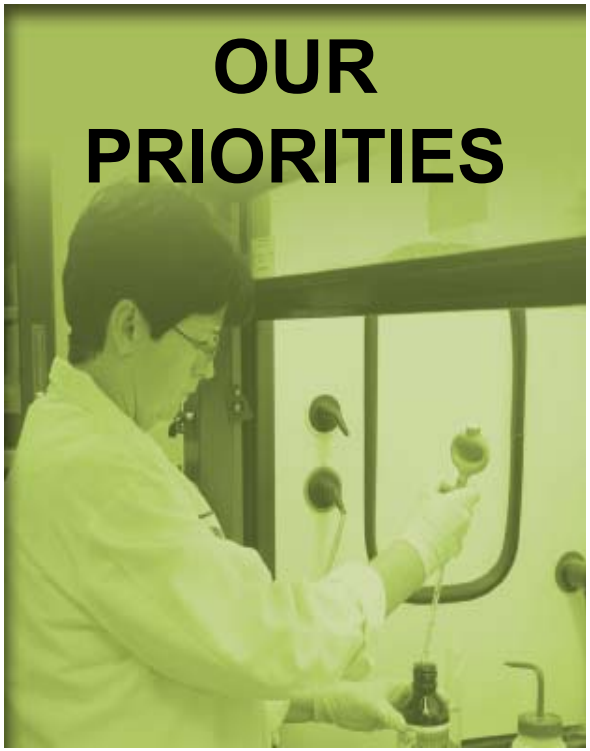

EERC
Critical Challenges.
Practical Solutions.
UNIVERSITY OF NORTH DAKOTA

PRACTICAL SOLUTIONS …

OUR ADVANTAGE



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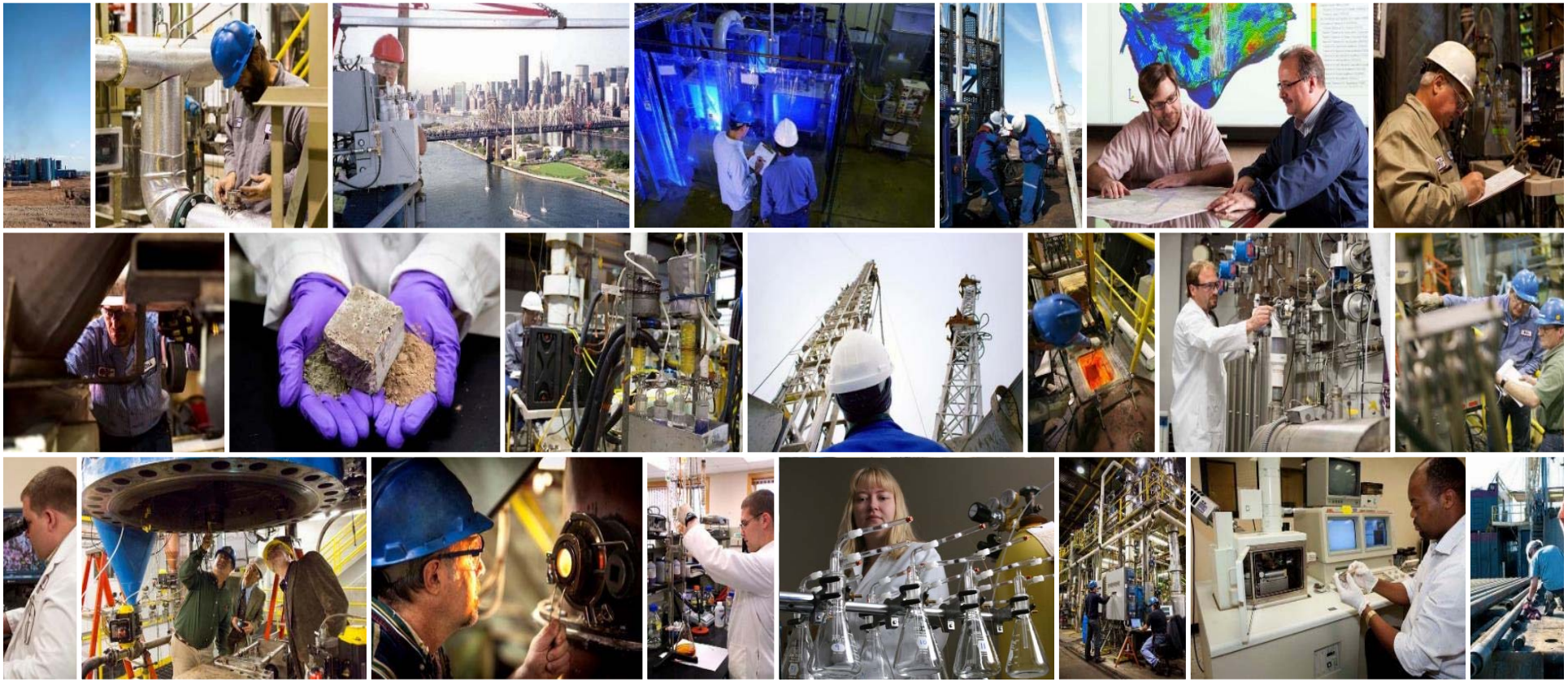
DIVERSE EXPERTISE

AND CAPABILITIES TO IMPACT THE WORLD



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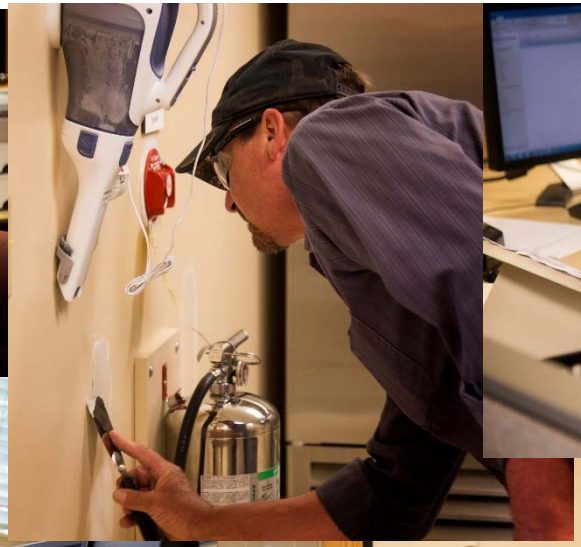
TOTAL TEAM APPROACH



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SERVING OUR COMMUNITY


Grand Forks Public Schools Adopt-a-Family Program


Teacher Workshops

Altru Foundation Spin for Kids Fundraiser


Student Tours


And More!

CORE VALUES, TO BE…

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OUR FACILITIES

254,000 square feet of facilities.

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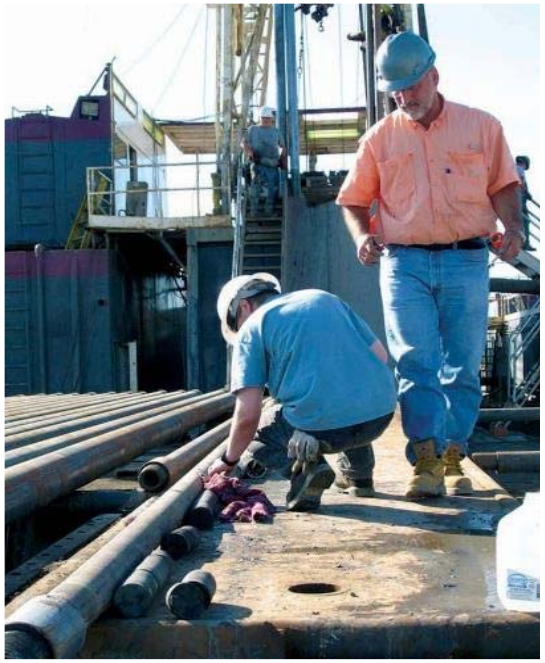
IN THE FIELD

The EERC has conducted numerous field projects throughout North America, including:

- Power and emission control testing.
- Full-scale carbon sequestration demonstrations.
- Seismic surveys.
- Monitoring, verification, and accounting work for subsurface CO_2 injection.
- Full-scale mercury field tests.
- Installation and testing on full-scale systems.
- Contaminant cleanup and water management.



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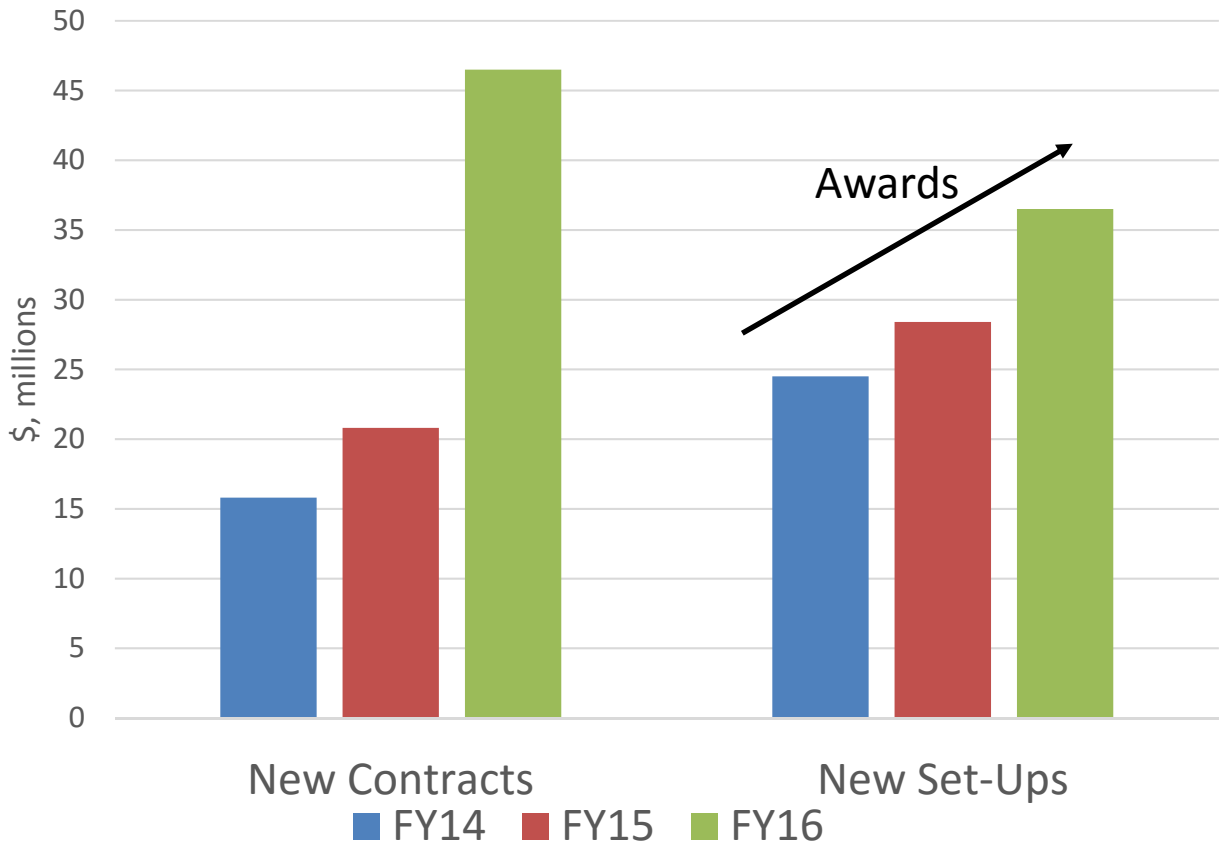
SIGNIFICANT REVENUE GROWTH



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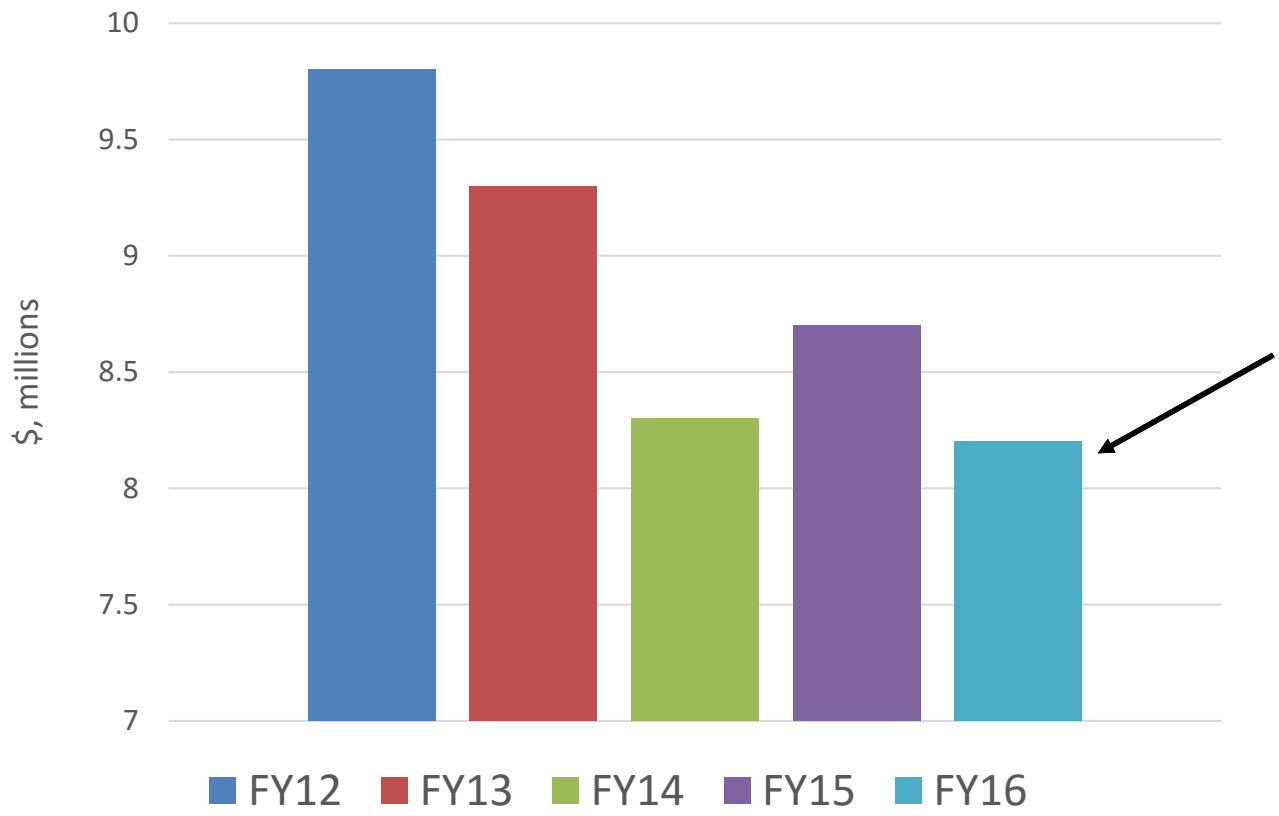
DECREASE IN OVERHEAD EXPENSES



Included an additional $500,000 for Program Development

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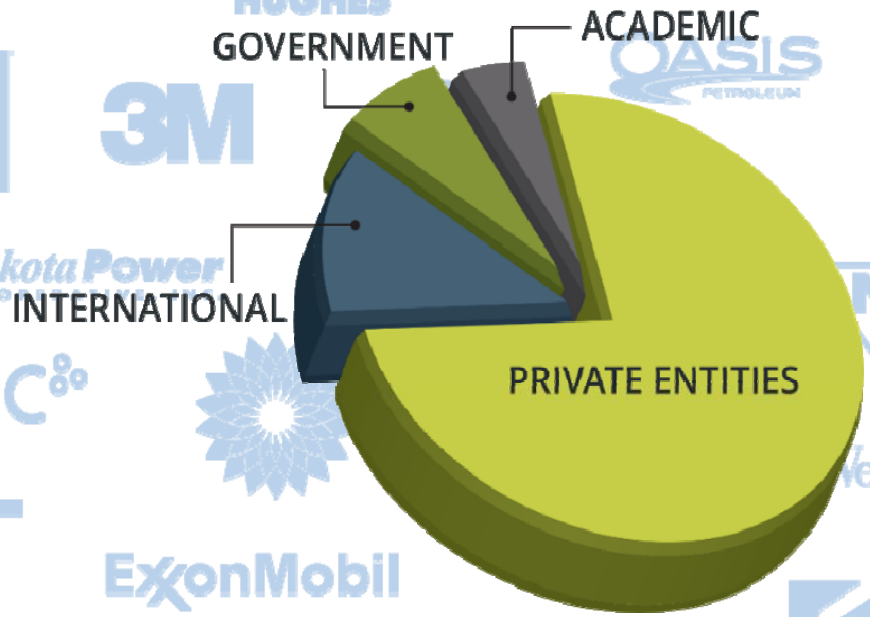
WORKING AROUND THE GLOBE

MORE THAN 1300 CLIENTS IN 52 COUNTRIES



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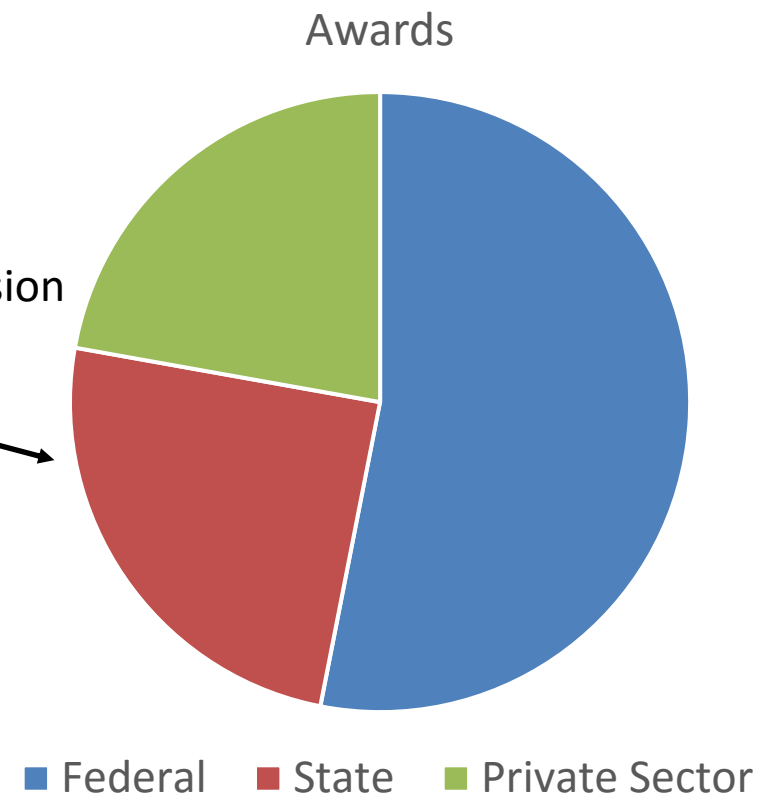
FUNDING SOURCES, FY16

North Dakota Industrial Commission
- LRC
- LRC/legislative
- OGRC
- REC

Pipeline study

Department of Commerce



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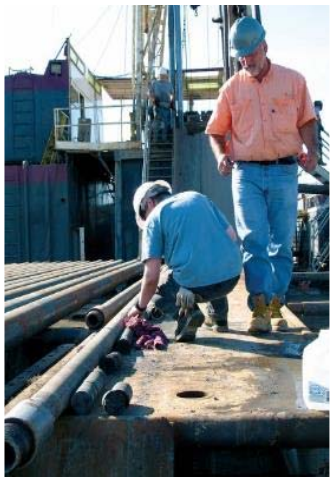
CORE PRIORITIES

- Coal Utilization & Emissions
- Carbon Management
- Oil and Gas
- Alternative Fuels and Renewable Energy
- Energy–Water





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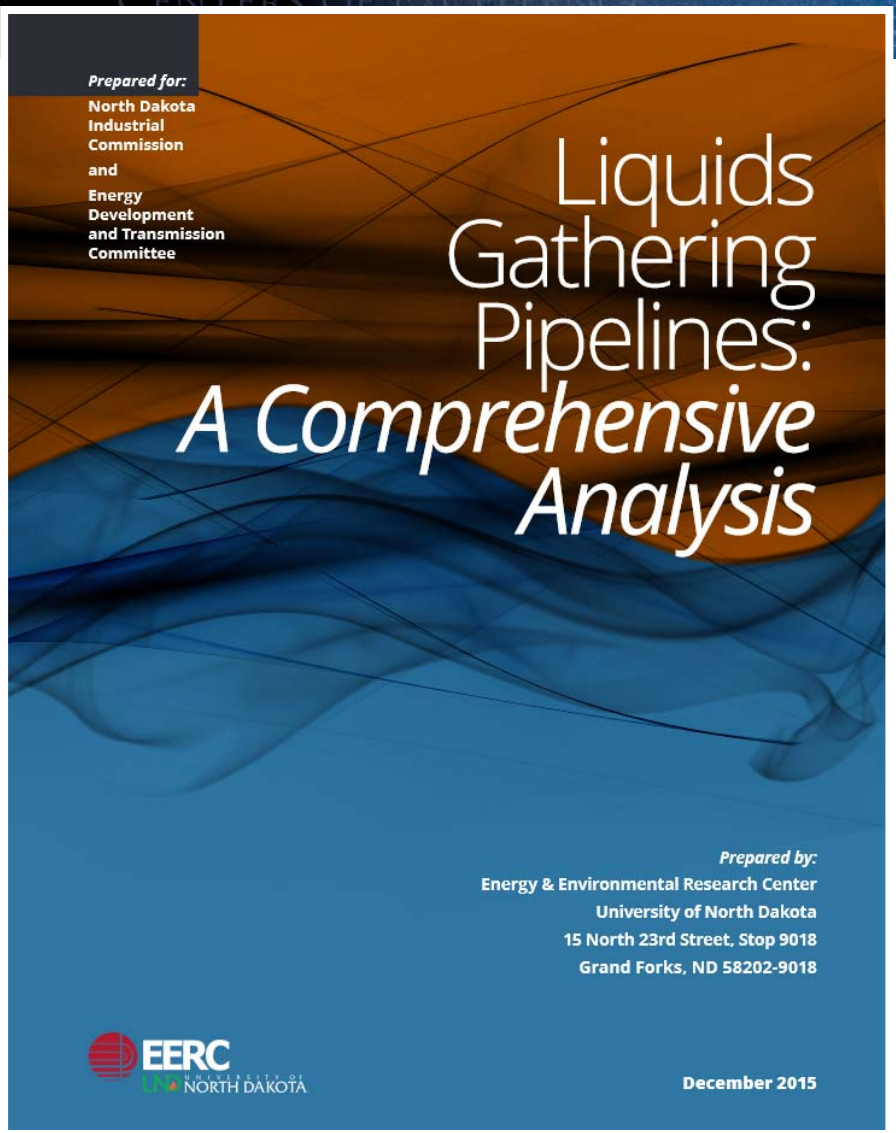
PIPELINE STUDY

- 23 recommendations made to NDIC and EDTC … many now evident in new proposed DMR rule making, currently open to public comment.
- Pilot demonstrations will provide information on the performance of those technologies with greatest potential to lessen the severity of *future* spills and leaks.



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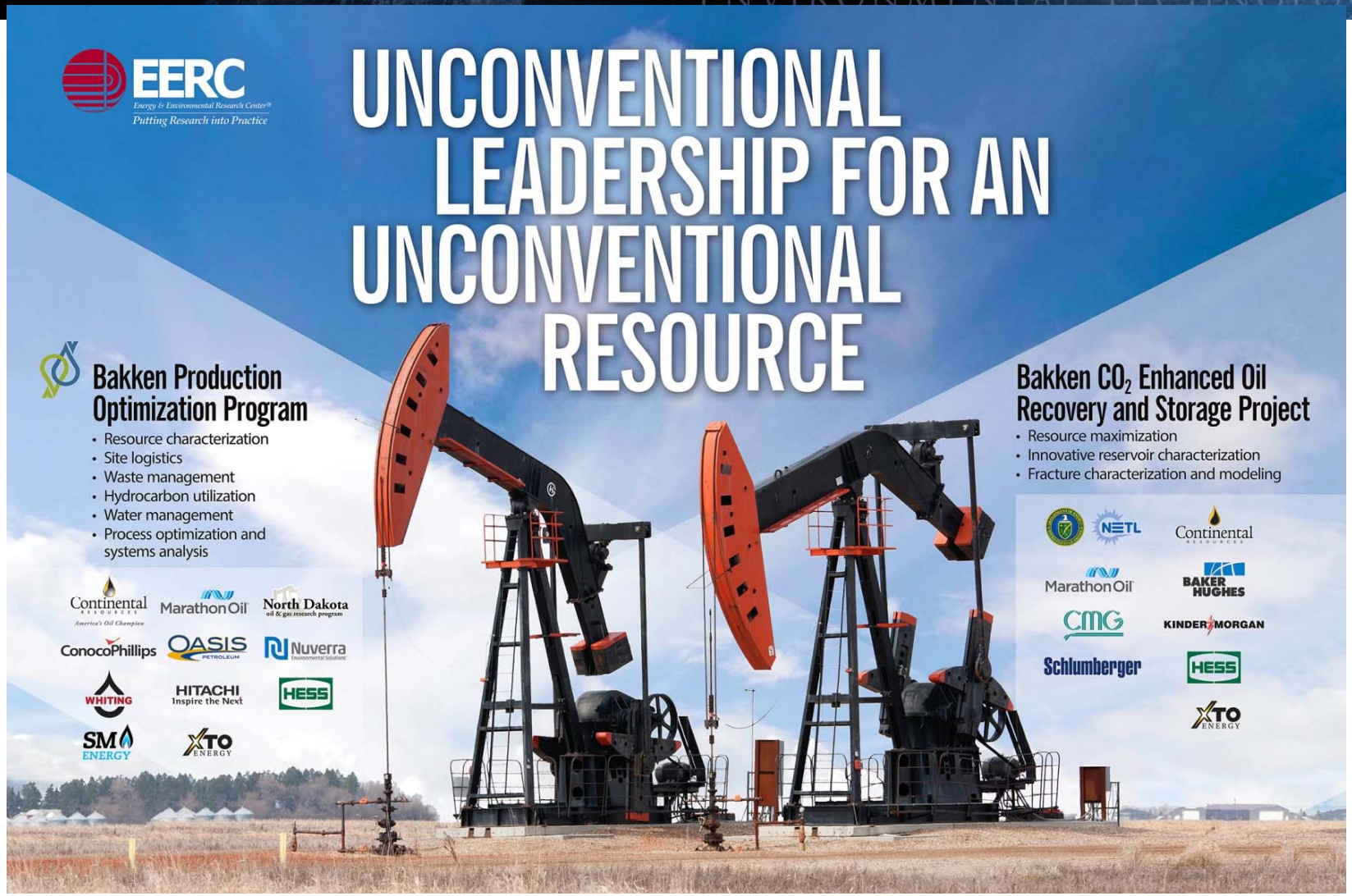
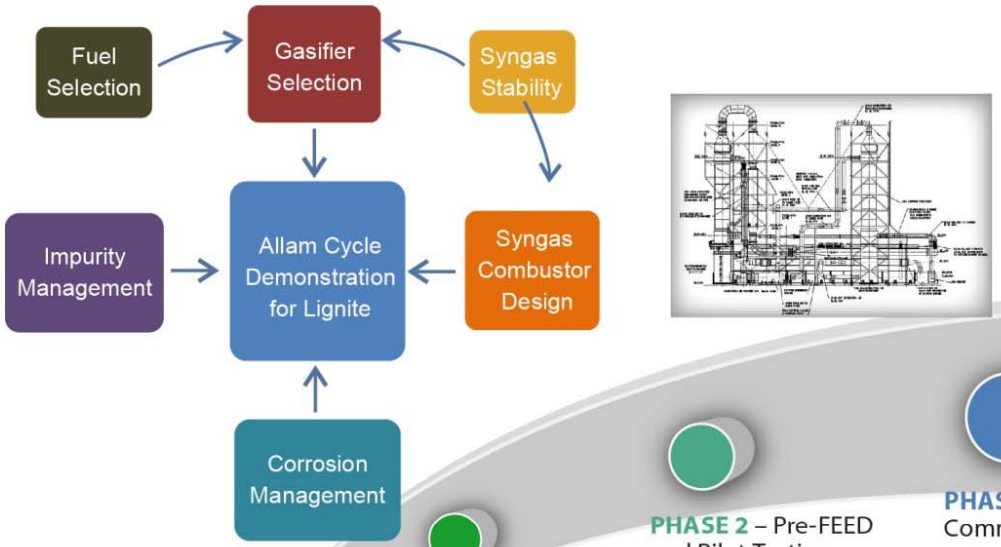
THE BRAVE NEW WORLD – UNCONVENTIONAL RESERVOIRS



ALLAM TECHNOLOGY DEVELOPMENT ROAD MAP

Lignite-Based Allam Cycle Technology Development Road Map



PHASE 1a – Addressing Technical Challenges, $3.18 million
- January – November 2016

PHASE 1b – Key Development Pathways, $5 million–$10 million*
- June 2016–December 2017
- Additional Follow-Up R&D Identified in Phase 1a
- Syngas Combustor Pilot Test

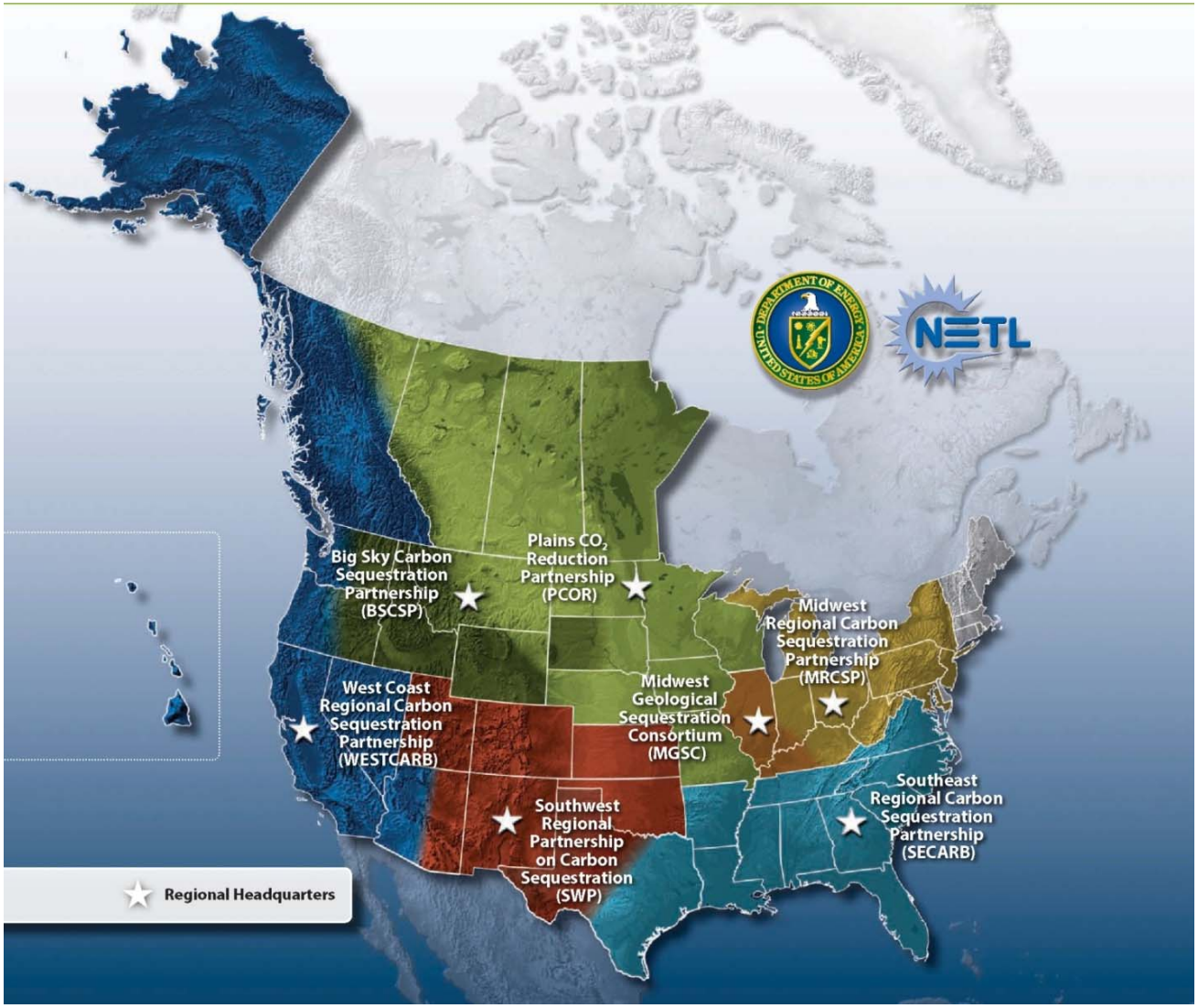
PHASE 2 – Pre-FEED and Pilot Testing, $20 million–$50 million*
- August 2016 – July 2019
- Preliminary Engineering of Commercial Plant
- Engineer, Procure, Construct, and Operate Pilot Plant
- 5–10-MW_e System

PHASE 3 – FEED for Commercial Plant, $10 million–>$30 million*
- August 2019 – July 2020
- Up Through Preliminary Design and Estimates of Commercial Operation

PHASE 4 – Commercial Demonstration, $500 million–>$900 million*
- July 2020–2024
- 100–300-MW_e System
- Detailed Engineering, Procurement, Construction, and Operation

*Costs are estimated and include matching support from federal and industrial sponsors.

PCOR PARTNERSHIP REGION



- Nine states
- Four Canadian provinces
- 1,382,089 mi^2

PCOR PARTNERSHIP

8/16

NORTH DAKOTA
FIELD DEMONSTRATIONS

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BOUNDARY DAM – AQUISTORE

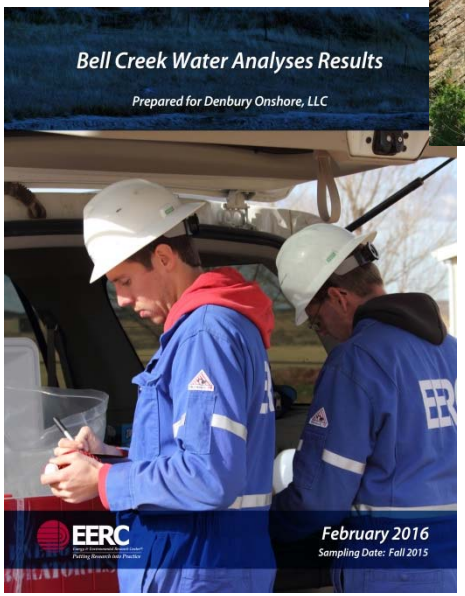
SaskPower

Aquistore

ptrc
Petroleum Technology Research Centre

BELL CREEK

2014
1,000,000
ONE
MILLION
TONNES OF CO2 INJECTED



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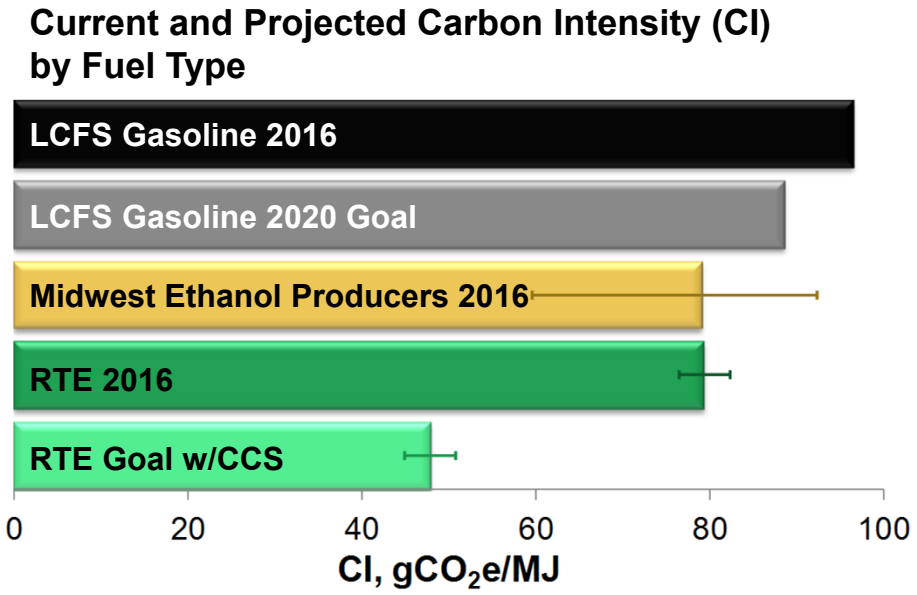
ETHANOL FUTURE WITH CCS



Source: California Air Resources Board (July 2016)

- Maximize California LCFS credits
- Credits based on CI
  - Quantifies carbon footprint
  - Based on cradle-to-grave life cycle analysis (LCA)
- Applicability for Oregon's Clean Fuels Program
  - Passed bill to fully implement in 2016
  - Goal is to reduce average CI by 10% over 10-year period

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PROJECT OBJECTIVES AND SCOPE

1. Feasibility study
   - Capture system assessment
   - Site characterization, modeling, simulation
   - Risk assessment, LCA
2. Field implementation plan (FIP)
   - Capture system design
   - Permitting; monitoring, verification, and accounting (MVA)
   - Well design, characterization, and testing
3. Economic analysis
   - Installation and operating costs
   - Potential revenue

EERC RTE

renewable ENERGY PROGRAM
NORTH DAKOTA INDUSTRIAL COMMISSION

NETL

TRIMERIC CORPORATION

The CETER Group, Inc.

Schlumberger Carbon Services

CMG COMPUTER MODELLING GROUP LTD.

North Dakota: Proud History of Pioneering

Current Situation

Quality of Life

EERC Experience

North Dakota Collective Vision for Energy Resource Management (ERM)

Time to Be Pioneers Again!

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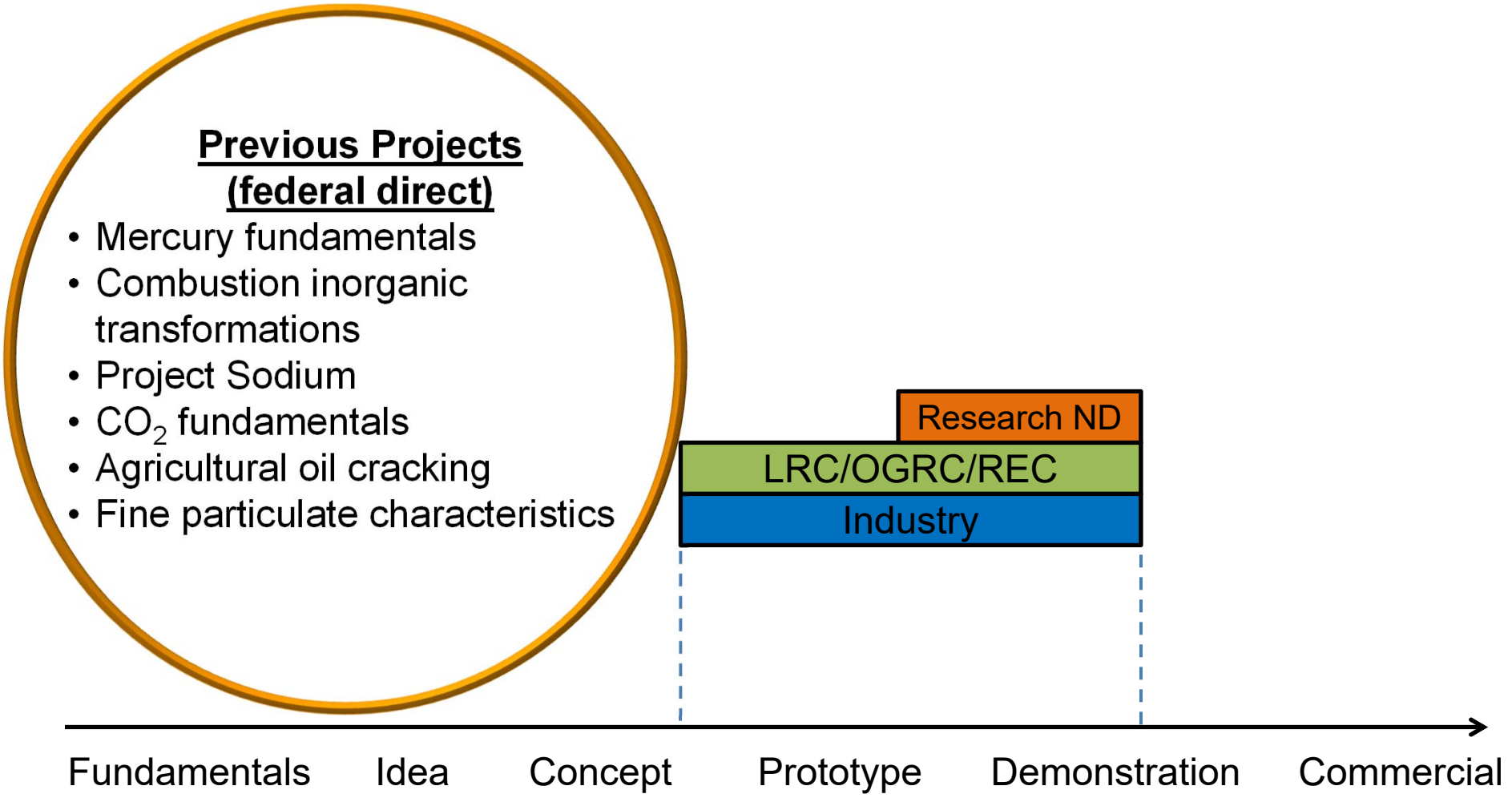
RESEARCH FUNDING



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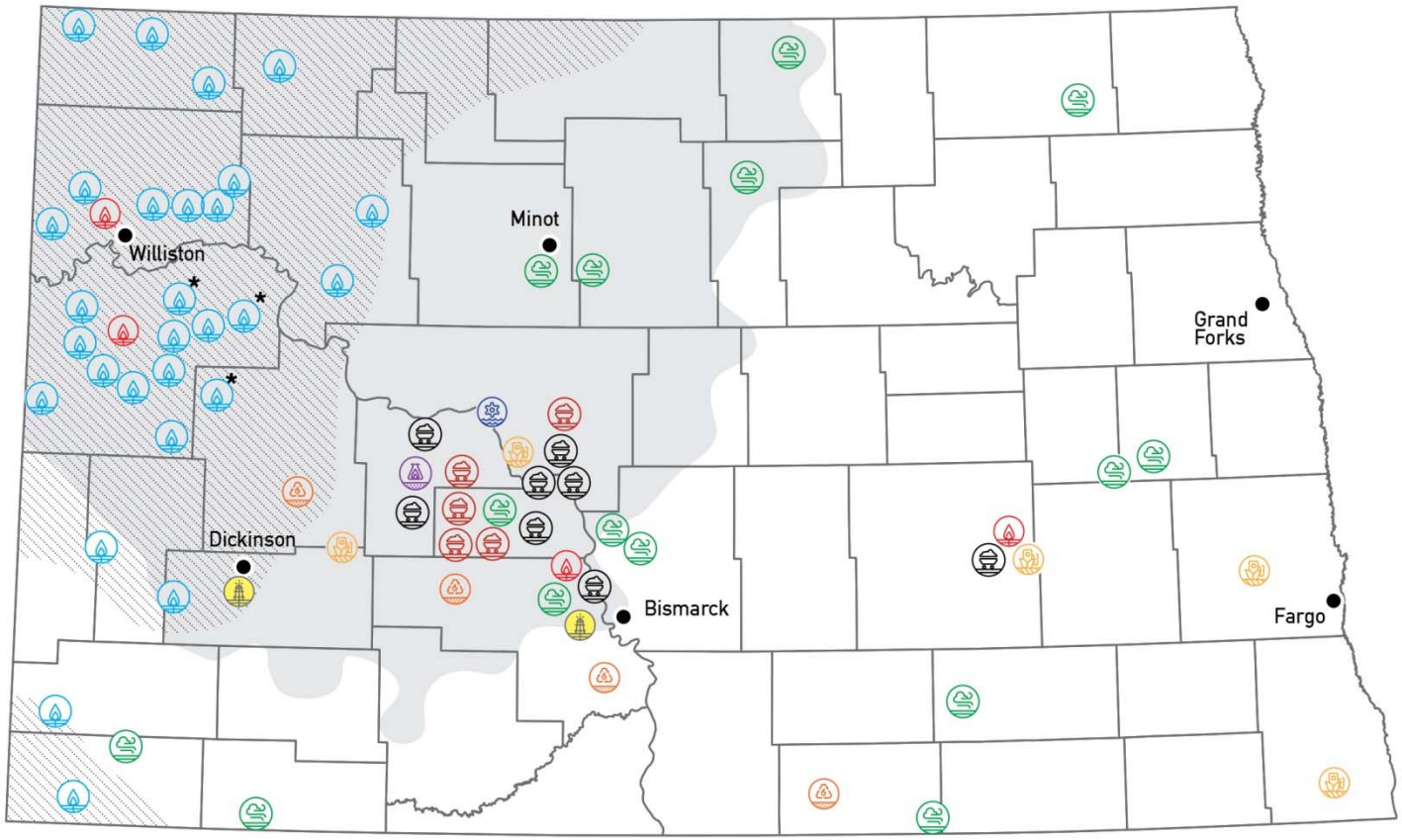
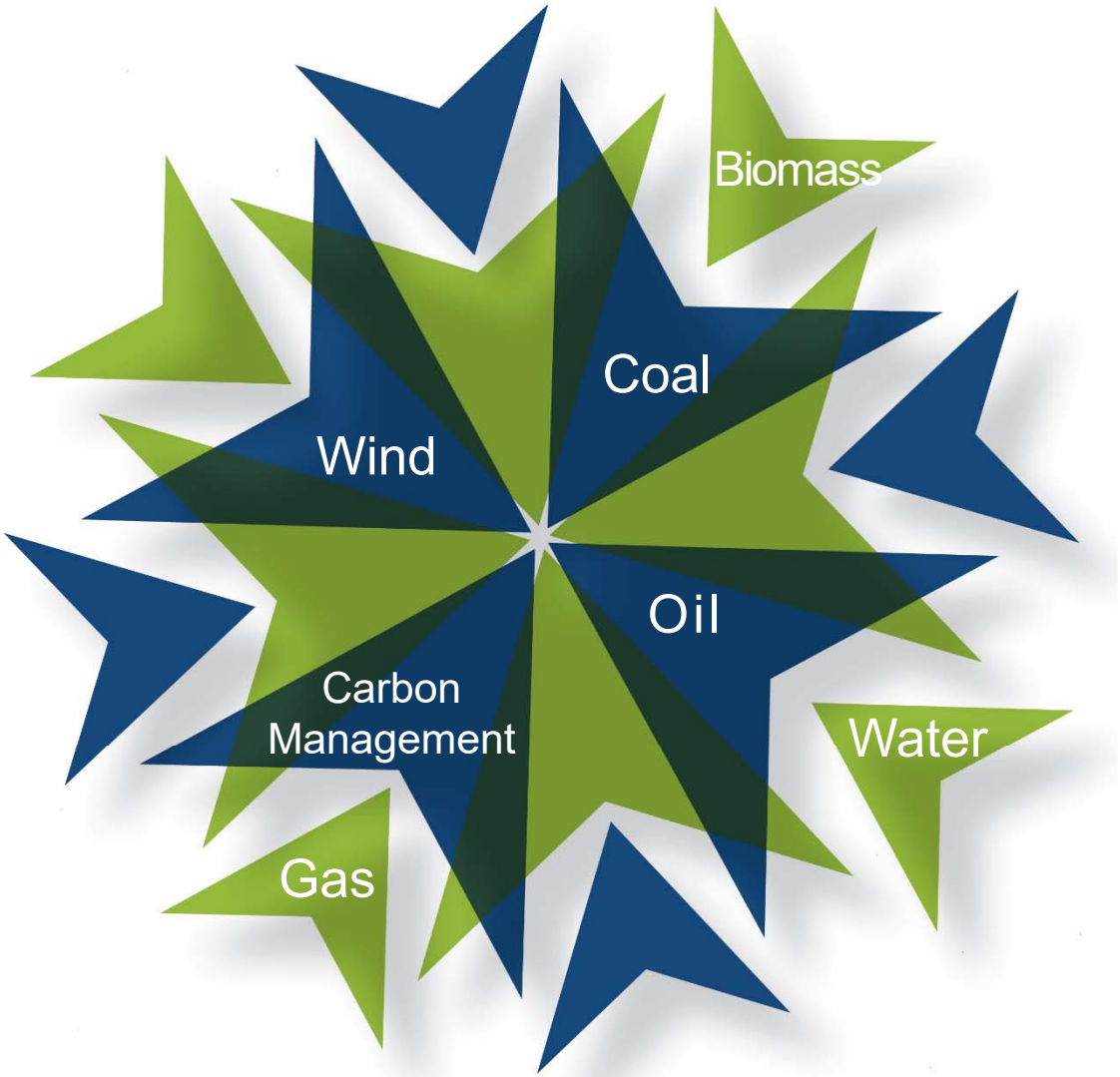
NORTH DAKOTA ENERGY SITES



Map from: *Spotlight on North Dakota Energy 2015*.

WORKING TOGETHER



ENERGIZING ND's FUTURE

- Interim EDTC Meeting
- EmPower Commission
- Energizing ND's Future event
- Joint U.S.–Canada Bakken Workshop

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WE CHOOSE TO…

"We choose to go to the moon in this decade and do the other things, not because they are easy, but because they are hard, because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept…"

– John F. Kennedy, September 12, 1962

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Chemical Looping Combustion (CLC)

Background on CLC:

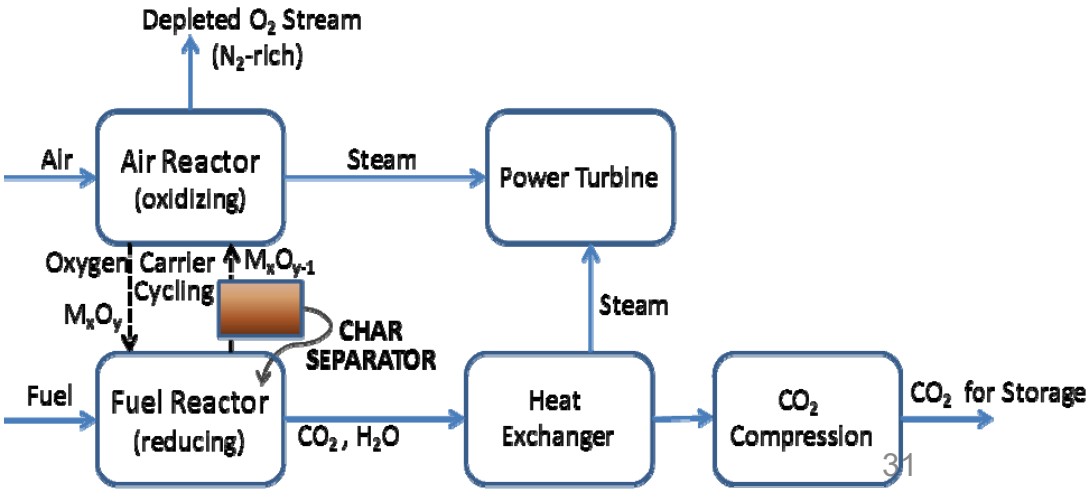
- CLC produces a pure CO_2 product
- No need for expensive and energy-intensive air separation unit (ASU) – by using an oxygen carrier (OC)

Key technical challenges being addressed:

- OC attrition, reactivity and long-term stability
- Optimizing process parameters/reactor design to maximize conversion rates
- Separation of OC from char/ash leaving fuel reactor

Funding:

- 4+ projects - Envergex LLC, US Department of Energy, and General Electric



UND ENGINEERING
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CACHYS™ CO_2 Capture Technology Overview

Project Objective:

- Improve current state-of-the-art (amine scrubbing) by developing a novel sorbent-based, post-combustion CO_2 capture technology

Focus of efforts:

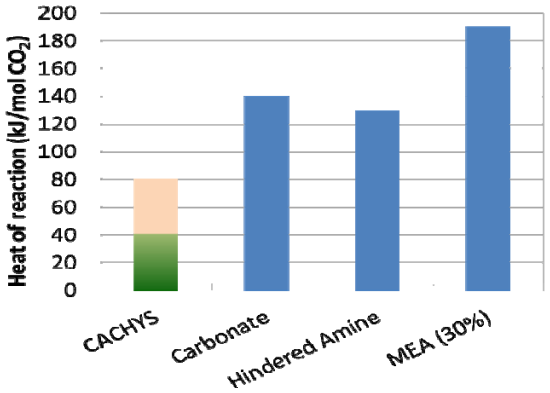
- Low cost chemical adsorbent: supported alkali carbonate – inexpensive materials
- Simple process design: fluidized bed adsorber & moving bed regenerator

Results:

- High CO_2 Capture: >90% from combustion flue gases with E-CACHYS™ sorbents
- Proprietary chemistry/Unique process conditions: faster kinetics/mass transfer, low sorbent regeneration energy

Funding:

- US Department of Energy, ND Industrial Commission, ALLETE, SaskPower, Envergex



UND ENGINEERING
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Technical and Economic Feasibility Analysis of Next Generation Valley City State University Heating Plant

Vision:

- Market disruptive technology of integration of activated carbon (AC) production with steam/electricity generation (lower cost AC)
  - Steam Plant needs fuel, makes steam
  - Carbon plant needs steam, makes fuel
- Provide opportunity to generate revenue for the university system steam plants with multiple carbon products, produced at low cost from ND feedstocks (lignite & biomass)

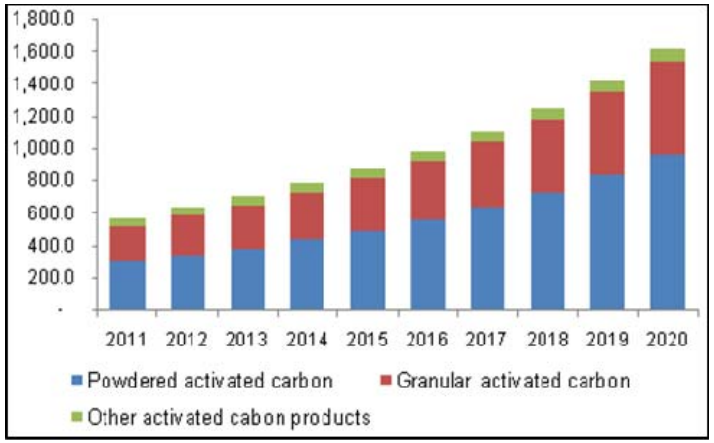
Project:

- Technical and Economic feasibility of a plant co-located at the VCSU steam plant

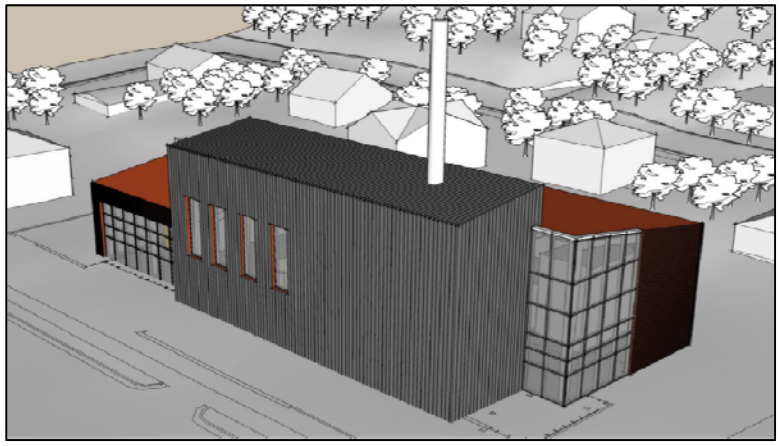
Funding:

- ND Department of Commerce Venture Grant

North American Activated Carbon Market Growth (millions US$)



Valley City Steam Plant



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Investigation of Rare Earth Element Extraction from North Dakota Coal-Related Feed Stocks

Background:

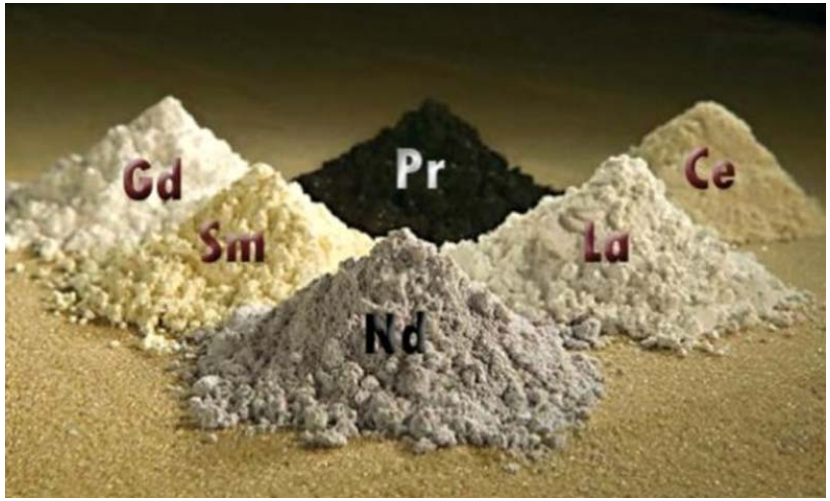
- Analysis of a unique North Dakota coal-related feedstock sources have shown levels of REE+Yttrium over 300 parts per million (ash basis).
- The REEs are mainly associated with the inorganic fraction of the coal in several mineral forms that include phosphates, carbonates, and clay minerals.
- Previous research and preliminary analysis of North Dakota coal-related feedstocks by UND indicates that the REEs are concentrated in the very small particles less than 10 μm in diameter.

Project:

- To develop high performance, economically viable, and environmentally benign concentrating technologies for coal-related feedstocks to REE concentration of 2% by weight

Funding:

- US DOE, ND Industrial Commission, Great River Energy, and North American Coal Company



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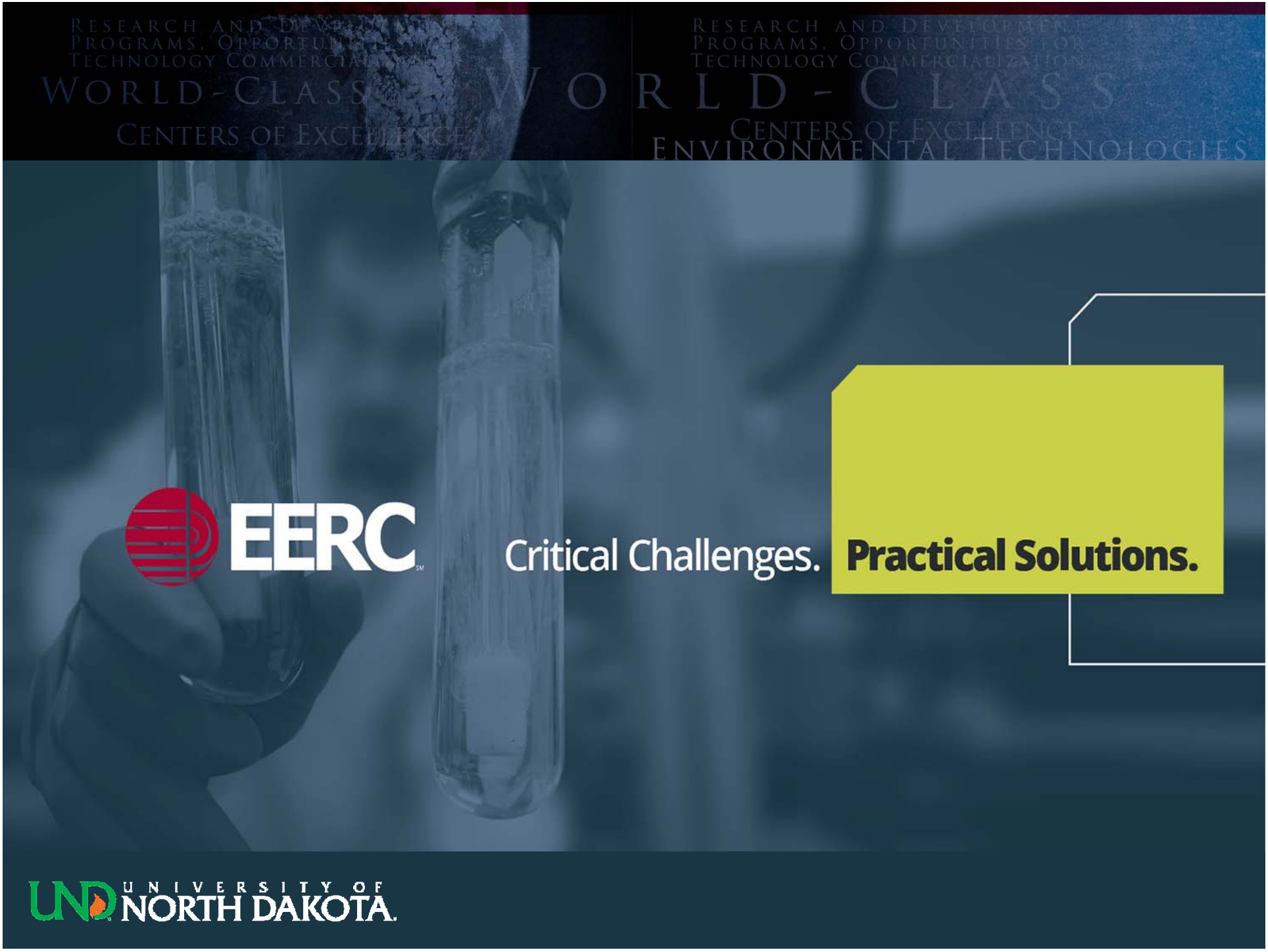
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