What’s going on in North Dakota with the Bakken?

Kari Cutting, North Dakota Petroleum Council
June 2014
Opportunities:
– ND Economy & Jobs
– Energy Independence

Challenges:
– Crime
– Housing-Rent escalation
– Roads-Traffic
– Regulatory Climate-flaring, waste and transportation
MAKING NORTH DAKOTA #1
One barrel at a time

2006  |  2014

North Dakota production

109,396 barrels of oil per day

1,000,000 barrels of oil per day (almost)
North Dakota Oil & Gas Production

- As of April 2014, North Dakota:
  - Produced over 1 Million bopd
  - Produced over 1 Million MCF/day
  - 1 barrel = $150 in ND economic activity
  - Had just over 10,700 producing wells (69% Bakken-Three forks)
  - Rig Count 188
  - 25,000-35,000 future
  - Two counties McKenzie & Mountrail--#2 in U.S.
MAKING NORTH DAKOTA #1
One barrel at a time

2006 | 2014

North Dakota’s economic ranking

#24 with modest growth

#1 with the fastest growing economy for last 3 years

www.northdakotaoilcan.com   |   www.ndoil.org
# 2005 to 2011 Economic Growth

## Economic Contribution of Petroleum Industry

<table>
<thead>
<tr>
<th></th>
<th>2005</th>
<th>2011</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Economic Contributions</strong></td>
<td>$4.4 billion</td>
<td>$30.4 billion</td>
<td><strong>592%</strong></td>
</tr>
<tr>
<td><strong>Government Revenues</strong></td>
<td>$378 million</td>
<td>$2.6 billion</td>
<td><strong>600%</strong></td>
</tr>
<tr>
<td><strong>Industry Jobs</strong></td>
<td>5,051</td>
<td>40,856</td>
<td><strong>709%</strong></td>
</tr>
<tr>
<td><strong>Household Income</strong></td>
<td>$1.5 billion</td>
<td>$11.6 billion</td>
<td><strong>512%</strong></td>
</tr>
</tbody>
</table>
MAKING NORTH DAKOTA #1
One barrel at a time

2006 | 2014

North Dakota’s per capita income

#40 in the nation, placing ND among the poorest one-fifth in the nation

$$_$$$ behind only Connecticut with wages 28% ABOVE the national average

www.northdakotaoilcan.com | www.ndoil.org
What does each well mean to N.D.? 

- 28 years producing life
- 550,000 barrels of oil
- $7.6 million royalties
- $1.6 million salaries & wages
- $2.3 million operating expenses
MAKING NORTH DAKOTA #1
One barrel at a time

2006 | 2014

North Dakota’s population
ranked 5th Oldest in the nation, with challenges of out-migration of youth
ranked #1 best state for young people & fastest growing population in the nation
1. North Dakota

- Unemployment rate for people age 20-24: **5.1 percent**
- Percentage of the population age 20-24: **9.1 percent**
- Average annual four-year college cost: **$11,092**
- Rental vacancy rate: **6.9 percent**
- Median rental cost: **$644**
- 50-state ranking for broadband Internet access: **17**
- Bars, pubs and nightclubs per million residents: **2,164**
- Fitness clubs per million residents: **124**

It's not exactly a glamour spot, but North Dakota is attracting young people: It now has a higher proportion of people age 18-24 than any other state. Having the lowest youth unemployment rate helps, but what may surprise you is that North Dakota also has more bars, pubs and nightclubs per capita than any state besides Wisconsin.
Domestic production satisfies 84% of total U.S. energy demand in 2013

U.S. energy flow (2013), quadrillion Btu

Source: U.S. Energy Information Administration

Note: Supply equals domestic production, plus imports, plus stock change and other. Consumption equals supply minus exports.
• Opportunities:
  – ND Economy & Jobs
  – Energy Independence

• Challenges:
  – Crime
  – Housing-Rent escalation
  – Roads-Traffic
  – Regulatory Climate-flaring, waste and transportation
FLARING
REGULATORY ACTIVITIES
CRUDE BY RAIL
Why study was initiated?

• Address the following:
  – Volatility?
  – Flammable Liquid or Flammable Gas?
  – Presence of subsidiary hazard?
    • Corrosive?
  – All Analyses conclude Bakken is properly Classified as a Flammable Liquid
  – Three studies all in agreement: NDPC, AFPM and Transport Canada
Testing Protocol

• Testing focused on parameters relevant to DOT hazardous material compliance

• The test slate included:
  – API Gravity
  – Flash Point by ASTM D3278
  – Initial Boiling Point (IBP) by ASTM D86
  – Vapor Pressure by ASTM D6377 at 37.8°C (100°F) *
  – Light Ends Analyses by IP344
  – High Temperature Simulated Distillation (HTSD) by ASTM D7169

* Results about 1 psi higher than if D323 RVP test method is used
### Lab Result Summary

**Sample Date Range**: 3/25 to 4/24/2014

<table>
<thead>
<tr>
<th></th>
<th>Avg</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total (152 Samples)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ambient Temp (°F)*</td>
<td>34</td>
<td>10</td>
<td>65</td>
</tr>
<tr>
<td>API Gravity</td>
<td>41.0</td>
<td>36.7</td>
<td>46.3</td>
</tr>
<tr>
<td>Vapor Pressure (PSI)</td>
<td>11.7</td>
<td>8.9</td>
<td>14.4</td>
</tr>
<tr>
<td>D86 IBP (°F)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>99.5 (PG II)</td>
<td>91.9 (PG I)</td>
<td>106.8 (PG II)</td>
</tr>
<tr>
<td>Light Ends (C2-C4s)</td>
<td>5.48</td>
<td>3.52</td>
<td>9.30</td>
</tr>
<tr>
<td><strong>Rail (49 Samples)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ambient Temp (°F)*</td>
<td>29</td>
<td>10</td>
<td>47</td>
</tr>
<tr>
<td>API Gravity</td>
<td>41.7</td>
<td>39.2</td>
<td>44.0</td>
</tr>
<tr>
<td>Vapor Pressure (PSI)</td>
<td>11.5</td>
<td>9.6</td>
<td>12.9</td>
</tr>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>100.3 (PG II)</td>
<td>96.7 (PG II)</td>
<td>104.1 (PG II)</td>
</tr>
<tr>
<td>Light Ends (C2-C4s)</td>
<td>4.95</td>
<td>3.91</td>
<td>6.44</td>
</tr>
<tr>
<td><strong>Well (103 Samples)</strong></td>
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<td></td>
<td></td>
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<tr>
<td>Ambient Temp (°F)*</td>
<td>36</td>
<td>11</td>
<td>65</td>
</tr>
<tr>
<td>API Gravity</td>
<td>40.6</td>
<td>36.7</td>
<td>46.3</td>
</tr>
<tr>
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<td>11.8</td>
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<td>91.9 (PG I)</td>
<td>106.8 (PG II)</td>
</tr>
<tr>
<td>Light Ends (C2-C4s)</td>
<td>5.76</td>
<td>3.52</td>
<td>9.30</td>
</tr>
</tbody>
</table>

*Some later samples missing Ambient Temp readings, may skew results colder

→ **API/Vapor Pressure**
Typical For Light Crude

→ **Packing Group**
Crude Currently Categorized/Transported as Expected

Rail Cars Used Rated For 100 PSI Transport
• Average API Gravity of 41 °
  – Consistent as a light crude oil
• Average Vapor pressure 11.5-11.8 psig
  – 61% below regulatory threshold
• Flashpoint <73 °F
  – Consistent for flammable liquid, Packing Group I or II
• Initial Boiling Point midpoint 95 °F
  – Consistent for flammable liquid, Packing Group I or II
• Low H2S & Total Acid Number (TAN)
  – No corrosivity
Class 3 Flammable Liquid, Packing Group I or II

• Defined by Hazardous Materials Regulations (HMR) as having the characteristics:
  – Material is a liquid at 68 °F (room temperature)
  – Material has Vapor Pressure <43.5 psig at 122 °F
  – Flashpoint <73 °F and:
    • Initial boiling point >95 °F - Packing Group II
    • Initial boiling point ≤95 °F - Packing Group I
  – Bakken = Flammable Liquid, PG I or II
Class 3 Flammable Liquid, Packing Group I or II

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  - Material is a liquid at 68°F (room temp.)
  - Material has Vapor Pressure <43.5 psig at 122°F
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– Bakken = Flammable Liquid, PG I or II
Vapor Pressure

- BKN Average Vapor pressure 11.5-11.8 psig (Mar-Apr)
  - 61% below regulatory threshold
- Seasonality (Rail terminal data outside control data set)
• Three labs* tested four identical Bakken crude samples for the following:
  – API Gravity by ASTM D5002
  – Vapor Pressure of Crude at 37.8°C (100°F), 4:1 V/L Ratio, by ASTM D6377
  – Initial Boiling Point (IBP) by ASTM D86 distillation

*Two in North Dakota and one in Louisiana
Round Robin Testing - Summary

• Excellent agreement on API Gravity and Vapor Pressure
  – Supports sample integrity maintained throughout transport and good lab performance

• Poor agreement on D86 IBP
  – Results for the same sample in each case fall on either side of the 95°F level used for PG I/PG II determination
  – Underscores shortcomings of tests required by PHMSA
  – API committee studying this, as well as alternatives
Results – D86 IBP

- All samples fall within Class 3 – Either PG 1 or 2
  - Shipped in same rail cars, same EMS response
- PHMSA prescribed methodology may not be optimal test for crude oil
  - Not designed for wide boiling range materials like crude oil
  - As a result, poor agreement on Packing Group determination

<table>
<thead>
<tr>
<th>Sample Location</th>
<th>Date @ Time</th>
<th>Intertek Mandan</th>
<th>SGS St. Rose</th>
<th>SGS Williston</th>
<th>Max Delta</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>5/1/14 @ 16:30</td>
<td>89.9</td>
<td>95.4</td>
<td>101.8</td>
<td>11.9</td>
</tr>
<tr>
<td>2</td>
<td>5/1/14 @ 16:30</td>
<td>83.1</td>
<td>89.1</td>
<td>102.6</td>
<td>19.5</td>
</tr>
<tr>
<td>3</td>
<td>4/30/14 @ 16:00</td>
<td>87.8</td>
<td>90.7</td>
<td>105.5</td>
<td>17.7</td>
</tr>
<tr>
<td>4</td>
<td>5/1/14 @ 16:30</td>
<td>89.2</td>
<td>94.5</td>
<td>102.2</td>
<td>13.0</td>
</tr>
</tbody>
</table>
Is Bakken corrosive?

- HMR defines corrosive material
  - Corrode steel or aluminum at rate of 0.25 inch per year
  - Bakken average sulfur is <0.10, low TAN
  - Bakken is not corrosive
Consistent Quality – Rail vs. Well

- Quality is consistent between well and rail
- Indicates there is no spiking of crudes before shipment

<table>
<thead>
<tr>
<th>Light Ends %</th>
<th>Well</th>
<th>Rail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethane</td>
<td>0.24</td>
<td>0.23</td>
</tr>
<tr>
<td>Propane</td>
<td>1.63</td>
<td>1.40</td>
</tr>
<tr>
<td>Isobutane</td>
<td>0.66</td>
<td>0.58</td>
</tr>
<tr>
<td>n-Butane</td>
<td>3.18</td>
<td>2.75</td>
</tr>
<tr>
<td>n-Pentane</td>
<td>2.92</td>
<td>2.72</td>
</tr>
<tr>
<td>C2-C4s</td>
<td>5.76</td>
<td>4.95</td>
</tr>
<tr>
<td>C2-C5</td>
<td>10.22</td>
<td>9.10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SimDist (°F)</th>
<th>Well</th>
<th>Rail</th>
</tr>
</thead>
<tbody>
<tr>
<td>IBP</td>
<td>&lt;97</td>
<td>&lt;97</td>
</tr>
<tr>
<td>5%</td>
<td>107</td>
<td>114</td>
</tr>
<tr>
<td>10%</td>
<td>155</td>
<td>166</td>
</tr>
<tr>
<td>20%</td>
<td>233</td>
<td>239</td>
</tr>
<tr>
<td>30%</td>
<td>312</td>
<td>317</td>
</tr>
<tr>
<td>40%</td>
<td>396</td>
<td>397</td>
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<tr>
<td>50%</td>
<td>483</td>
<td>483</td>
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<tr>
<td>60%</td>
<td>574</td>
<td>574</td>
</tr>
<tr>
<td>70%</td>
<td>673</td>
<td>672</td>
</tr>
<tr>
<td>80%</td>
<td>787</td>
<td>789</td>
</tr>
<tr>
<td>90%</td>
<td>936</td>
<td>943</td>
</tr>
<tr>
<td>95%</td>
<td>1055</td>
<td>1061</td>
</tr>
<tr>
<td>FBP</td>
<td>1271</td>
<td>1278</td>
</tr>
</tbody>
</table>
Loading vs. Destination Testing

- 5 Railcars loaded in North Dakota - Discharged at St. James, Louisiana

<table>
<thead>
<tr>
<th>Test</th>
<th>Units</th>
<th>Avg. ND Rail Terminal Car Samples</th>
<th>Avg. St. James Rail Terminal Car Samples</th>
<th>Avg. NDPC Data for Same Rail Terminal</th>
</tr>
</thead>
<tbody>
<tr>
<td>VPCR 4 (37.8° C)</td>
<td>psi</td>
<td>10.47</td>
<td>10.61</td>
<td>10.45</td>
</tr>
<tr>
<td>IBP</td>
<td>°F</td>
<td>94.7</td>
<td>90.4</td>
<td>101.7</td>
</tr>
<tr>
<td>Flash Point</td>
<td>°F</td>
<td>&lt;50</td>
<td>&lt;50</td>
<td>&lt;73</td>
</tr>
<tr>
<td>H2S in Vapor Phase</td>
<td>ppm v/v</td>
<td>&lt;1</td>
<td>&lt;1</td>
<td></td>
</tr>
<tr>
<td>C2-C4s</td>
<td>Vol %</td>
<td>4.00</td>
<td>4.08</td>
<td>4.23</td>
</tr>
<tr>
<td>C2-C5s</td>
<td>Vol %</td>
<td>8.01</td>
<td>7.89</td>
<td>8.13</td>
</tr>
</tbody>
</table>
Remaining Work

• Analyze operating conditions/quality data
  – Ambient Temperatures
  – Separator and treater temps and pressures
  – Production rates/last movements out of tank
  – Tank heights
  – Vapor capture status

• Develop field operating standards at well site operations

• Final Report to be issued in late June

• Establish BKN Benchmark
Establish BKN Benchmark

• Define BKN specifications
• Value:
  – Create reference point for buyers and sellers
  – Producers will follow specific field standards to meet BKN specs
  – Ensure proper BKN oil characterization, now and future
Questions?
DOT-111 Railcar Specifications

- Bakken Average Vapor Pressure 11.5 – 11.8 psig
- DOT-111 Railcars
  - Shell designed to 100 psig
  - Pressure relief value set at 35 psig
  - 240 psig minimum design burst pressure
  - BUILT IN SAFETY MARGIN
New RC design: Jacketed 9/16”

- Compared to non-jacketed 1/2” shell RC
  - Heavier—less capacity
  - 10 - 14.5% less capacity
  - 415 - 620 additional unit trains per year
- Compared to jacketed 7/16” RC:
  - Heavier—less capacity
  - 1.5 - 6% less volume
  - 60 - 265 additional unit trains per year
Federal Wells in N.D.

- Dakota Prairie Grasslands
  - Rigs = 1 (federal surface)

- Fort Berthold Reservation
  - Rigs = 24 (9 fee & 15 trust lands)
  - 300,777 bopd
  - 1200 active wells
  - Total future 3400 wells