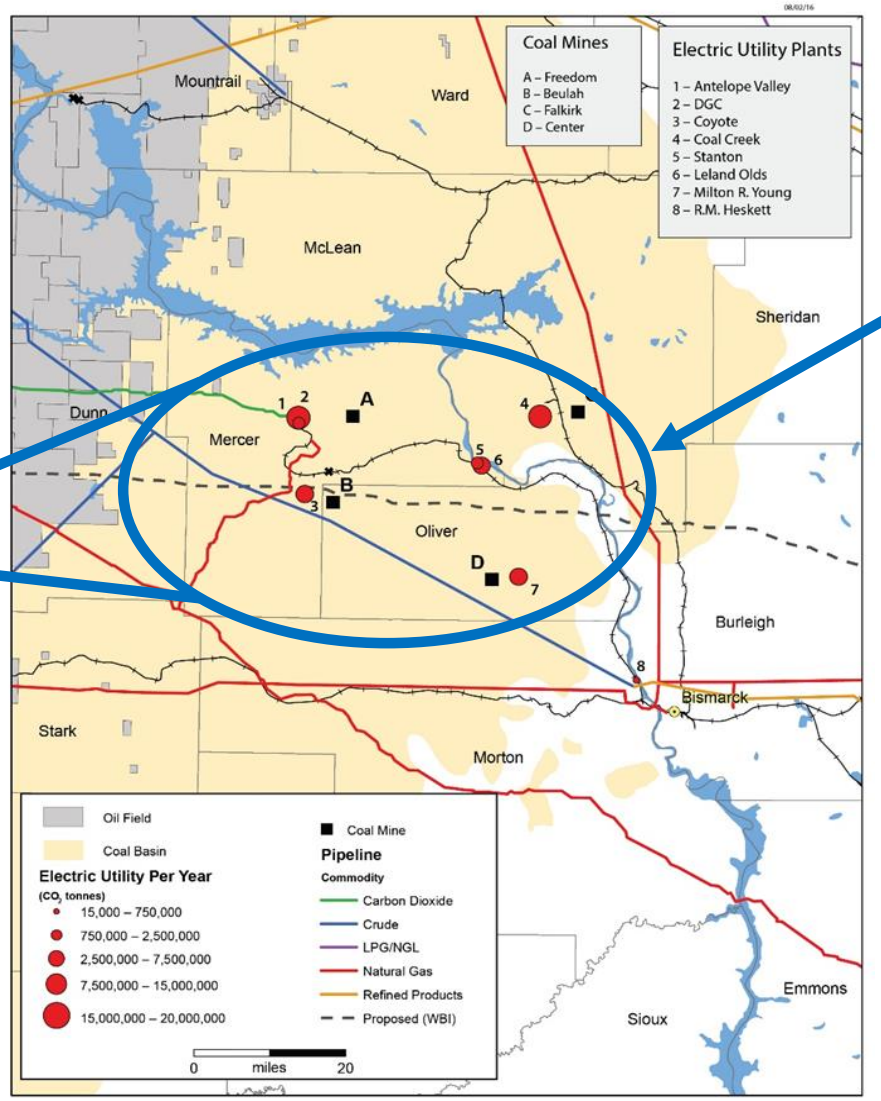
Map courtesy of Lignite Energy Council.

North Dakota – A State of Opportunity

Oil Fields

Coal Plants



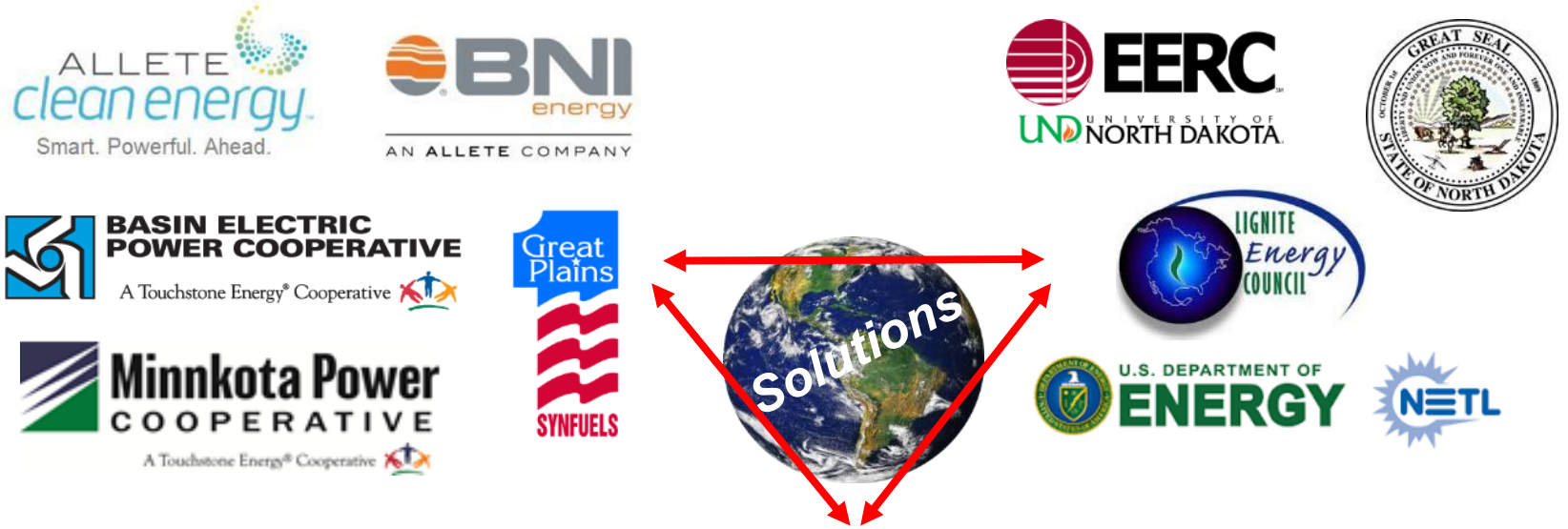


Our Partnerships –

Working Together to Create a Pathway for Carbon Solutions

Energy Industry

Government & Research



Technology Industry

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