Overview of the Energy & Environmental Research Center’s Proposed Bakken Production Optimization Program

NDIC - OGRC
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Bakken Production Optimization Program

A public–private partnership to optimize oil and gas activities and improve the efficiency of operation.

- Tasks executed within the program will be funded by the commercial partners with matching funds from NDIC-OGRC
- Activities directed by the commercial partners, with technical support from the EERC
  - Laboratory, pilot, and field-based
- Results of the project communicated to NDIC-OGRC and other program sponsors
- Proposing ~$1,000,000/yr for three years from NDIC. Requesting ~$200,000/yr from multiple industry partners
Focus areas to be addressed within this proposed program will be developed in collaboration with partners. Preliminarily, the EERC has suggested the following four broad categories:

- **Hydrocarbon utilization**
  - Bi-fuel operation of drilling rigs, hydraulic fracture operations
  - Associated gas use for site operations

- **Water management**
  - Water treatment, recycle, and reuse technologies

- **Site logistics**
  - Evaluation of equipment siting and workflow at multi-operation and/or multi-well locations
  - Site construction materials
  - Environmental challenges

- **Process optimization and systems analysis**
  - Investigation of sources of well failure and development of mitigation strategies
  - Standardization of wellsite design to increase efficiency & reduce cost
  - Emission characterization & testing
Program Goal

• Explore wellsite optimization approaches that have potential to
  – Reduce wellsite costs
  – Improve wellsite production
  – Reduce wellsite development and operation impacts to surrounding land owners
  – Decrease demands on surrounding infrastructure and water sources
Possible Examples of Program Tasks

• Specific tasks will be defined/refined by industry partners and OGRC, but might include tasks such as:
  – Combined NGL recovery and natural gas utilization on-site for power
  – On-site wastewater and hydraulic fracturing fluid recycling to minimize transportation and disposal costs
  – Drilling, workover, and completion rig repowering to enable utilization of associated gas available on-site or nearby
  – Wellsite opportunities that integrate power- and water-related aspects during drilling / workover / completion activities, water transport and utilization, and fuel utilization to achieve cost containment (= max economic output)
  – Means of improving handling/disposal efficiency for drilling and production wastes, including naturally occurring radioactive materials (NORM)
  – Any optimizations that result in a net reduction of truck traffic in and out of the wellsite
Anticipated Results

Environmental
• Less truck traffic
  – Decreased diesel emissions
  – Decreased road damage and subsequent maintenance
  – Decreased road dust
  – Decreased incidence of spills
• Less wastewater production and reduced demand for freshwater supplies
• Less flaring/reduced emissions from flares
• Potential for smaller well pads

Economic
• Increased royalties and tax base from oil, harnessed associated gas and NGL streams
• Increased profits from added product streams, engaged earlier in the well life cycle
• Decreased road maintenance costs
• Decreased costs for water and wastewater hauling and disposal
Industrial Partners to Date

• Committed at Time of Proposal Submittal
  – Marathon Oil
  – Whiting
  – Continental

• Near-Term Commitment Possible from Other Partners
  – Halcón
  – Hess
  – Oxy
  – XTO
  – Oasis
  – Statoil
## Program Schedule

<table>
<thead>
<tr>
<th>Task</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
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<tbody>
<tr>
<td>Program Management</td>
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<tr>
<td>Semi-Annual OGRC Briefings</td>
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<td>Consortium Steering Meetings</td>
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<td>Outreach Activities</td>
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<td>Year 1 Tasks <em>(Detail Developed During Kickoff Mtg)</em></td>
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<td>Year 2 Tasks <em>(Detail Developed During Annual Steering Mtg)</em></td>
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<td>Year 3 Tasks <em>(Detail Developed During Annual Steering Mtg)</em></td>
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## Program 3-Year Budget

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<thead>
<tr>
<th>Project Associated Expense</th>
<th>NDIC Share</th>
<th>Industry Share</th>
<th>Total Program</th>
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<tbody>
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<td>Total Labor</td>
<td>$2,433,292</td>
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<td>Natural Materials Analytical Res. Lab.</td>
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<td>Total Project Cost</td>
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Backup Slides
EERC’s Oil- and Gas-Related Experience and Capabilities
State-of-the-Art Facilities

More than 245,000 square feet of state-of-the art laboratory, demonstration, and office space.
EERC Engineering Capabilities

- The EERC has dedicated staff to carry mechanical and chemical process designs from conception through fabrication and installation.
  - Multiskilled, matrixed engineering and science staff
  - Instrumentation and automation specialists
  - Process design group
  - Mechanical design group
  - Fabrication shop
  - Quality assurance/quality control personnel
  - Skilled technician/operator staff
AGL Equipment

- Optical profilometer
- +20-ton universal compression frame
- Flexible-wall permeameter
- Hoek-style triaxial and core-flood cells
- Scanning electron microscopy (SEM)
- Supergamma spectrometer
- GC-MS
- Thermal dilatometer
- Ion chromatographer
- X-ray diffraction (XRD) and x-ray fluorescence (XRF)
- Helium porosimeter
- Petrographic microscope
Proppant Embedment and Penetration Testing
Modeling and Simulation

Modeling Capabilities

• Log and well test normalization and interpretation
• Petrophysical analysis
• Property modeling, including facies modeling using multiple-point statistics
• Fluid modeling and equation-of-state calibration
• Numerical simulation, including history matching and prediction
Dickinson Lodgepole Mounds
Monitoring and Characterization Well Real-Time Data for Bell Creek Oil Field

Casing-Conveyed Pressure/Temperature Gauges

Distributed-Temperature Fiber Optic Cable
Soil Gas Field Analyses

- Near active wells, and between active wells (interspaced)

- Near plugged and abandoned (P&A) wells (three-spot)

RAE Systems PGM-54 Handheld Multigas Analyzer

- CO₂, total VOCs, O₂, H₂S

Agilent 490 Micro Quad GC (field laboratory)

- CO₂, individual VOCs, N₂, O₂, H₂, H₂S
Soil Remediation

- Joint industry–government-funded programs.
- Remediation of soils impacted by hydrocarbons and gas-processing constituents.

- Complete removal of amines after 200 days of operation.
- Other parameters were below regulatory limits after 300 days of operation.
Innovative Management of Produced Water and Frac Fluids

Produced brine is suitable (ideal) for use in deep (>2200 ft) drilling applications.

Treated water is suitable for use in surface and near-surface (<2200 ft) drilling applications.

In some states, treated water can be used for stock-watering and/or irrigation.


Joint industry–government-funded project.
Project Experience
Gas/Diesel-Powered Drilling Rig
Project Overview

• Tested dual-fuel operation of a Caterpillar 3512 engine at the EERC using simulated rich gas.
  – Butler Machine supplied Caterpillar 3512 engine.
  – Simulated rich-gas mixture produced using bottled/tank-delivered industrial gases and EERC-fabricated gas-metering system.
  – GTI Bi-Fuel® system used to supply gas to engine.
  – Monitored engine performance and emissions over a range of operating conditions and fuel mixtures.

• Field demonstration of gas-powered drilling operations using rich Bakken gas.
  – Two wells drilled using GTI Bi-Fuel system and rich wellhead gas from nearby well.
  – Monitored engine performance, gaseous and diesel fuel use, and emissions.
Rich-Gas Test Results

• Simulated rich-gas tests at the EERC
  – Diesel replacement rates of greater than 40% can be achieved, and the GTI Bi-Fuel system can control fuel use to ensure safe engine operation.
  – Matching engine load with diesel replacement rate is important to prevent poor fuel utilization and to minimize unburned hydrocarbon emissions.
• Field testing of gas-powered drilling operations
  – GTI Bi-Fuel system was operated August–September.
  – The EERC installed a data acquisition system to enable real-time continuous monitoring and logging of engine performance; provided on-site technical support throughout field test.
  – Data analysis and reporting are ongoing; final report will be submitted to NDIC in late 2012.
  – Demonstrated efficient, economical use of wellhead gas; vendor claimed savings of >$3000/day.
Associated Gas Use Study

- Study goal: to evaluate technologies capable of utilizing associated gas upstream of natural gas-processing plants
  - Natural gas liquids recovery
  - Compressed natural gas for vehicle fuels
  - Electrical power generation
  - Chemical production
- Broad contribution from a wide variety of stakeholders
- Study submitted to NDIC July 2012
- Webinar tentatively scheduled November 5, 2012
  - https://www.dmr.nd.gov/pipeline/
Low-Btu Gas Utilization

Low-Btu Gas Utilization:
Thermal Application

Power Generation

- Satellite Communication for Remote Monitoring
- Enclosed Building
- Two 65kW Microturbiners

Modified Burner for Low-Btu Gas
Bakken CO$_2$ EOR Project Goals

- To predict the performance of CO$_2$ EOR in the Bakken using lab experiments coupled with modeling.
  - Quantify phase behavior and fluid properties under reservoir conditions.
  - Compare different Bakken reservoir types.
  - Lab analyses include:
    - Detailed analyses of Bakken reservoir rocks.
    - Effects of CO$_2$ on key oil properties.
  - Modeling activities will:
    - Generate geologic reservoir models.
    - Conduct dynamic simulation modeling.
Recent Bakken Work – Benchmarking Proppants, Stimulation Methods, and Frac Fluids

- **Proppants** (ceramic vs. sand)
- **Stimulation Methods** (sliding sleeves vs. plug and perf vs. combo)
- **Frac fluid types** (diesel-based vs. water-based)
Bakken Water Opportunities Assessment

- **Goals**
  - Evaluate feasibility of recycling frac flowback waters.
  - Assess technical and economic feasibility of upgrading nonpotable groundwater for use in fracs.

- **Outcomes:**
  - Frac flowback quantity and quality data collected from 89 wells, representing five producers.
  - Because of low initial flowback water recovery rates and extremely high dissolved salt content, recycling of Bakken frac flowback water is challenging.
  - A pilot project using reverse osmosis (RO) to treat brackish groundwater was conducted.
  - If access to freshwater sources is limited, RO treatment may be economically feasible.
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