UPDATES AND DEVELOPMENTS AT THE EERC WILLISTON BASIN PERSPECTIVE

EOR Carbon Management Workshop
at the 22nd Annual CO_2/ROZ Conference

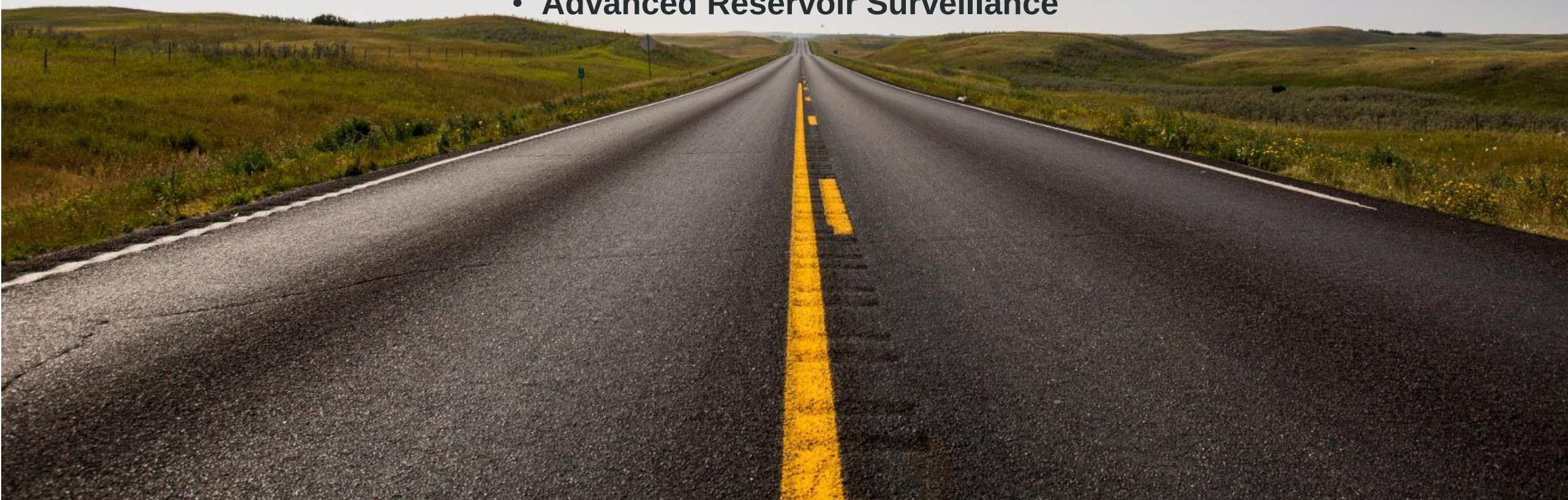
Midland, Texas
December 6, 2016

James Sorensen
Energy & Environmental Research Center

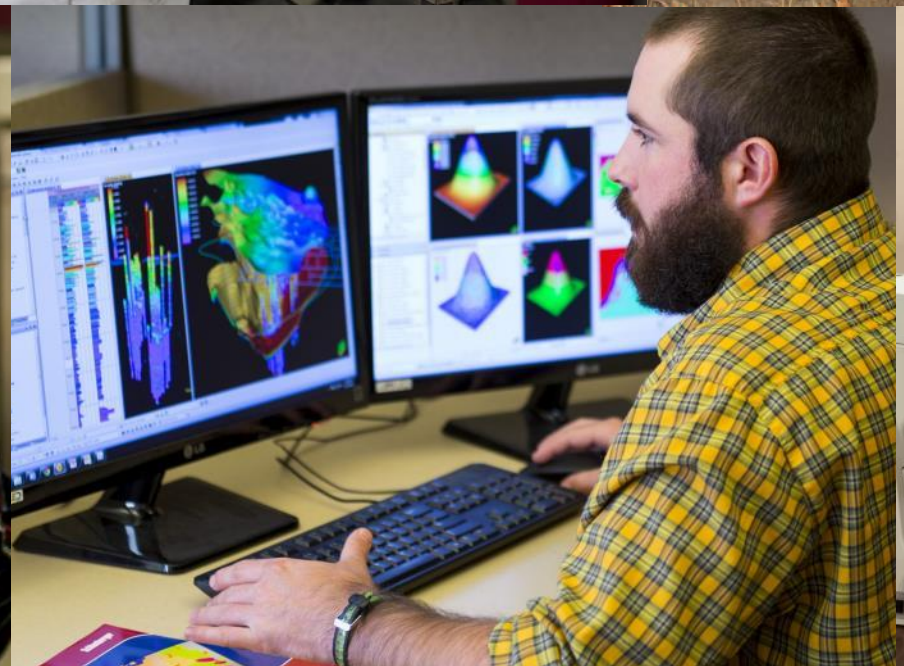
Critical Challenges. Practical Solutions.

WHERE'S HE GOING WITH THIS?

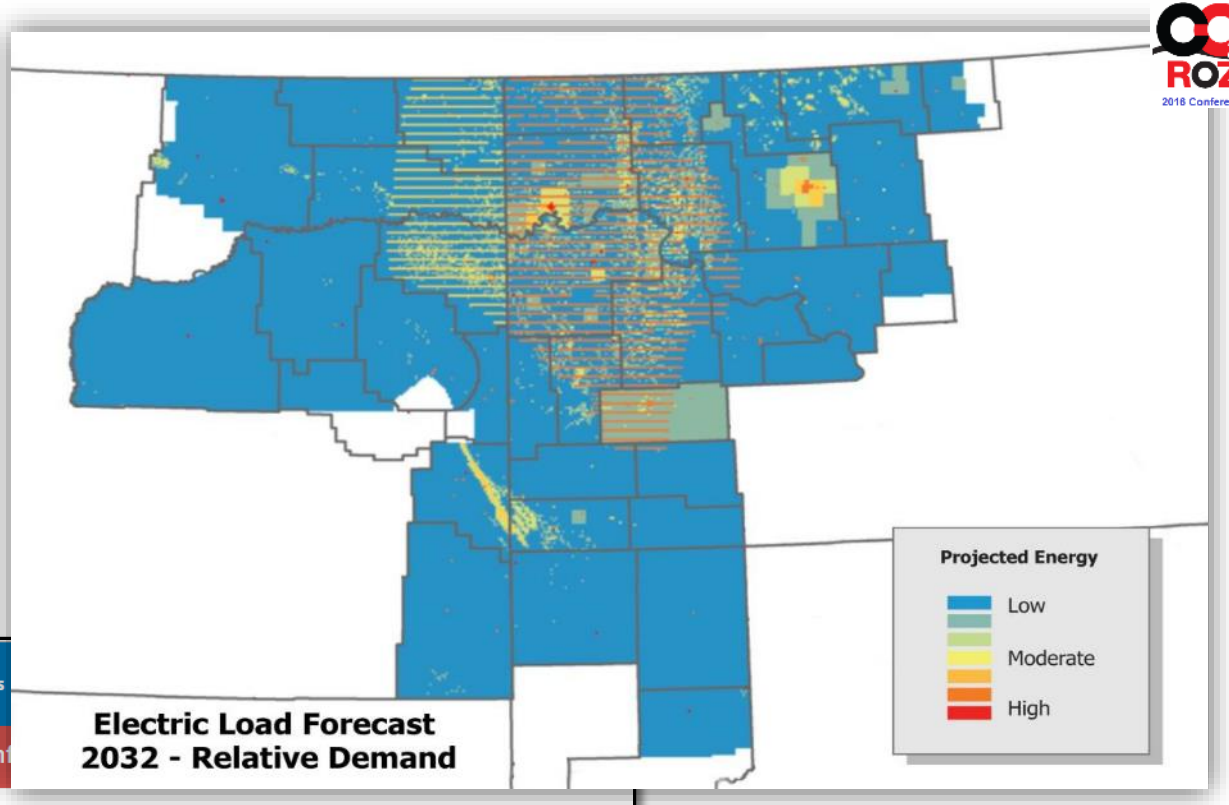
- EERC – Who We Are and What We Do
- Sources of CO_2 for the Williston Basin
- EOR Potential in Conventional Reservoirs
- Bakken Efforts
- ROZ Efforts
- Advanced Reservoir Surveillance



EERC CAPABILITIES



WILLISTON BASIN – TIMES ARE A CHANGIN'



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America's Biggest Boomtown

How North Dakota's economy doubled in 11 years

by Blake Ellis @blakeellis3

July 14, 2014: 2:48 PM ET

North Dakota's economic output

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BREAKING $7 million more approved for protest law enf

North Dakota population could top 1 million by 2040

Patrick Springer Forum News Service Jan 19, 2016

FARGO -- North Dakota's population should continue to grow steadily despite the oil slowdown and could flirt with the 1 million mark by 2040 under a range of new population projections.

The North Dakota Census Office developed a series of population forecasts from 2020 to 2040,

3721 MW required for load demand…

3x today's demand.

EERC

MORE POWER = MORE CO_2

Opportunities for CCUS…

KRTV.com
CONTINUOUS NEWS COVERAGE
GREAT FALLS & NORTH CENTRAL MONTANA

NEWS SPORTS WEATHER COMMUNITY

Posted: Aug 31, 2016 6:40 PM CDT
Updated: Sep 01, 2016 7:51 AM CDT

Is `carbon capture' the savior of Colstrip and other coal-fired power plants?

By Mike Dennison - MTN News CONNECT

Prairie Business
premier business magazine of the northern plains

BUSINESS ENERGY HEALTH CARE HIGHER EDUCATION

ENERGY

IMAGE: Kayla Prasek/Prairie Business

Project Tundra takes step forward

By Kayla Prasek, Prairie Business on Aug 22, 2016 at 5:22 p.m.

CO2 ROZ 2016 Conference

SaskPower's 'clean coal' project plant passes one-million-tonne mark for CO2 capture

BRUCE JOHNSTONE, REGINA LEADER-POST
More from Bruce Johnstone, Regina Leader-Post

Published on: August 12, 2016 | Last Updated: August 12, 2016 2:27 PM CST

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Synfuels plant reaches CO2 delivery milestone

By LAUREN DONOVAN | Bismarck Tribune Feb 26, 2013

A milestone was reached early Sunday when the Dakota Gasification Co. measured 25 million tons of carbon dioxide delivered by pipeline to Canadian oil fields.

The CO2, an unregulated greenhouse gas, is a byproduct from the company's Great Plains Synfuels plant near Beulah where lignite coal is processed into natural gas.

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INDUSTRY NEWS › ENERGY

Denbury gets Montana oil field flowing again

Aug 8, 2013, 9:30pm CDT

INDUSTRIES & TAGS Energy, Mining And Drilling, Oil & Gas, Energy Inc.

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Red Trail Energy, EERC researching carbon capture at the Richardton (ND) ethanol plant

By DAVE THOMPSON • AUG 15, 2016

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Allam Cycle showing potential in a carbon-constrained world

Chris Gessele - Basin Electric Power Cooperative - 04/26/16

The vision for the Allam Cycle consists of gasifying lignite coal to produce synthetic natural gas, which would then be used along with oxygen and carbon dioxide (CO2) to drive a turbine generator.

Clean Power Plan

On Aug. 3, 2015, the Environmental Protection Agency released its Clean Power Plan.

On Oct. 23, 2015, the Clean Power Plan was published in the Federal Register

Williston Herald
Williams County's Newspaper, North Dakota

NEWS SPORTS OBITS LIFESTYLE OPINION EVENTS CLASSIFIEDS MEDIA SPECIAL SECTIONS 72°

Carbon capture technique could be a 'gamechanger'

DOE funds $2.5 million grant toward enhanced oil recovery method

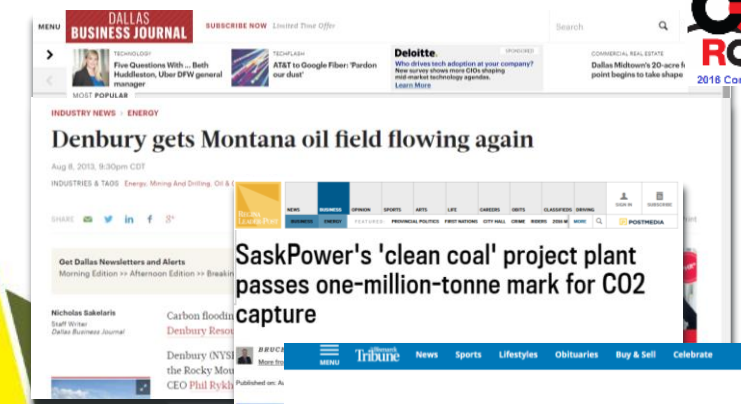
More from our site

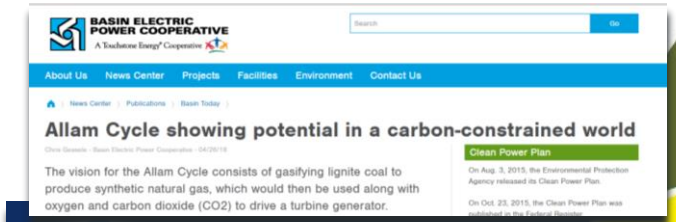
Ruby Herland
Ruby Herland, 83, of Williston, passed away at CHI St. Alexius Health Care Center in Willist...

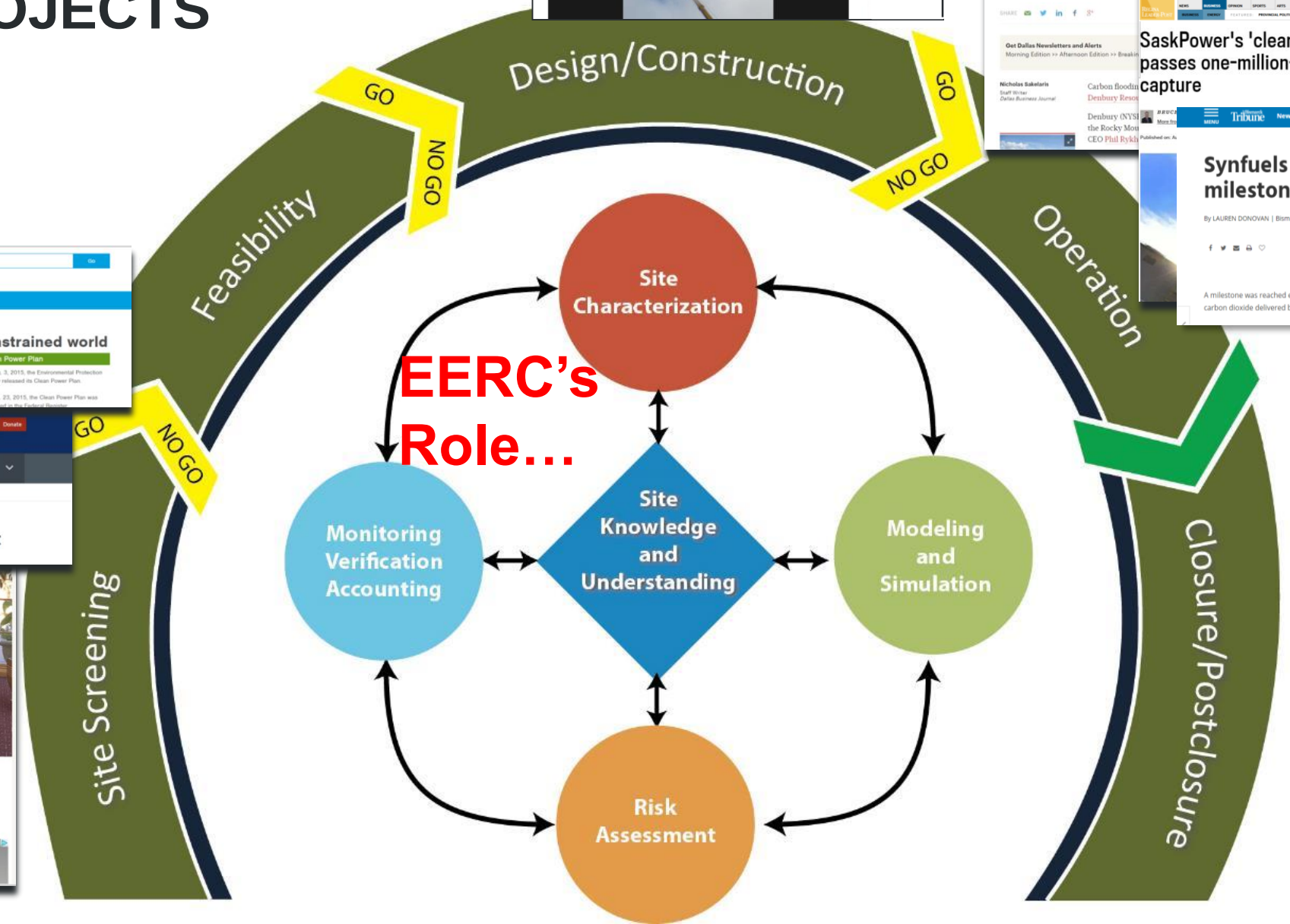
More oil for NorthStar
More oil could soon be headed to the NorthStar Transloading Facility, located in East Fairvi...

Kathryn R. Rathert

STAGES OF DEVELOPMENT FOR NORTHERN PLAINS CCUS PROJECTS





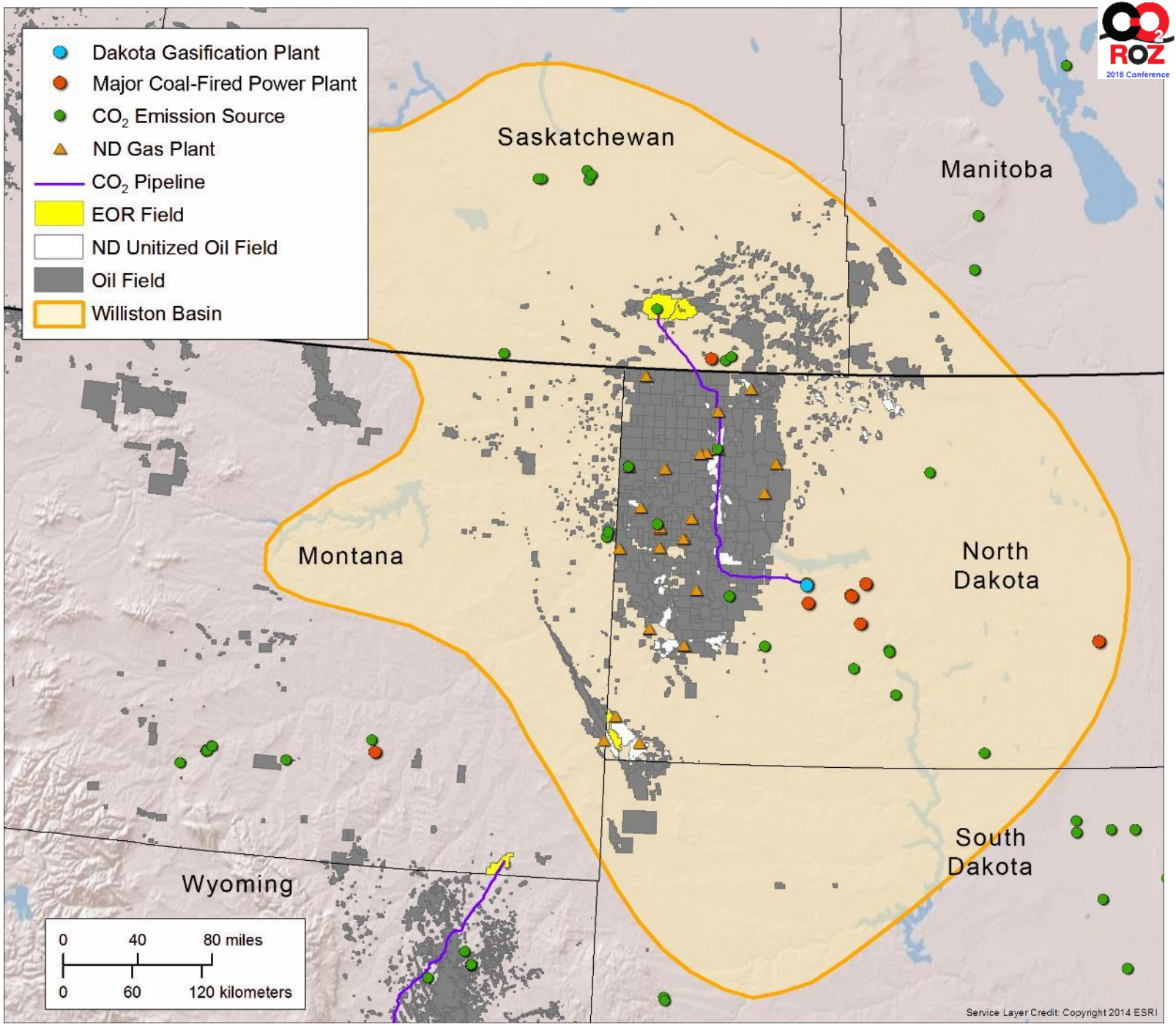


WILLISTON BASIN CCUS POTENTIAL

The Williston Basin is one of the most prolific oil-producing regions of North America.

- **Conventional**
- **Unconventional**
- **ROZs?**

There is also an abundance of anthropogenic CO_2 sources.

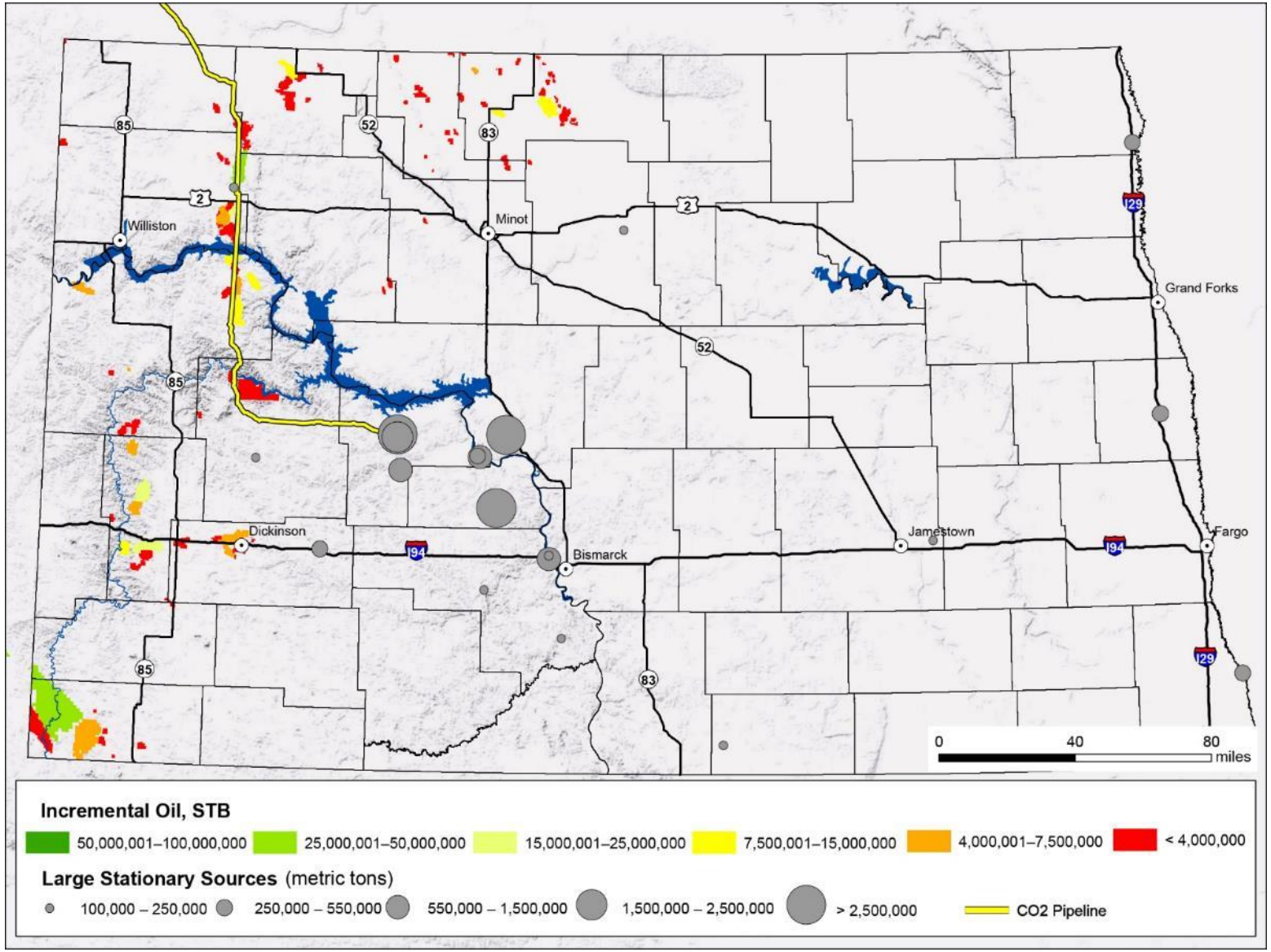


EERC

CONVENTIONAL OILFIELD CO_2 EOR OPPORTUNITIES IN NORTH DAKOTA

An EERC study published as part of a report by KLJ (2014) shows:

- **In 86 conventional unitized oil fields:**
  - **280 to 631 million bbl of incremental oil**
  - **47 to 283 million metric tons of CO_2 needed**



THE BRAVE NEW WORLD – UNCONVENTIONAL BAKKEN AND THREE FORKS

OOIP Estimates

300 Bbbl
(Flannery and Kraus, 2006)

900 Bbbl
(Continental Resources, 2011)

Technically Recoverable Reserve Estimates

7.4 Bbbl
(USGS, 2013)

24 Bbbl
(Continental Resource, 2011)

BAKKEN PRODUCTION OPTIMIZATION PROGRAM

<u>Near-term maximization</u> of Bakken and Three Forks oil production through:

- Advanced reservoir characterization.
- Improved drilling, stimulation, completion, and production techniques.

Optimizing wellsite surface operations through reductions in:

- Flaring.
- Environmental impacts.
- Equipment failures.
- Demands on surrounding infrastructure and water sources.

Program Partners

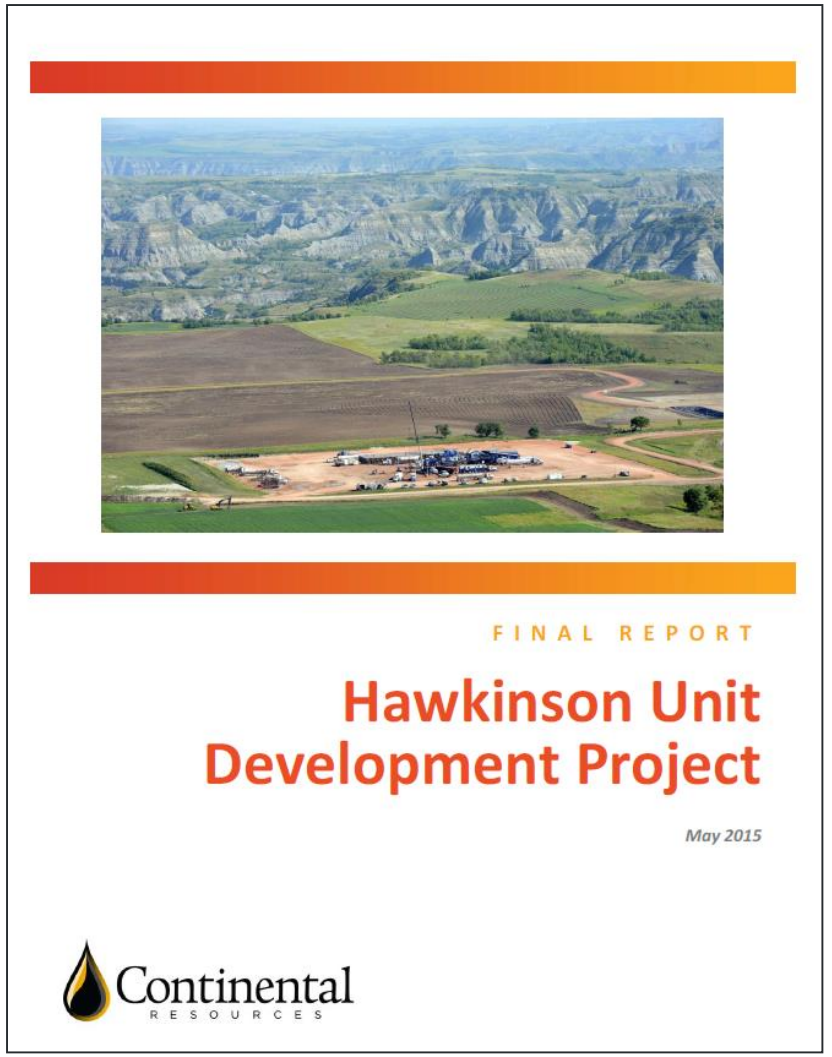
Continental Resources · Marathon Oil · Whiting · North Dakota oil & gas research program · ConocoPhillips · Nuverra Environmental Solutions · Hitachi Inspire the Next · XTO Energy · Hess · Oasis Petroleum · SM Energy

www.undeerc.org/Bakken/Bakken-Production-Optimization-Program.aspx

BAKKEN PRODUCTION OPTIMIZATION PROGRAM

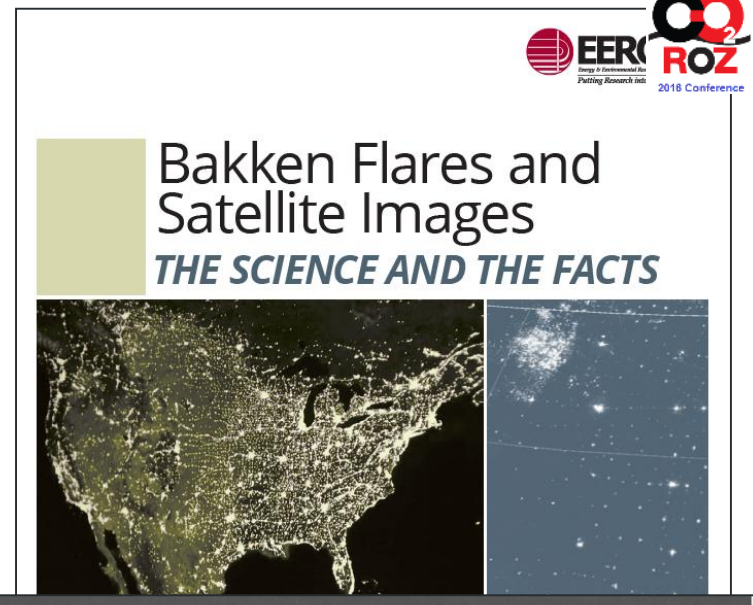
Advanced reservoir characterization:

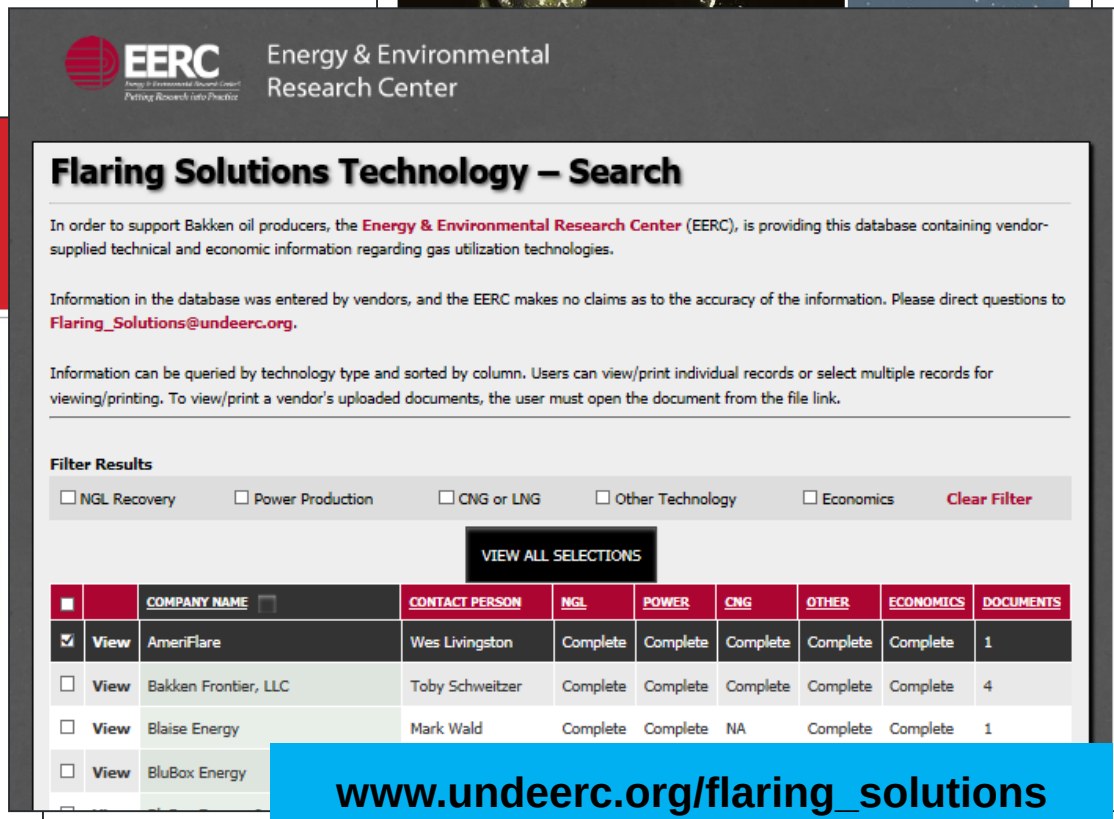
- **Continental Resources** conducted a robust, multidisciplinary study of its Hawkinson Unit.
  - ♦ Core characterization
  - ♦ Petrophysical analysis
  - ♦ Microseismic study
  - ♦ Vertical seismic profile study
  - ♦ Stimulation communication tests
  - ♦ Pulse tests
  - ♦ Stimulation modeling
  - ♦ Numerical reservoir simulation



BAKKEN PRODUCTION OPTIMIZATION PROGRAM

EERC Products





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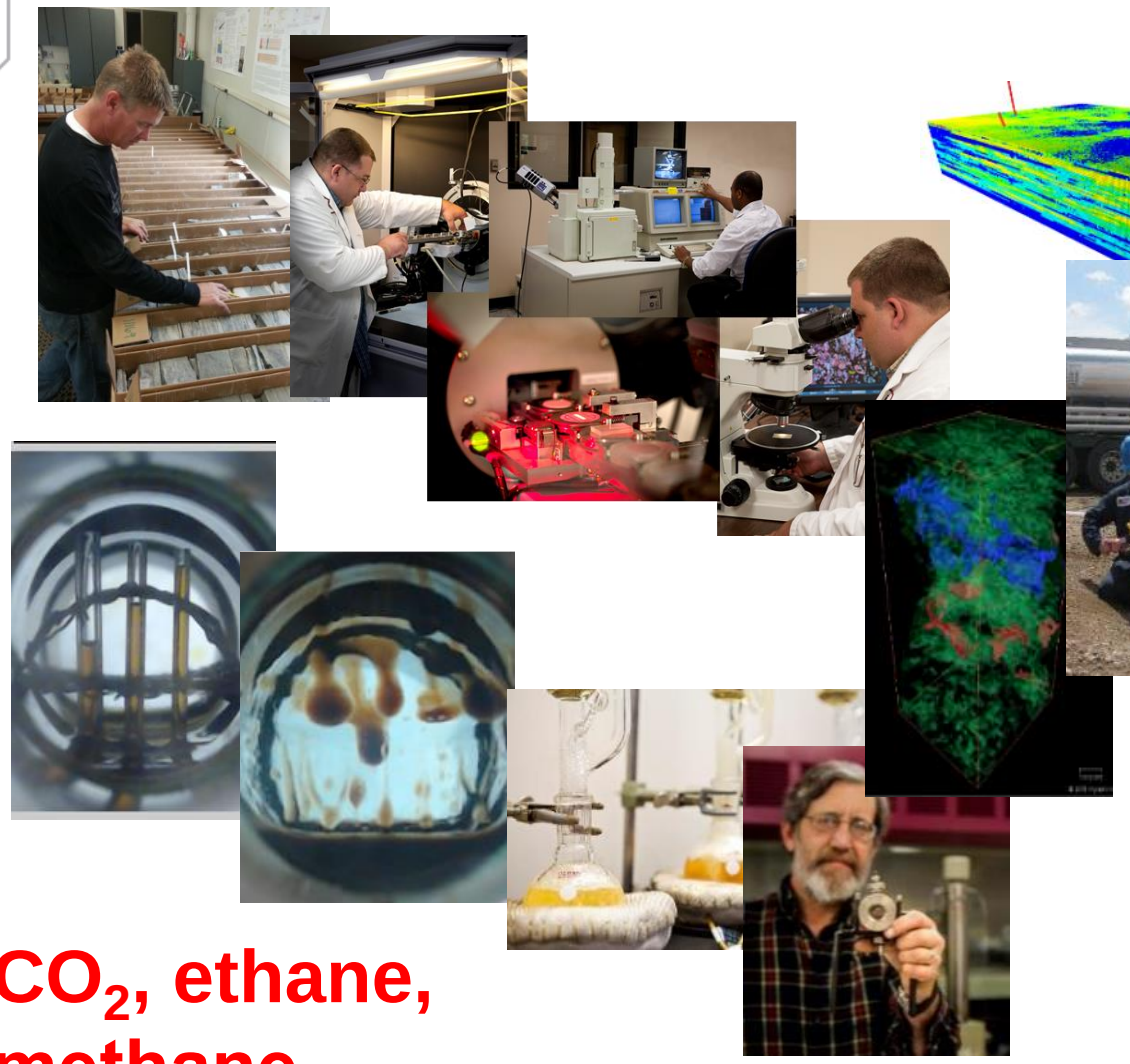
www.undeerc.org/flaring_solutions

BAKKEN CO_2 STORAGE AND EOR RESEARCH EFFORTS

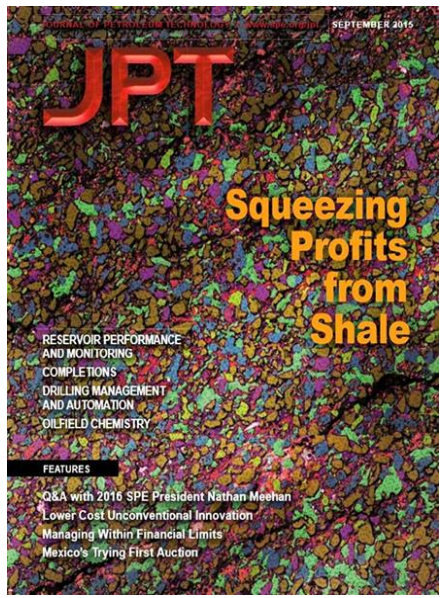


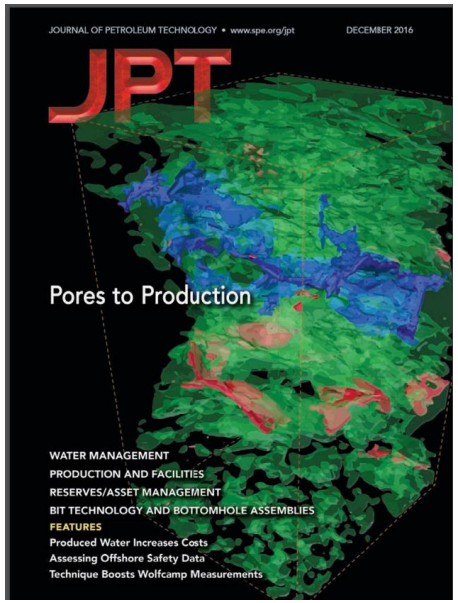
www.undeerc.org/Bakken/Bakken-CO2-Storage-Program.aspx

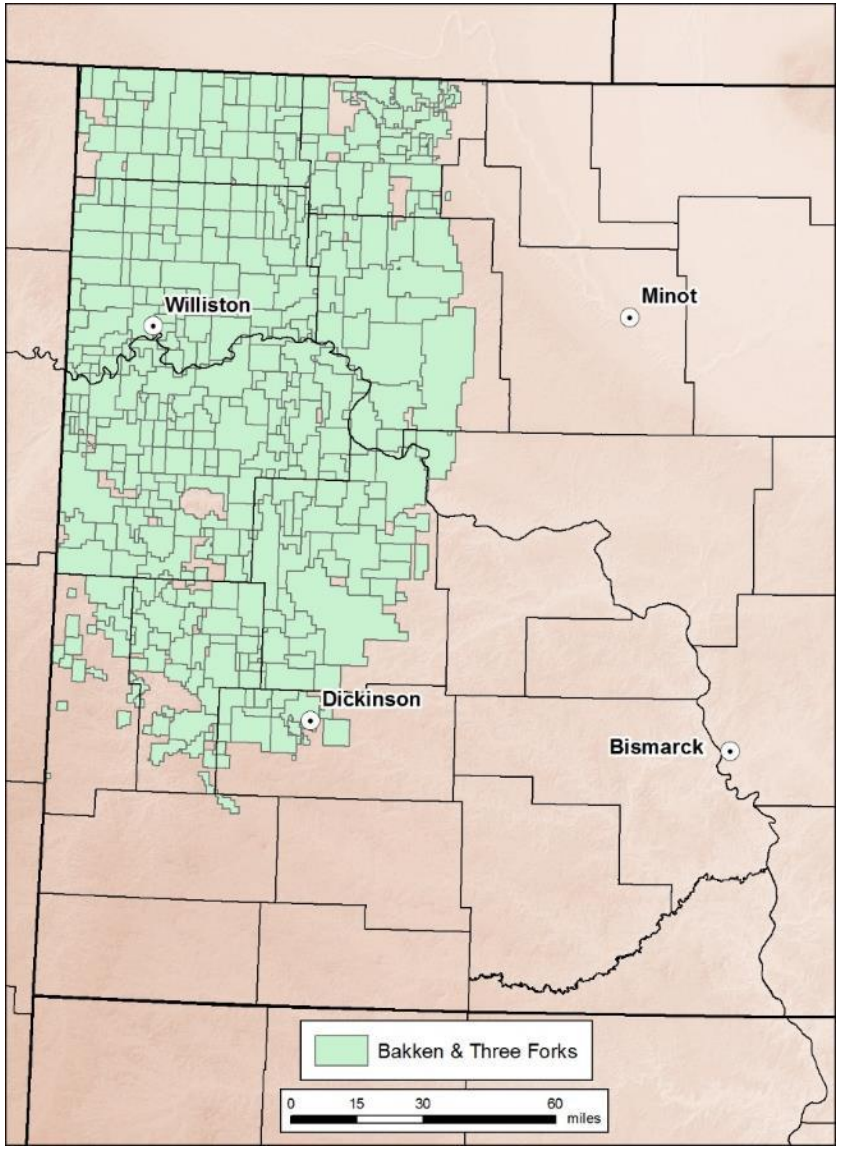
CO_2, ethane, methane…

NORTH DAKOTA BAKKEN/THREE FORKS EOR POTENTIAL

EERC's Bakken CCUS Research Efforts







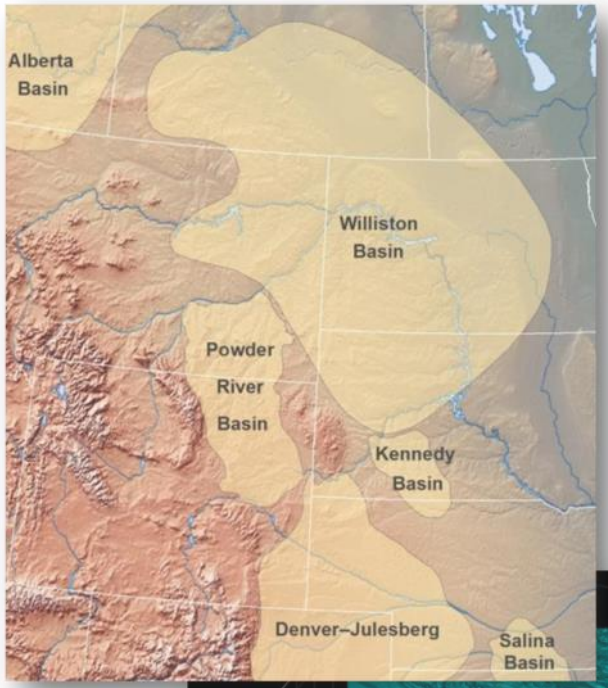
Widespread deployment is perhaps a decade away.

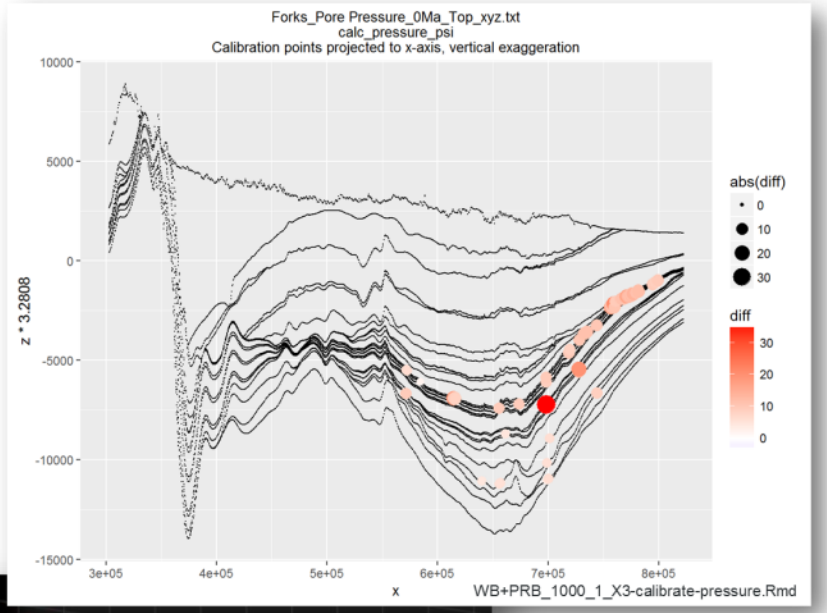
1000 to 4000 million bbl of incremental oil.

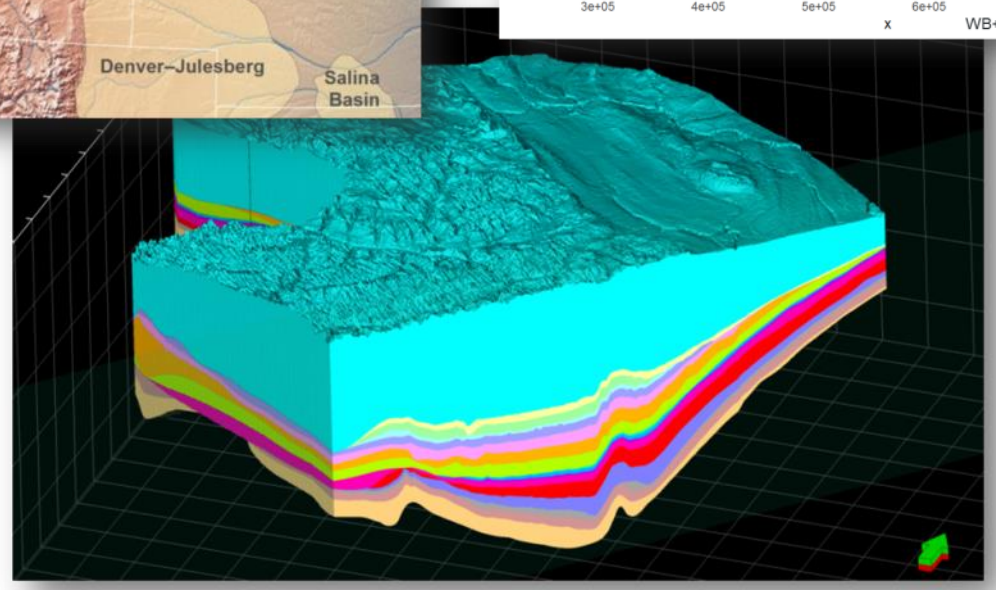
200 to 2000 million metric tons of CO_2 needed.

IDENTIFICATION OF RESIDUAL OIL ZONES (ROZS) IN THE WILLISTON AND POWDER RIVER BASINS

- Identify and characterize the presence and extent of potential ROZs in the Williston and Powder River Basins.
- Translate geologic history of basins into an input for modeling.
- Estimate residual oil in place and CO_2 storage potential.
- Determine potential for CO_2 EOR in identified ROZs.







NEW RESERVOIR SURVEILLANCE ACTIVITIES

DEMONSTRATION OF EMERGING GEOPHYSICAL MONITORING TECHNIQUES

SASSA

A NEW way to track CO_2

- Autonomous receivers and semipermanent stationary source
- Interpret boundary of CO_2 front
- Monitor CO_2 progression between wells or around sensitive areas
- Monitoring of overlying zones

K-Wave

A NEW subsurface signal to possibly track CO_2

- Scalable
- Potential autonomous operation
- Rapid processing
- Low impact
- Reduced acquisition cost
- Guide timing and extent of other surveillance
- Inform timely operations
  - Conformance
  - Pattern analysis
  - Intelligent monitoring systems
- Viable long-term monitoring

- Wellhead-mounted sources and receivers
- Monitor CO_2 progression between wells

EERC Denbury CMG COMPUTER MODELLING GROUP LTD. seismos Critical Challenges. Practical Solutions.


THANK YOU!

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