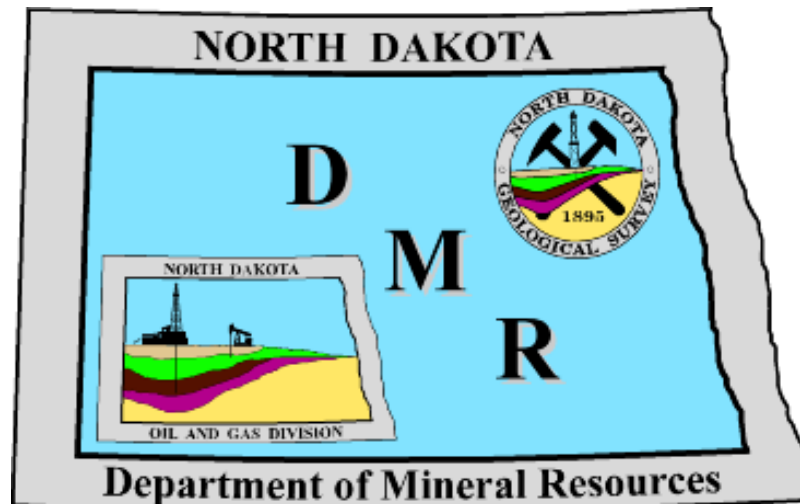


# **North Dakota Department of Mineral Resources**

## **CCUS Resource Management in North Dakota**



*<http://www.oilgas.nd.gov>*

*<http://www.state.nd.us/ndgs>*

***600 East Boulevard Ave. - Dept 405***

***Bismarck, ND 58505-0840***

***(701) 328-8020      (701) 328-8000***

Opportunities

Barriers

Bridges

## Oil and Gas : ArcIMS Viewer

Legend / Layers

Overview Map

View Entire State

Previous View

Clear Selection

Search

Create PDF

Zoom In

Zoom Out

Pan

Rect Identify

Select Object

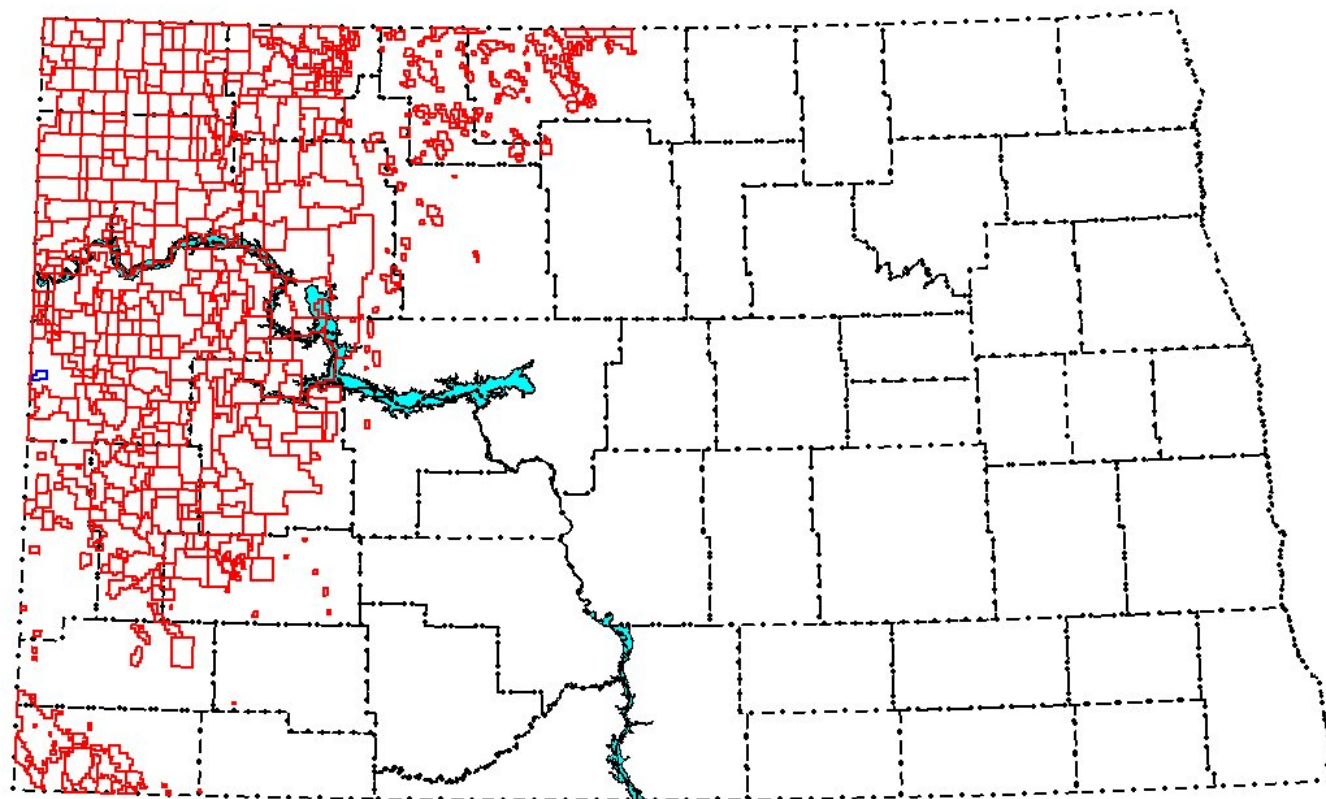
Buffer

Distance

Find Well

Find Field / Unit

Find Section



0 97mi

# Conventional: Case Study of North Dakota Fields/Pools for CO<sub>2</sub> Flooding and CO<sub>2</sub> Sources

CONFIDENTIAL DRAFT

NDIC Well Name	NDIC Pool	NDIC Estimated OOIP, million stb	CO <sub>2</sub> Oil Recovery at 14% NDIC OOIP, million stb	CO <sub>2</sub> Needed Using 6 Mcf/stb Oil Recovered, Bcf	Potential CO <sub>2</sub> Storage, Bcf	Potential CO <sub>2</sub> Storage, million tons
McDuck Well South	Red River, B	140	4.3	34	34	21
Page	Madison	210	20	207	207	13
Beaver Lodge	Madison	172	21	165	165	10
Big Lake	Madison	140	20	139	139	10
Poling	Beaumont	135	19	149	149	10
Beaver Lodge	Beaumont	130	17	133	133	8
Arndale	Madison	140	13	96	96	6
Neelburg	Neelburg	90	12	83	93	6
Wiley	Gilbertson	90	12	97	97	5
Blue Butte	Madison	93	11	89	89	5
Charlton North	Madison	80	10	77	77	5
Royal	Madison	79	9	76	76	5
Goldman	Beaumont	63	7	59	59	4
Madison	Beaumont	59	7	56	56	4
North Edgemoor	Madison	50	7	42	42	3
Ranch	Beaumont	24	4	23	23	2
Beaver Lodge	Madison	23	4	21	21	2
Leah	Madison	21	4	20	20	2
Rough Rider East	Madison	27	3	26	26	2
Cedar Creek	Madison	22	3	21	21	1
Poling South	Beaumont	19	3	18	18	1
Kudwin	Beaumont	18	3	18	18	1
Beaver Lodge	Beaumont	16	2	16	16	1
Arndale	Beaumont	15	2	15	15	1
Madison	Beaumont	14	2	13	13	1
Blue Creek	Beaumont	13	2	12	12	1
Charlton South	Beaumont	10	1	9	9	1
Tracy Mountain	Beaumont	8	1	8	8	1
Total Potential Storage in Selected Fields					2095	128

- ▶ OOIP = 2184 Mstb
- ▶ CO<sub>2</sub> needed = 2095 Bcf
- ▶ Potential CO<sub>2</sub> storage:
  - 2095 Bcf
  - 128 Mt
- ▶ EOR = 300 Mstb
- ▶ Estimated CO<sub>2</sub> for EOR in North Dakota oil fields is 1.18 Bt
- ▶ EPIC 500-MW plant
- ▶ CO<sub>2</sub> = ~4 Mtpy
- ▶ Preliminary assessments

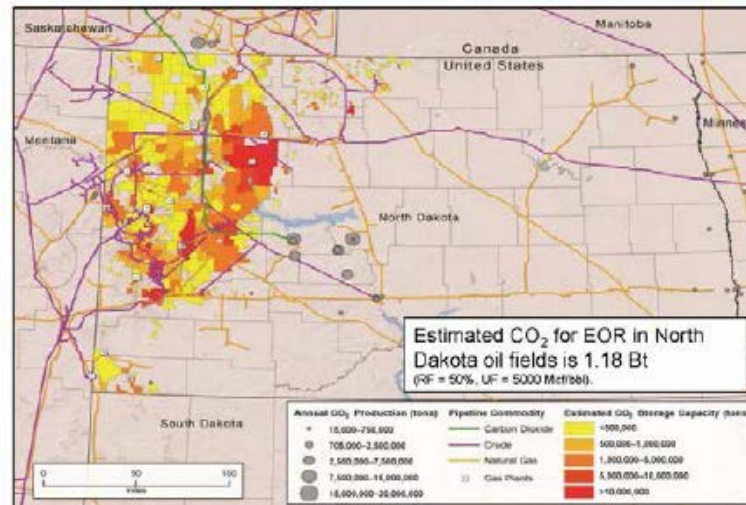
Source: North Dakota Industrial Commission (NDIC) data and Smith and others (2005).



The International Center for Applied Energy Technology

## CO<sub>2</sub> Production, Pipelines, and Estimated CO<sub>2</sub> Storage Capacity

CONFIDENTIAL DRAFT



The International Center for Applied Energy Technology

## DHSU & C12 Energy Overview

### DHSU

- Discovered in 1958
  - OOIP ~61 million barrels
  - Production started in 1965
- Wells are completed in Tyler sandstone
  - Avg depth 7900' TVD
  - Most completed on 160 acre spacing
  - 72 wells completed in Tyler at some point
    - 23 active producers
    - 6 active injectors
- Field unitized in 1973
- Operatorship transferred from Cline Production Company to C12 Energy in July 2013

### C12 Energy

- Started off as a carbon capture start up in 2008
- Transitioned to CO2 flooding company in 2013
- DHSU was first oil field purchased by C12 Energy
  - First part of plan to purchase more fields in ND
  - Desire to have first CO2 flood in ND by bringing CO2 from Dakota Gasification facility in Beulah, ND

DHSU field is 2.5 miles wide x 8 miles long

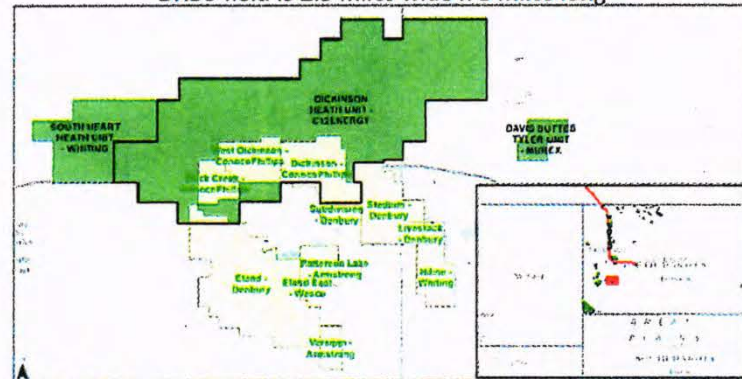


Figure 1: Dickinson area fields. Red box in insert denotes spotlighted area.



Scale of Overall CO<sub>2</sub>-EOR Opportunity

C12 Energy

C12 Energy

Producing Interval	Unit	Unit Operator	Current Production (bbls/mon)	Cumulative Production (bbls)	Estimated PSUP (bbls)	CO <sub>2</sub> -EOR Potential (%PSUP)	CO <sub>2</sub> -EOR Potential (bbls)	Rough CO <sub>2</sub> Appetite
Tyler	Dickinson Heath	Cline	3,840	26,500,000	26,800,000	40%	10,720,000	4,288,000
	South Heart Heath	Whiting	887	793,000	796,000	40%	318,400	127,360
	Davis Buttes Tyler	Murex	488	251,000		40%	-	-
Lodgepole	Versippi Lodgepole	Armstrong	1,200	577,000	594,000	40%	237,600	95,040
	Patterson Lake Lodgepole	Armstrong	18,800	622,000		40%	-	-
	Eland East Lodgepole	Wesco		[Not in YODA]		40%	-	-
	Eland Lodgepole	Denbury	25,200	28,800,000	30,200,000	40%	12,080,000	4,832,000
	Duck Creek Lodgepole	ConocoPhillips	2,420	1,630,000	1,700,000	40%	680,000	272,000
	West Dickinson Lodgepole	ConocoPhillips	6,620	5,400,000	5,810,000	40%	2,324,000	929,600
	Dickinson Lodgepole	ConocoPhillips	4,790	7,060,000	7,620,000	40%	3,048,000	1,219,200
	Subdivision Lodgepole	Denbury	242	181,000		40%	-	-
	Statium Lodgepole	Denbury	15,700	11,900,000	13,700,000	40%	5,480,000	2,192,000
	Livestock Lodgepole	Denbury	88	223,000		40%	-	-
	Hilline Lodgepole	Whiting	2,360	1,790,000	2,020,000	40%	808,000	323,200
	Sum (All)		82,635	85,727,000	89,240,000		35,696,000	14,278,400
	Sum (Key)		56,150	79,660,000	84,130,000		33,652,000	13,460,800

- 40% PSUP recovery for CO<sub>2</sub>-EOR from Keg River (Canada) analog for Lodgepole units (% for Tyler?)
- "CO<sub>2</sub> Appetite" calculated using 2.5 bbls/ton

INDUSTRIAL COMMISSION  
STATE OF NORTH DAKOTADATE 2-24-16 CASE NO. 24708Introduced By C12 EnergyExhibit 3Identified By Ramsay

C12 Energy

Case No. 24708

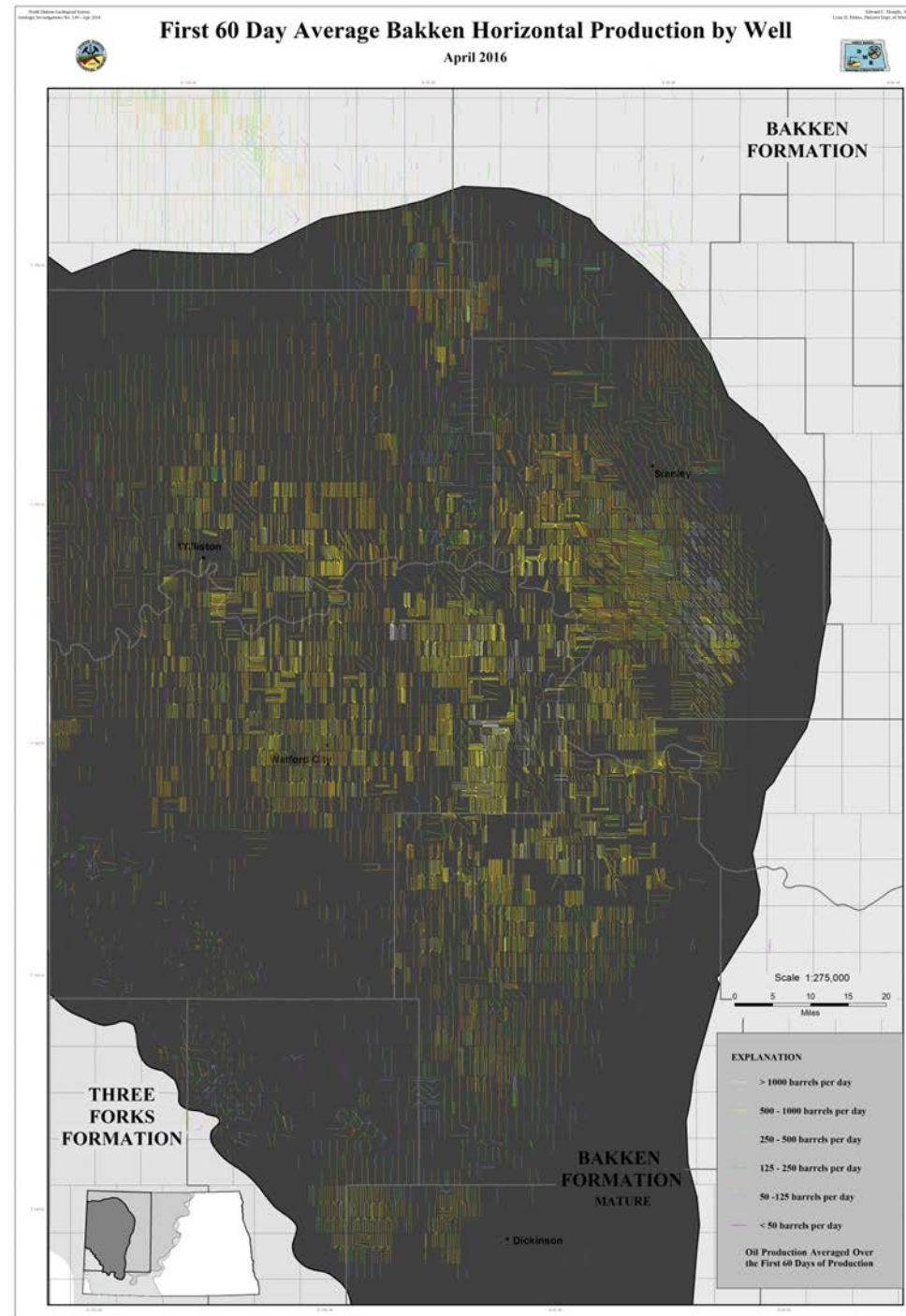
February 24, 2016

Exhibit #3

2 – 3 billion tons of CO<sub>2</sub>

Could yield

4 – 7 billion barrels of oil





## Mines and Power Plants



[R.M. Heskett Station](#)

[Coal Creek Station](#)

[Milton R. Young Station](#)

[Leland Olds Station](#)

[Stanton Station\\*](#)

[Antelope Valley Station](#)

[Great Plains Synfuels Plant](#)

[Coyote Station](#)

[Spiritwood Station](#)

1. [Falkirk Mine](#)

2. [Center Mine](#)

3. [Beulah Mine](#)

4. [Freedom Mine](#)

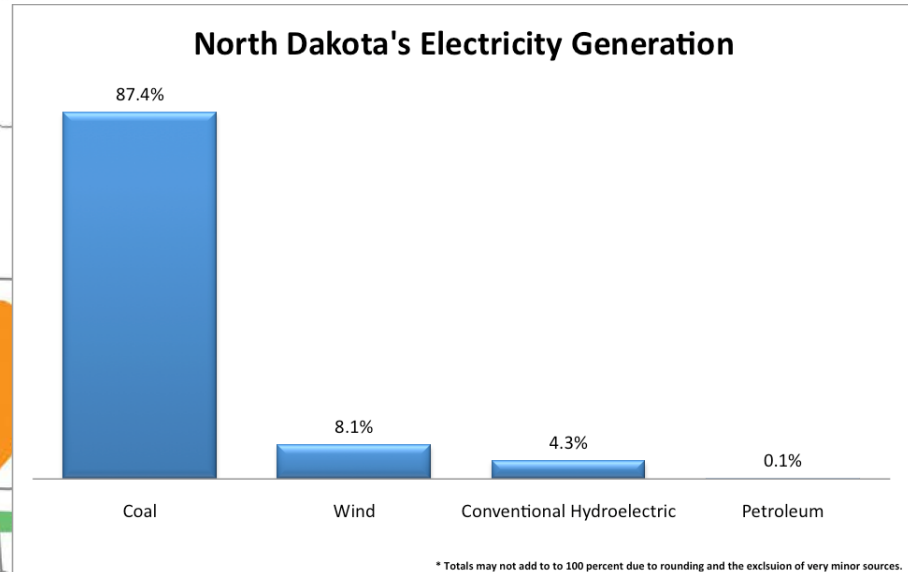
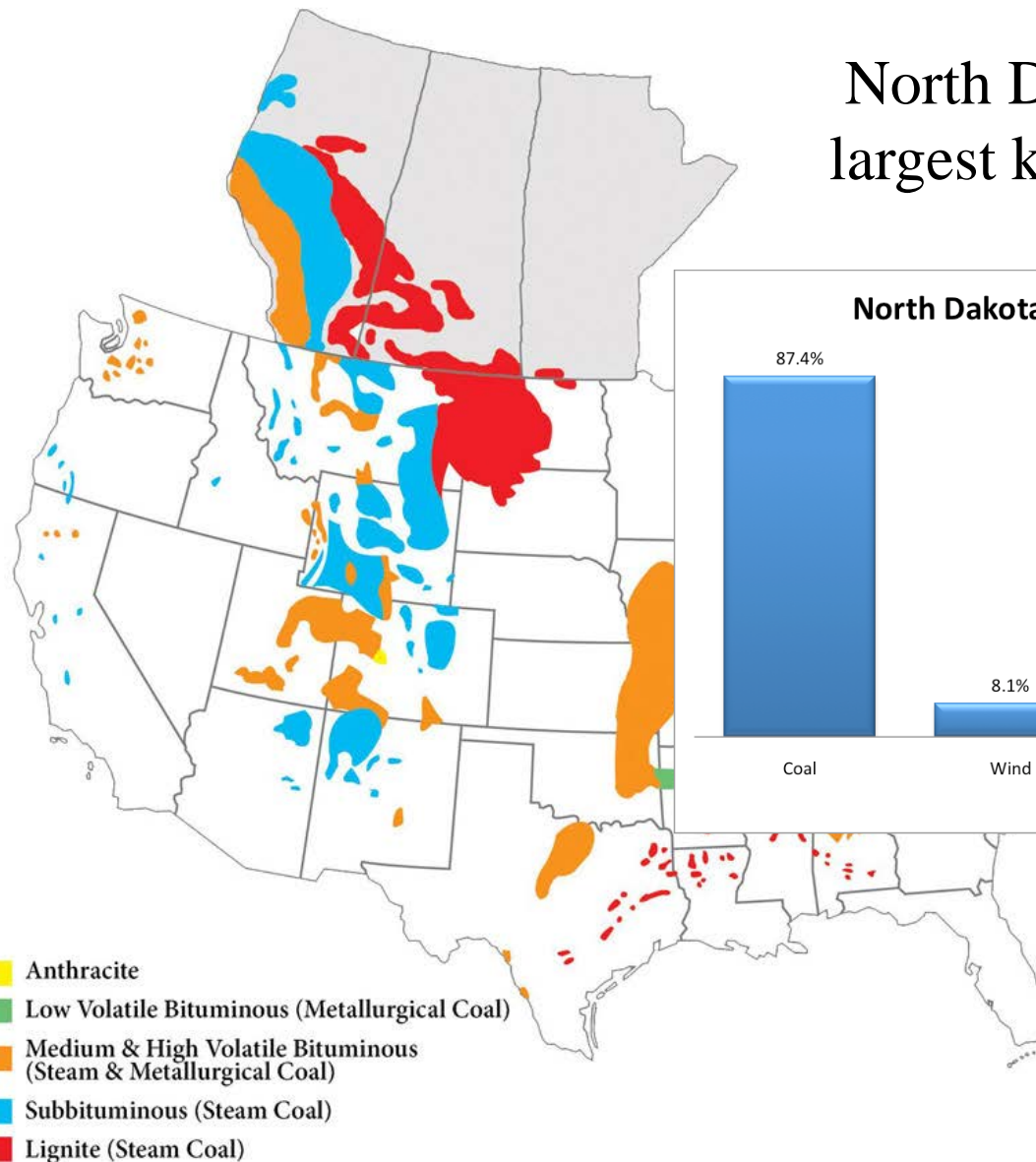
Not shown above: [Lewis & Clark Station](#) and [Savage Mine](#) near Sidney, MT.

\* Not a lignite power plant.

37 million ton  
Source US EIA



# North Dakota contains the single largest known deposit of lignite in the world



*Freedom Mine near Beulah, ND is the largest lignite mine in the world*

# 1.3 Trillion Tons of Coal in North Dakota

## THE LIGNITE RESOURCES OF NORTH DAKOTA

by

Edward C. Murphy, Ned W. Kruger, Gerard E. Goven,  
Quentin L. Vandal, Kimberly C. Jacobs, and Michele L. Gutenkunst



REPORT OF INVESTIGATION NO. 105  
North Dakota Geological Survey  
Edward C. Murphy, State Geologist  
Lynn D. Helms, Director Dept. of Mineral Resources  
2006

# 25 Billion Tons of Mineable Lignite 800+ year supply

## THE LIGNITE RESERVES OF NORTH DAKOTA

by

Edward C. Murphy



REPORT OF INVESTIGATION NO. 104  
North Dakota Geological Survey  
Edward C. Murphy, State Geologist  
Lynn D. Helms, Director Dept. of Mineral Resources  
2006

## Cost – Value

Capture cost \$40-50 / ton

Value to EOR operators \$15-20 / ton

## Federal Regulation

### BLM

Hydraulic Fracturing  
Sage Grouse

### EPA

Waters of US  
Clean Power Plan  
UIC

### USACOE

ROW

### BIA / Tribes

ROW rule  
Tax Agreement



## Technology

Capture

Unconventional EOR





17.0272.01000

Sixty-fifth

Legislative Assembly of North Dakota

FIRST DRAFT:

Prepared by the Legislative Council staff for the  
Energy Development and Transmission Committee  
August 2016

A BILL for an Act to create and enact section 57-51.1-03.2 of the North Dakota Century Code, relating to an oil extraction tax credit for carbon dioxide used for enhanced oil recovery; to amend and reenact subsection 2 of section 57-51-05 and subsection 6 of section 57-51.1-01 of the North Dakota Century Code, relating to administration of an oil extraction tax credit and the definition of a qualifying tertiary recovery project; and to provide an effective date.

**SECTION 1. AMENDMENT.** Subsection 2 of section 57-51-05 of the North Dakota Century Code is amended and reenacted as follows:

2. On oil or gas produced and sold, the gross production tax thereon must be paid by the purchaser, and the purchaser is authorized to deduct in making settlement with the producer or royalty owner, the amount of tax paid after deduction of any credit under section 57 - 51.1 - 03.2 to which the producer would be entitled if paying the tax as verified by documentation provided from the producer to the purchaser; provided, that in the event oil produced is not sold but is retained by the producer, the tax on the oil not sold must be paid by the producer after deduction of any credit under section 57 - 51.1 - 03.2 to which the producer is entitled, including the tax due on royalty oil not sold; provided further, that in settlement with the royalty owner the producer has the right to deduct the amount of the tax paid on royalty oil or to deduct therefrom royalty oil equivalent in value at the time the tax becomes due with the amount of the tax paid.

**SECTION 2. AMENDMENT.** Subsection 6 of section 57-51.1-01 of the North Dakota Century Code is amended and reenacted as follows:

6. "Qualifying tertiary recovery project" means a project for enhancing recovery of oil which meets the requirements of section 4993(c), Internal Revenue Code of 1954, as amended through December 31, 1986, and includes the following methods for recovery:

- a. Miscible fluid displacement.
- b. Steam drive injection.
- c. Microemulsion.
- d. In situ combustion.
- e. Polymer augmented water flooding.
- f. Cyclic steam injection.
- g. Alkaline flooding.
- h. Carbonated water flooding.
- i. Immiscible carbon dioxide displacement.
- j. New tertiary recovery methods certified by the industrial commission.

It does not include water flooding, unless the water flooding is used as an element of one of the qualifying tertiary recovery techniques described in this subsection, or immiscible natural gas injection, or miscible carbon dioxide displacement. To be eligible for the tax exemption provided under section 57-51.1-03, a tertiary recovery project must be certified as qualifying by the industrial commission, the project operator must continue to operate the unit as a qualifying tertiary recovery project, and the project operator must have obtained incremental production as defined in subsection 3 of section 57-51.1-03.

**SECTION 3.** Section 57-51.1-03.2 of the North Dakota Century Code is created and enacted as follows:

**57-51.1-03.2. Oil extraction tax credit for carbon dioxide purchased or acquired for use in enhanced oil recovery.**

1. A producer of oil subject to taxes under this chapter is entitled to a credit against those taxes that apply to the producer's interest in that oil. **The credit is equal to ten dollars per ton [907.18 kilograms] of carbon dioxide purchased or acquired for use in enhanced oil recovery in this state.**

2. An oil producer shall report to the industrial commission the amount of carbon dioxide initially injected by the oil producer into an oil reservoir in this state for purposes of enhanced oil recovery. The industrial commission shall certify to the tax commissioner the amount, by each oil producer, of carbon dioxide initially injected into an oil reservoir in this state for purposes of enhanced oil recovery.

3. An oil producer claiming the credit under this section shall claim the credit in the format prescribed by the tax commissioner. The purchaser of oil may deduct from taxes due any credit under this section to which the producer would be entitled if paying the tax. The return filed by the purchaser for the taxable period must include documentation, in a format prescribed by the tax commissioner, verifying the amount of the producer's credit deducted.

**SECTION 4. EFFECTIVE DATE.** This Act is effective for taxable events occurring after June 30, 2017.

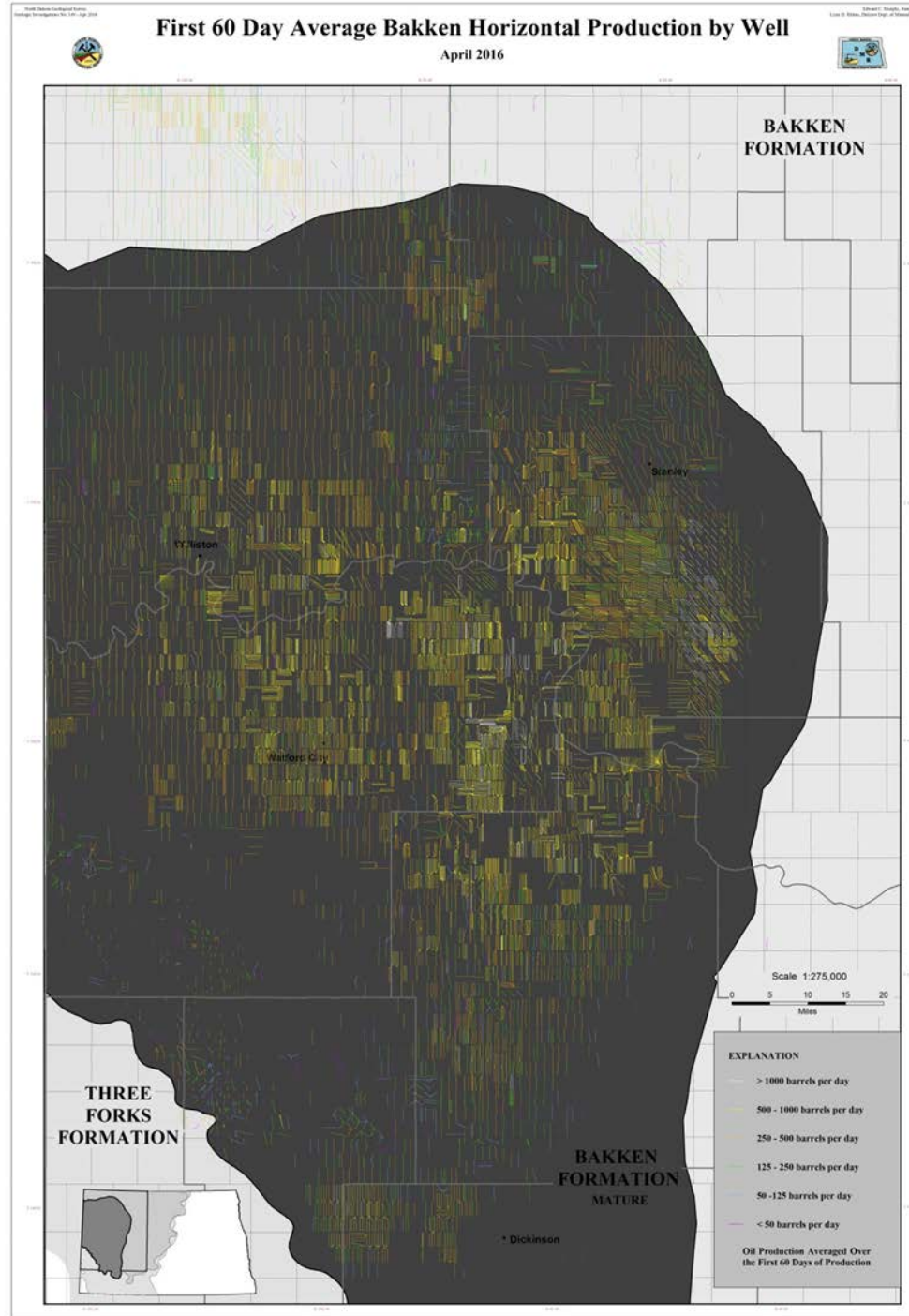
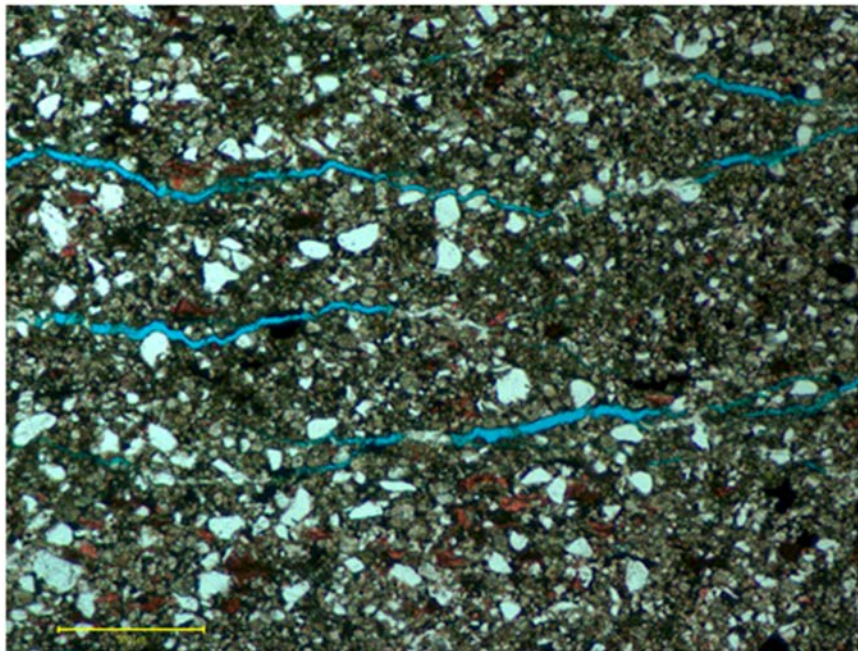
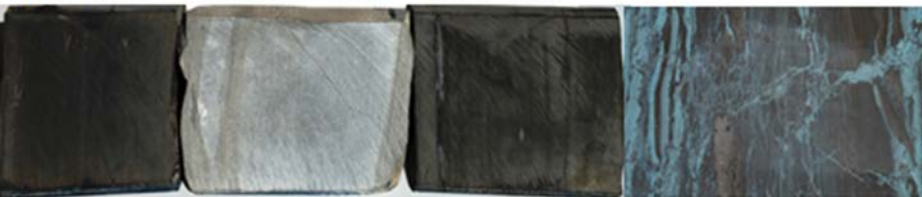


# Class VI Primacy

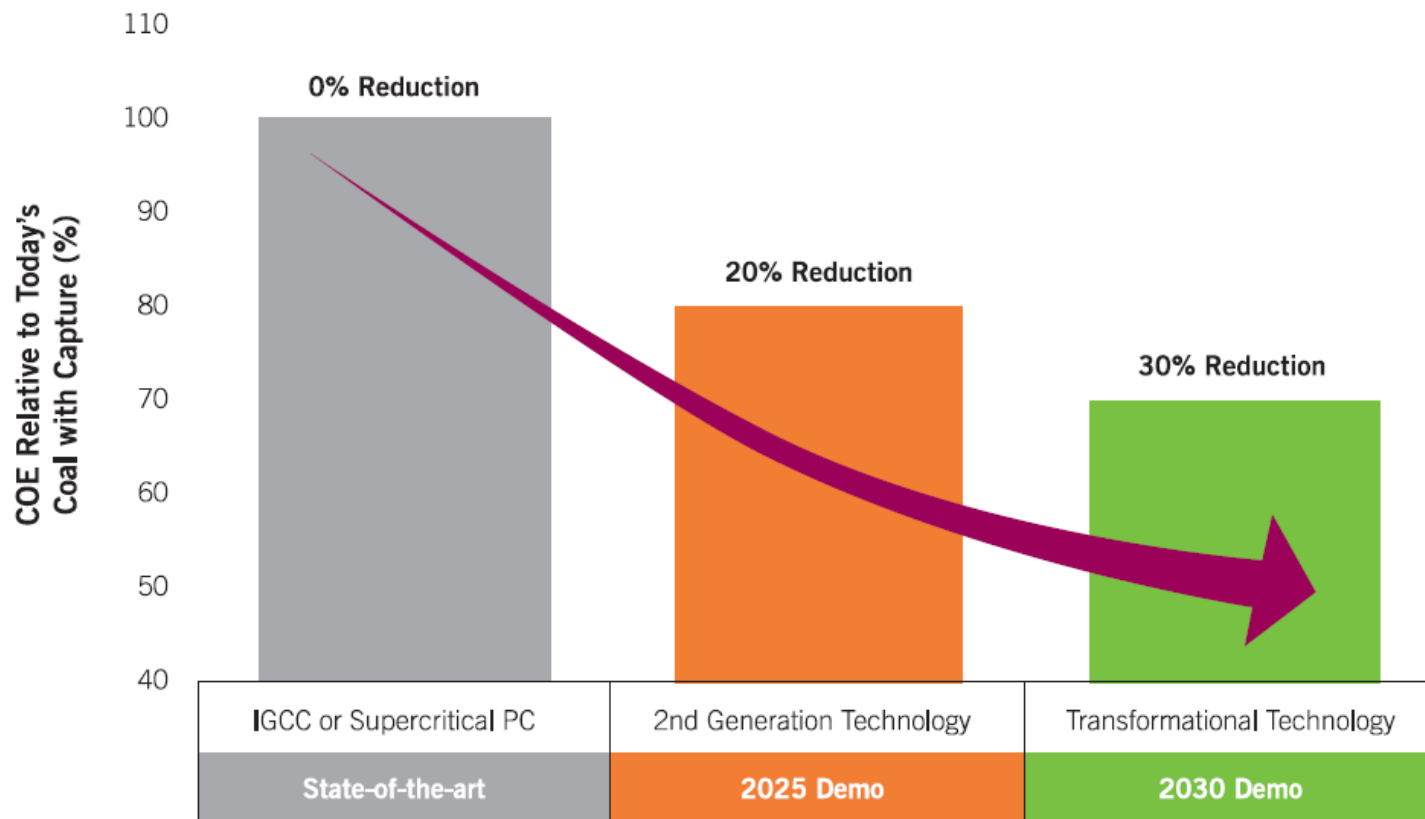
- EPA federal authority
  - Waste Disposal Framework
  - SDWA
    - UIC Programs
  - Class VI Rule
- North Dakota laws and Regulations
  - Resource Management Framework
  - Statute – CO<sub>2</sub> Underground Storage
  - Subsurface Pore Space Policy
  - Administrative Rules
- Two Regulatory Jurisdictions
  - Project development and financing deterrent
    - Pore Space Ownership
    - Long-term liability of Stored CO<sub>2</sub>
- Primacy Application Submitted June 21, 2013



# **Bakken Formation**      **Three Forks Formation** upper shale    middle member    lower shale



**Figure 7** Relative US DOE cost reduction targets and timing for second generation and transformational carbon capture technologies<sup>13,14</sup>



Pilot-scale testing of second generation technologies using actual process gases is a critical step in advancing more cost-effective capture technologies. There are several second generation capture technologies that are currently being tested at pilot scale (or soon will be) worldwide. These are candidates for the next significant wave of lower-cost demonstrations that can eventually lead to widespread deployment.



# EPIC's Synergies

CONFIDENTIAL DRAFT

- **Synergy:** natural resources, energy systems, and innovative technologies
- **Sustainable expansion** of North Dakota lignite and agricultural resources
- **Production, utilization, and export** of environmentally sound, low-carbon products
  - Liquid fuels
  - Chemical feedstocks and fertilizer
  - Oil
  - CO<sub>2</sub> for EOR
  - Electricity (North Dakota needs +2500 MW by 2032)
- **Manufacture** of new technology innovations



The International Center for Applied Energy Technology

## Maximized Revenue per Ton of Feedstock

CONFIDENTIAL DRAFT





