Plastics: The Next Boom for North Dakota?
North Dakota Planning Association, 2019

planning for a petrochemicals future
a scenario for North Dakota 2020-2040
Commissioner Fedorchak advocated in-state use of NGLs years ago

Bakken Midstream believes the state could become a leader in value-added natural gas related products

Lt. Gov. Sanford promotes petrochemicals at the 2019 Bakken Expo

Gov. Burgum recently visited Canada

Sen. Majority Leader Wardner promotes petrochemicals facility
• “The amount of gas we are producing far exceeds the needs of a petrochemical plant as we understand them,” he (Shawn Kessel, Deputy Commerce Commissioner) said. “And the amount of natural gas production as a percentage is going higher, so it appears we will have enough supply for enough years to make a petrochemical industry very attractive in North Dakota.”

• The legislature’s renewal of tax incentive, with midstream production, will be helpful, Kessel believes.
from Williston Herald, May 15, 2019:

• “They are going to need things like collection pipes,” Kessel said. “They are going to need rail facilities eventually. They are going to need workforce, and a geology, because both of these steps will require underground storage. So they will need appropriate geology in place to help them with that.”

• “A plastics manufacturing operation in the Bakken region would have significant cost advantages in the form of discounted ethane available for chemical feedstock, and then also discounted natural gas to fuel the energy-intensive operations and cracking furnaces,” said Greg Haas, with Stratas Advisors.
Barr has been studying this issue for a few years

In 2017, Barr began work on valuable materials recovery from produced water

- NDIC funded 1% conceptual design of chemical processing facility (Contract #G-045-085)
  - economically attractive production of valuable chemicals from produced water is possible
  - local markets exist for several products

In 2019, Barr updated the electric power forecast for 2020 – 2040 in North Dakota

- electric power consumption will increase due to increased oil & gas production and processing
- population is expected to increase
- NG processing, and NGL takeaway will be bottlenecks for years to come

In this presentation, we’ve put the numbers together in one convenient place
• **ethane**: the largest component of associated gas other than methane. Ethane has no market or use locally and is blended with either NGLs or natural gas to simply get rid of it.

• dealing with ethane and NGLs is critical to meeting NDIC gas capture targets

situation in western North Dakota
North Dakota Captured* NGL’s – Aug. 2019

*Non-flared NGL’s & Assumes 10 GPM
• about 300,000 bbl/day = 7.4 million tons/year currently produced

• Northern Border Pipeline has high ethane and no ability to take away more

• ethane is nearly valueless in North Dakota – sold as fuel with methane which is < $1/MMBTU in AECO (Alberta) and ~$2/MMBTU in Ventura Iowa

• equates to $90/ton as fuel, typically worth $150/ton as chemical (in Mont Belvieu, TX) (0.18/gal)

• this could make 7.1 million tons/year of PE resin worth $4.7 billion/year
  - average pricing of $0.66/lb for HDPE

• or it could make 14 million tons/year of PVC resin worth $12 billion/year
  - average pricing of $0.88/lb

• or it could make 1 million tons/year of CPVC (100% of global market) worth $2 billion/year + 13 million tons PVC worth $11 billion/year
  - total = $14 billion/year
getting the chlorine: chlor-alkali in North Dakota

what is Chlor-Alkali?

• process separates sodium and chloride from salt
• recycles produced water as feedstock, otherwise goes to saltwater disposal well (SWD)
• prime focus is on the manufacture of commodity materials (acid, caustic, chlorine)
• requires a large amount of electric and thermal energy for processing
• produces hydrochloric acid for the local industry, large use for well cleaning
• UND/Barr project verified that Bakken produced water can be a source of high quality salt feedstock to chlor-alkali process
• Barr is continuing work to reduce costs of chlor-alkali process in ND
where does the salt come from?

from North Dakota Pipeline Authority:

• the WOR (water oil ratio) in the Bakken for June 2019: 1.165
• total statewide water for June 2019: 60,250,776 bbl
  • ~2.0 million BPD of water
produced water: is currently disposed of into the Dakota Formation and represents a cost. Volume will continue to increase in the future. Various efforts to reuse or recycle it have so far been uneconomic. There are environmental and economic pressures to find a better disposition for the produced water. The produced water from the Bakken contains saturation levels of salt, primarily sodium chloride. The challenge is to find an economic use for the constituents.
### Trends in PVC

- Consumption expected to keep growing by 3.5%/year
- Feedstock costs drive economic viability; many VCM plants idled because of high costs, global capacity utilization < 70%
- Most PVC producers (India, Indonesia, Norway) must import ethane or ethylene
- Ethane is shipped from US to UK, Norway, Sweden, India, and Brazil, and may soon ship to China
- China makes VCM using coal; environmentally disastrous operation
- New environmental regulations are making legacy producers less competitive
- US produces 8 million tons/year and consumes 6 million tons/year, largest net exporter
- Biggest customer regions: India, Middle East, Africa, South America, CIS, Southeast Asia
will it work in North Dakota?

- easier to ship plastic pellets out on rail than ethane and more potential markets
- PVC production costs in North Dakota will be comparable to US Gulf Coast
- North Dakota has lower ethane costs than US Gulf Coast or East Coast
- Regulated electric rates in North Dakota are comparable to US Gulf Coast
- salt for chlor-alkali readily available from produced water (10x saltier than sea water)
- hurricanes prove that US needs more than one source region for major petrochemicals
  - Gulf Coast is not always a safe location for chemicals manufacture
  - Ohio River Valley is fast becoming new petrochemicals hub
  - North Dakota can be a third location
- geographic center of North America is in North Dakota; we have good rail access to west coast and Great Lakes Region
how do we get there from here?

- Produced Gas Gathering Flaring Reduction
- Produced Water Gathering Class 1 Disposal Wells
- Salt Recovery Chlor-Alkali
- 3000 Mw - 4000 Mw Power/CoGen
- Gas Processing NGL Fractionation De-Ethanizers
- Ethane Cracker
- Ethane Storage
- Railroad Upgrades
- 7500 New Workers Operator Training

$14 Billion CPVC/PVC Industry
Running the numbers

Making 14 million tons/year PVC & CPVC will require:

- 7.4 million tons/year ethane (100% of North Dakota supply)
- 7.9 million tons/year chlorine
- 20,000 GW-Hr/year electric energy or 2300 MW new capacity @80% c.f.
- Rail loading/transport for 1,100 unit trains/year
- 7,000 new trained highly skilled workers
underground storage for ethane

- storage in Prairie Salts
- storage in Dakota aquifer
- reinjection to Bakken/Three Forks (with EOR)
- interconnect to Canadian system for storage

Major Gas Pipeline and Processing Infrastructure
running the numbers

making 7.9 million tons/year chlorine will require:

- 13 million tons/year of salt (sodium chloride)
  - recovered from 680,000 bbl/day of produced water (34% of current supply)
  - 20,000 GWh/year of electric energy
- 20 world class chlor-alkali facilities (400,000 ton size)
- will co-produce
  - 9 million tons / year caustic soda = $5 billion
  - and 200,000 tons / year hydrogen
Running the numbers

Generate 29,000 GWh/year additional electricity:

- In 2018, the oil producing region of North Dakota used 10,500 GWh; without PVC, load is projected to grow to 17,000 GWh in year 2039.
- Salt and chlorine will require additional 20,000 GWh/year.
- Ethane cracking and related operations requires another 2,000 GWh/year.
- 5 large new power plants (typical 750 MW combined cycle)
  - Together they consume 470 million cubic feet/day natural gas (about 600 - 700 MMSCFD is flared)
  - Require 12,000 gpm water for evaporative cooling
  - 30-40 skilled workers for each new power plant
railroads

requirements to ship products:

• 14 million tons plastic pellets = 1,100 unit trains per year
• 9 million tons caustic solution = 1,400 unit trains per year
• rail infrastructure exists on the north side of Lake Sakakawea
• more than half of the ethane is south of Missouri River
  – rail infrastructure must be developed
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<th>PVC consumption globally is 50 million tons/year</th>
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<tr>
<td>ND production could be 30% of global consumption</td>
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<td>PVC production capacity in North America is 8.8 million tons/year</td>
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<td>ND production could triple North America capacity</td>
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<td>by 2020, China is expected to produce 27 million tons/year</td>
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<td>China is largest producer and consumer of PVC and now a net exporter</td>
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<td>80% of Chinese product is from calcium carbide method using coal</td>
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<td>$5 billion caustic soda ~ 1/3 of North America market</td>
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<td>North Dakota exports 6 million tons/year soybeans and 7 million tons/year corn</td>
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<td>PVC is approximate tonnage shipped as corn + beans</td>
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Return on resources comparison
resources to net $1 million direct benefit for North Dakota residents & governments

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<th>$1 million from PVC &amp; CPVC requires:</th>
<th>$1 million from oil requires:</th>
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<td>• 1.8 skilled employees</td>
<td>• 2.6 skilled employees</td>
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<tr>
<td>• $1.1 million total resin sales</td>
<td>• $3.4 million oil and gas sales</td>
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<td>• calculated by Barr</td>
<td>• calculated from data in 2017 NDSU report</td>
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$14 billion resin sales + $5 billion caustic soda results in $31.7 billion gross business volume = 1.67 economic multiplier

$19.5 billion oil and gas sales results in $32.6 billion gross business volume = 1.67 economic multiplier

Conclusion: plastics production is a high margin business; North Dakota is energy rich and workforce constrained; very likely that North Dakota will move towards plastics to capture more value from available resources