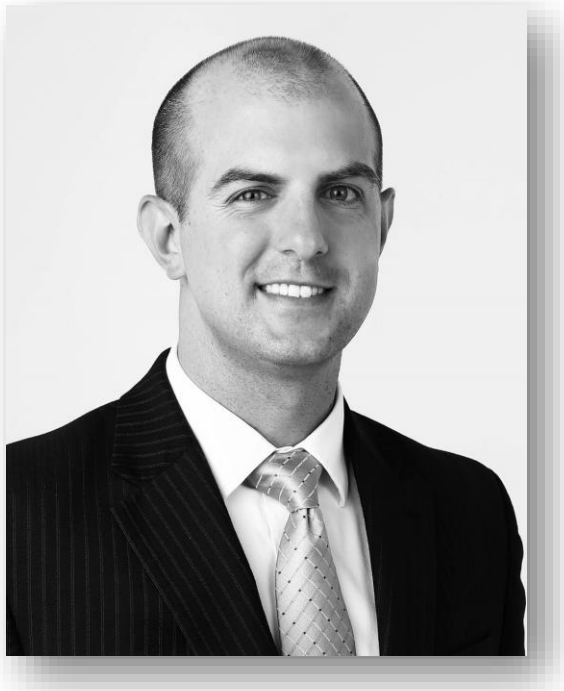
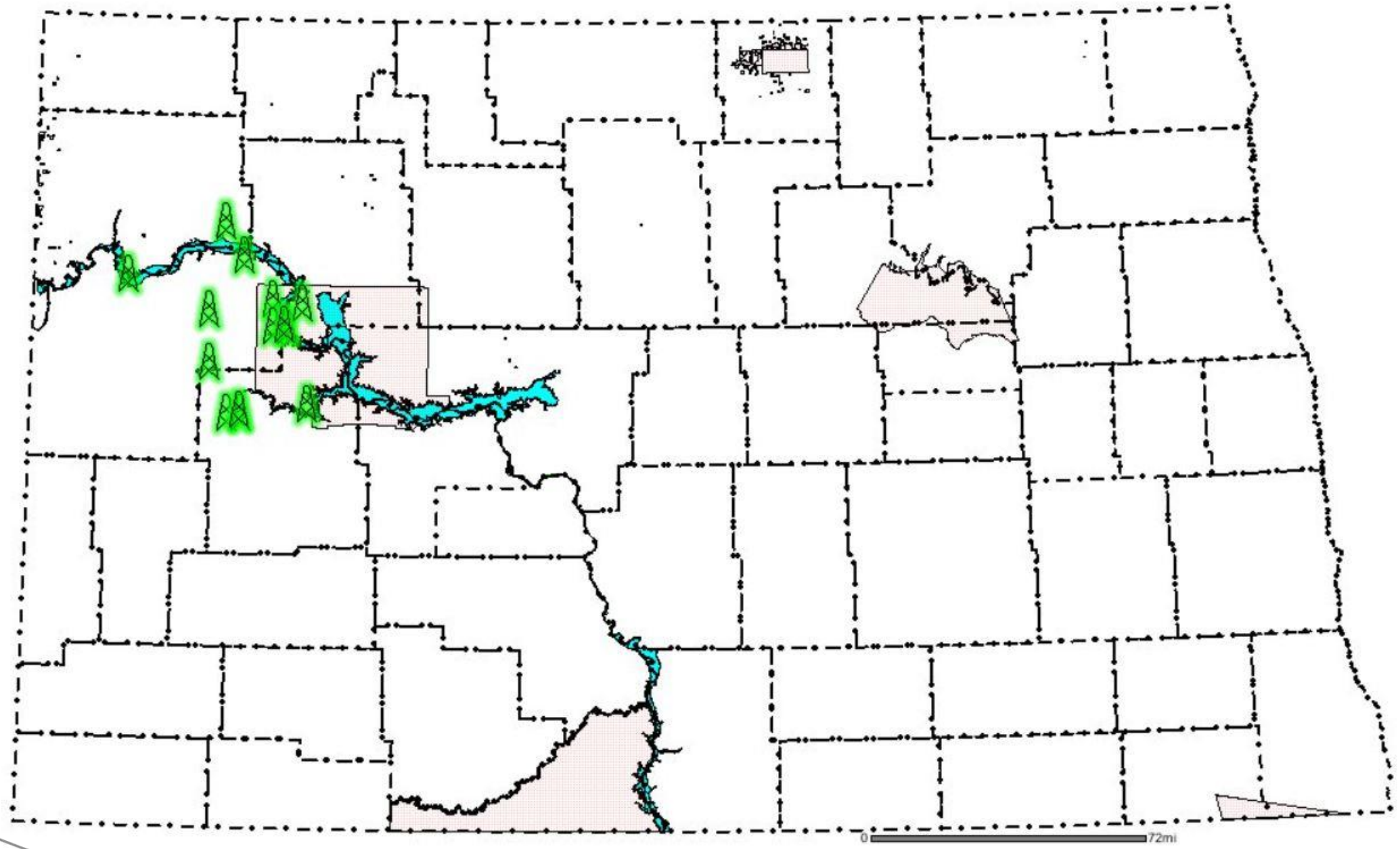
North Dakota Oil & Gas Research Program



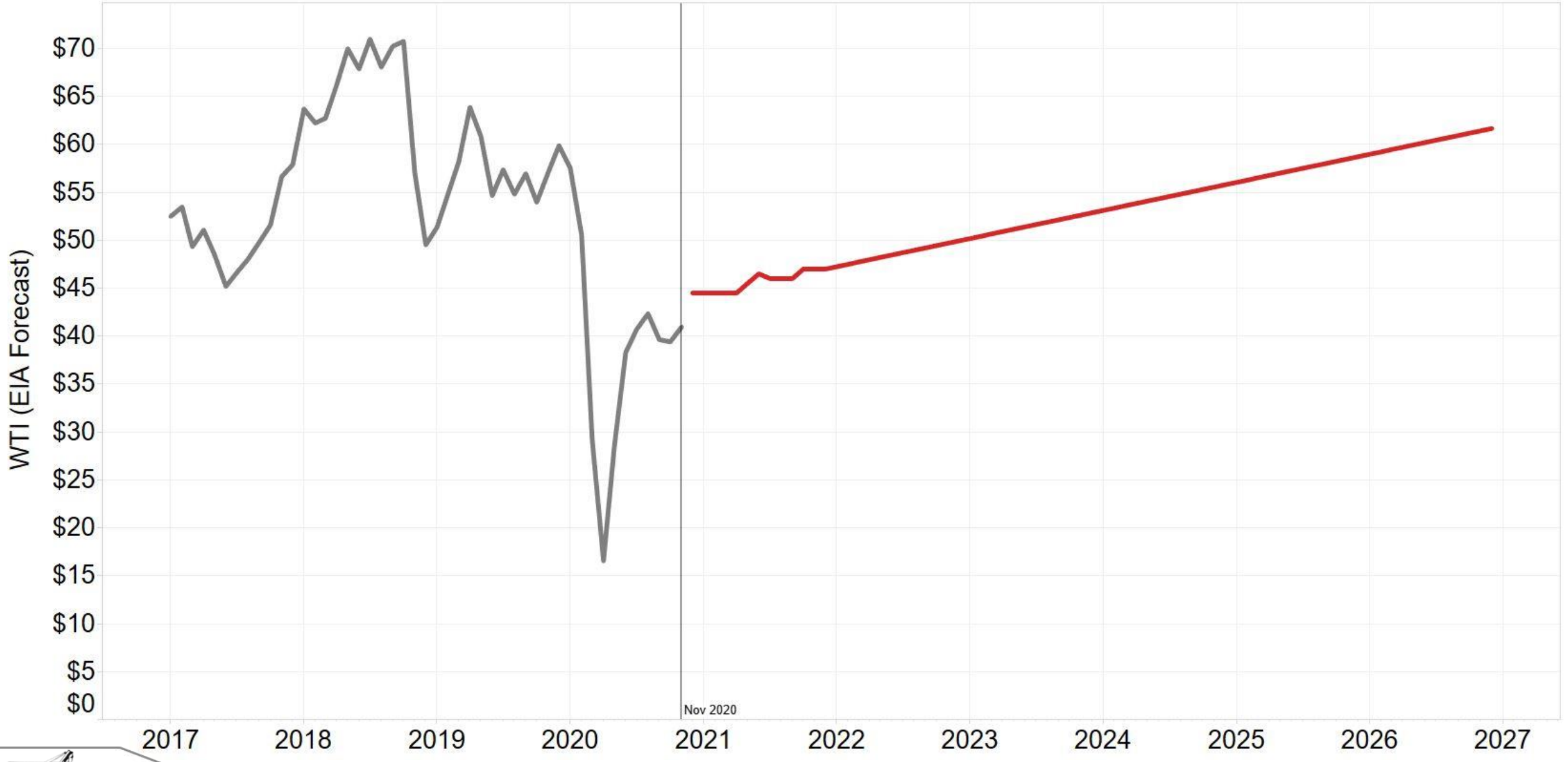
Justin J Kringstad
Geological Engineer
Director
North Dakota Pipeline Authority

December 16, 2020

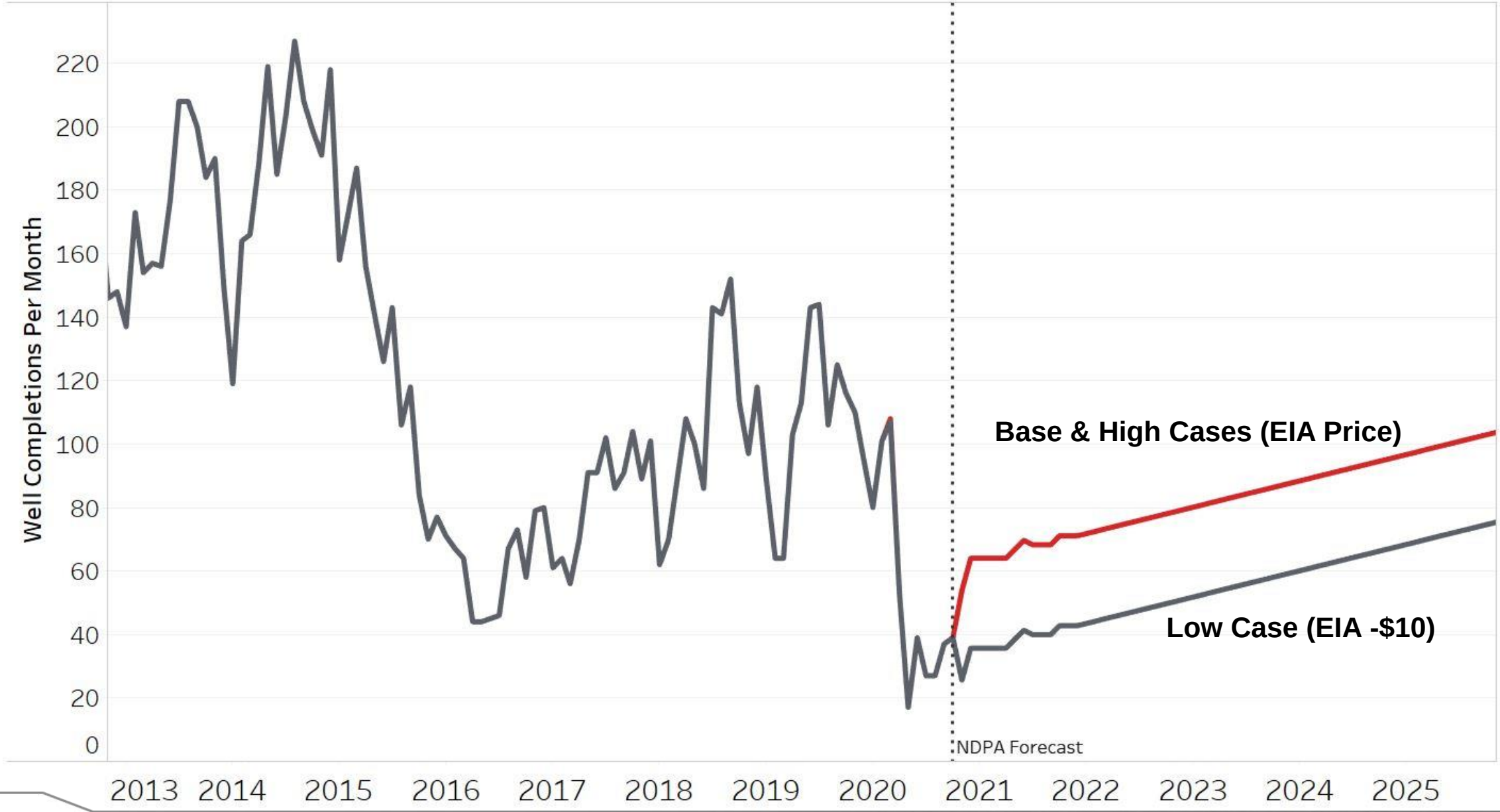
Current Drilling Rig Fleet – 14 (December 15, 2020)



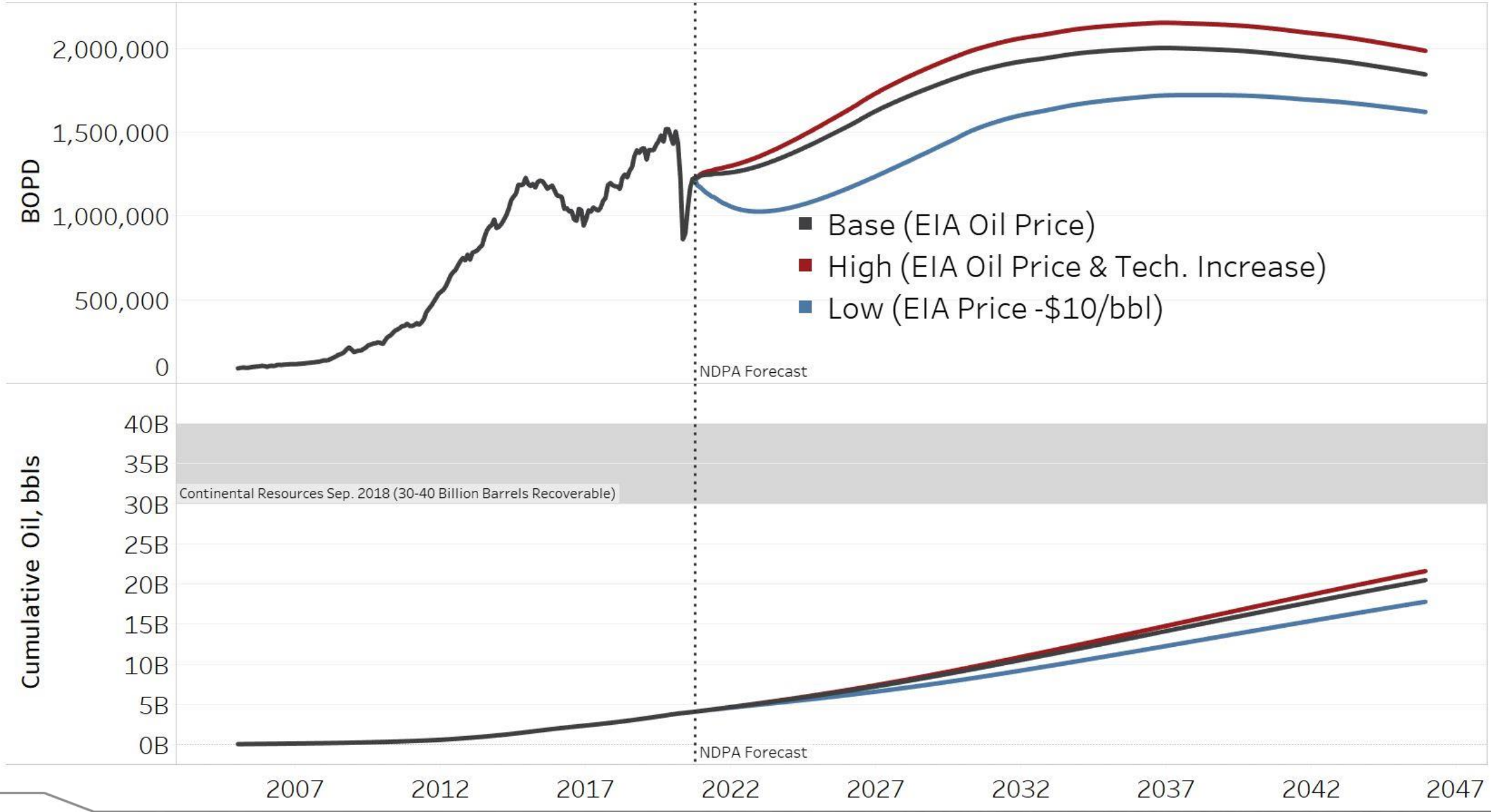
EIA Price Deck (Near Term)



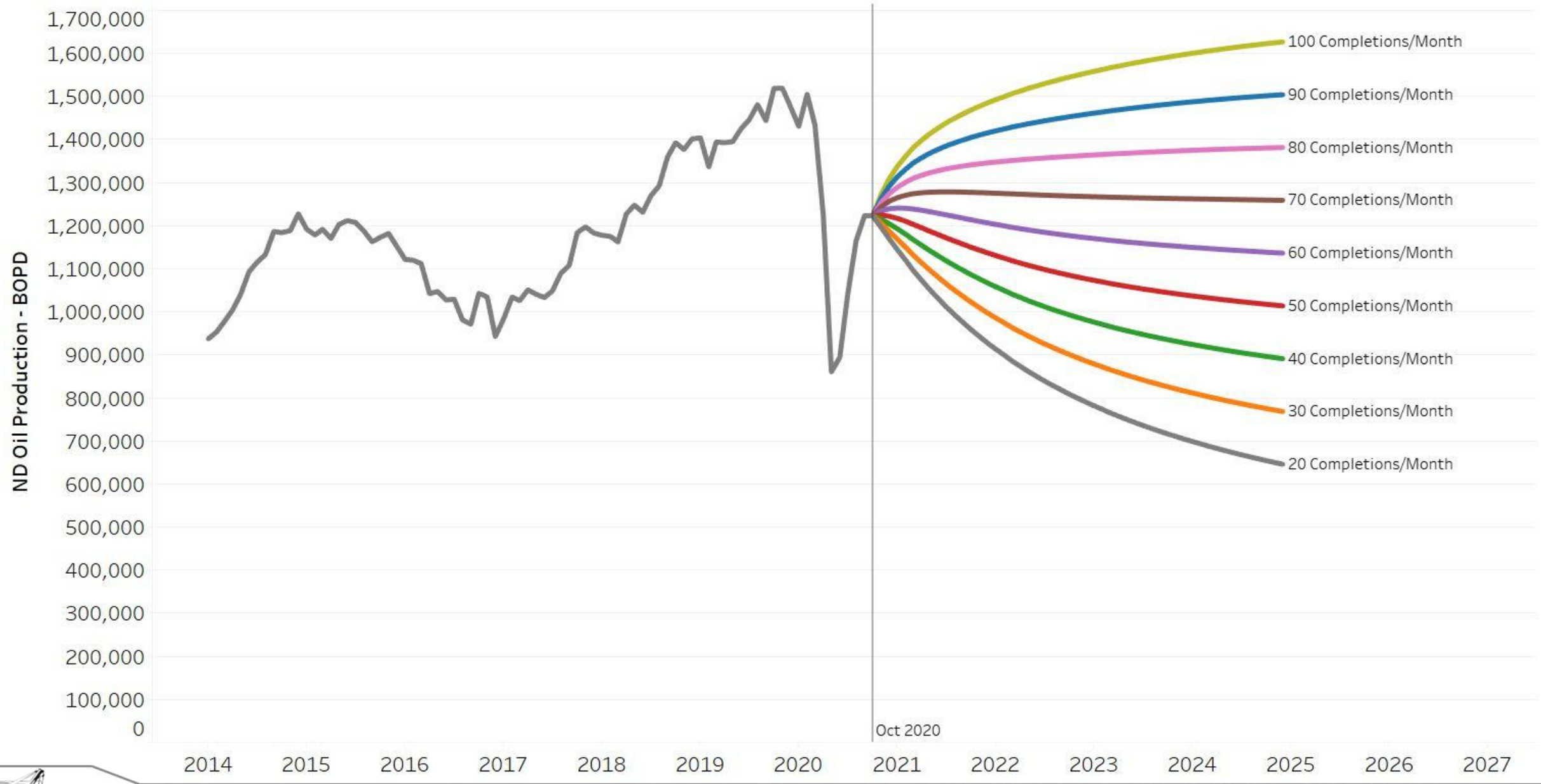
ND Completions: EIA Price Deck (Near Term)



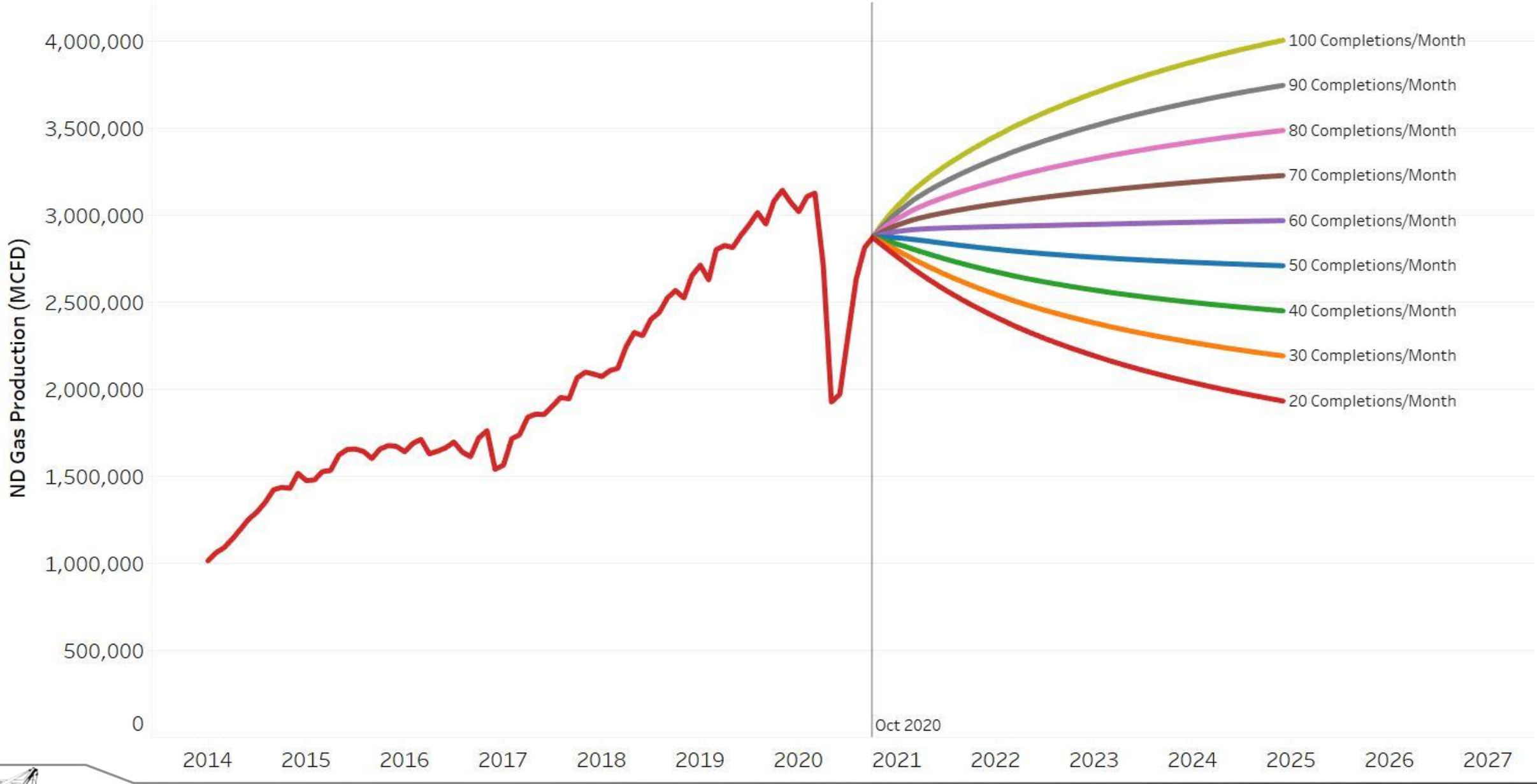
ND Oil Production: EIA Price Deck



Monthly Completion Scenarios - Oil

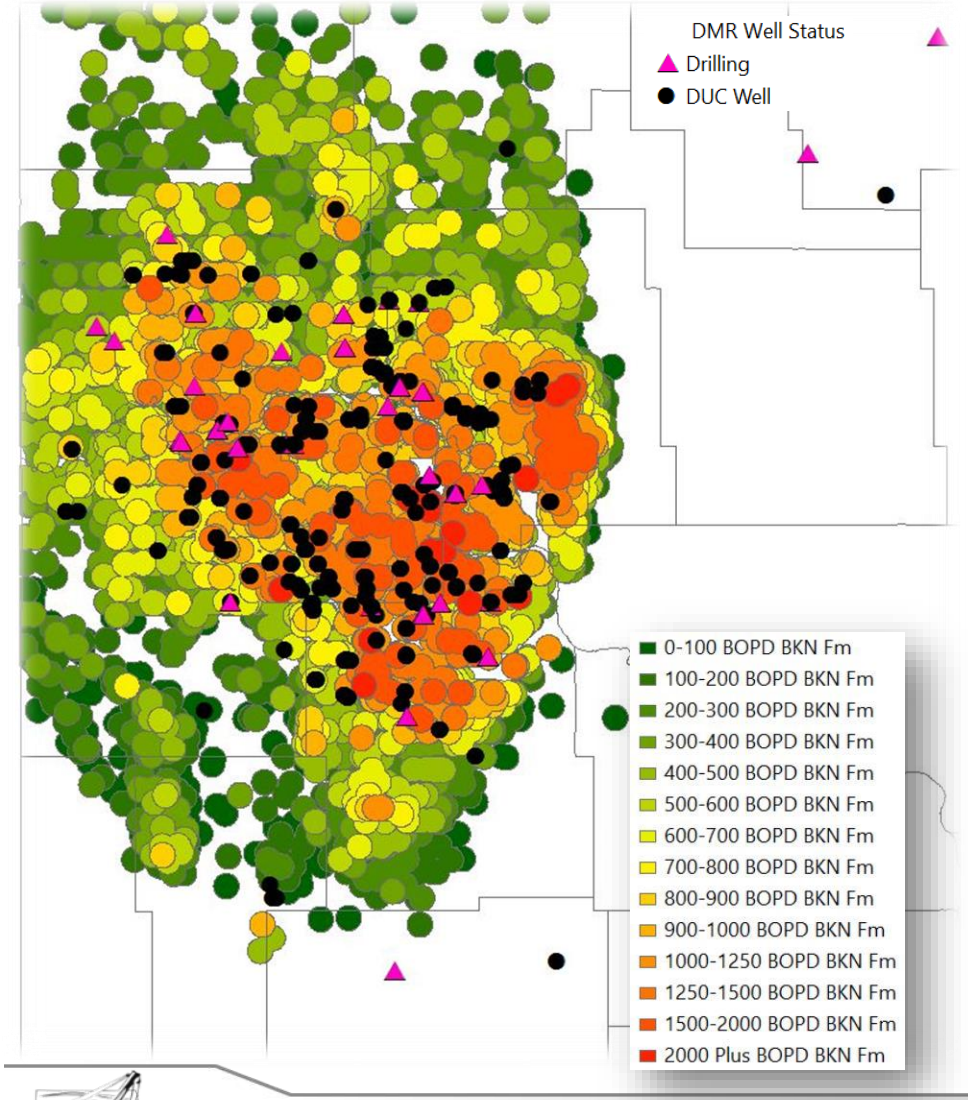


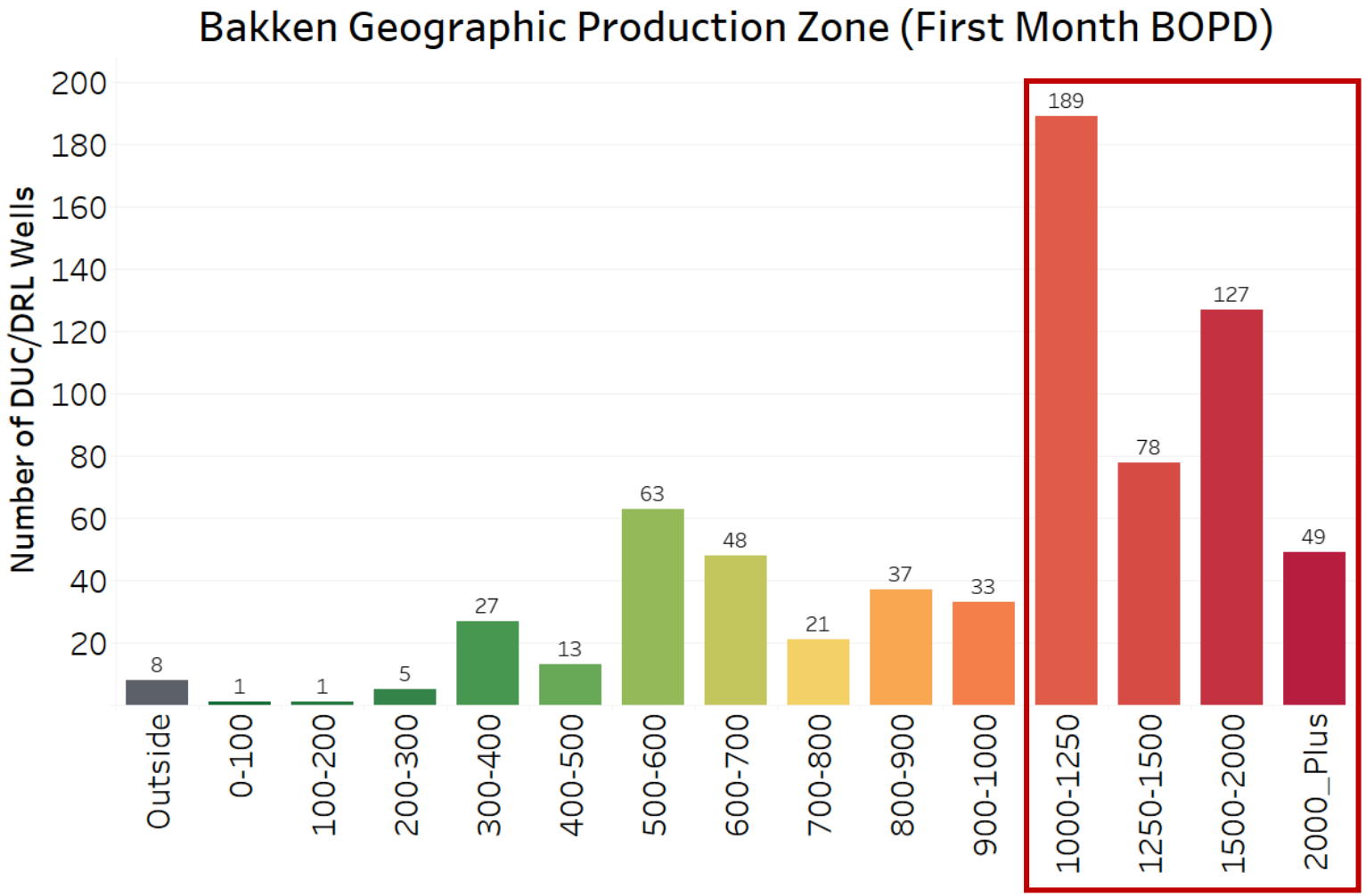
Monthly Completion Scenarios - Gas



North Dakota Wells Waiting on Completion – October 2020

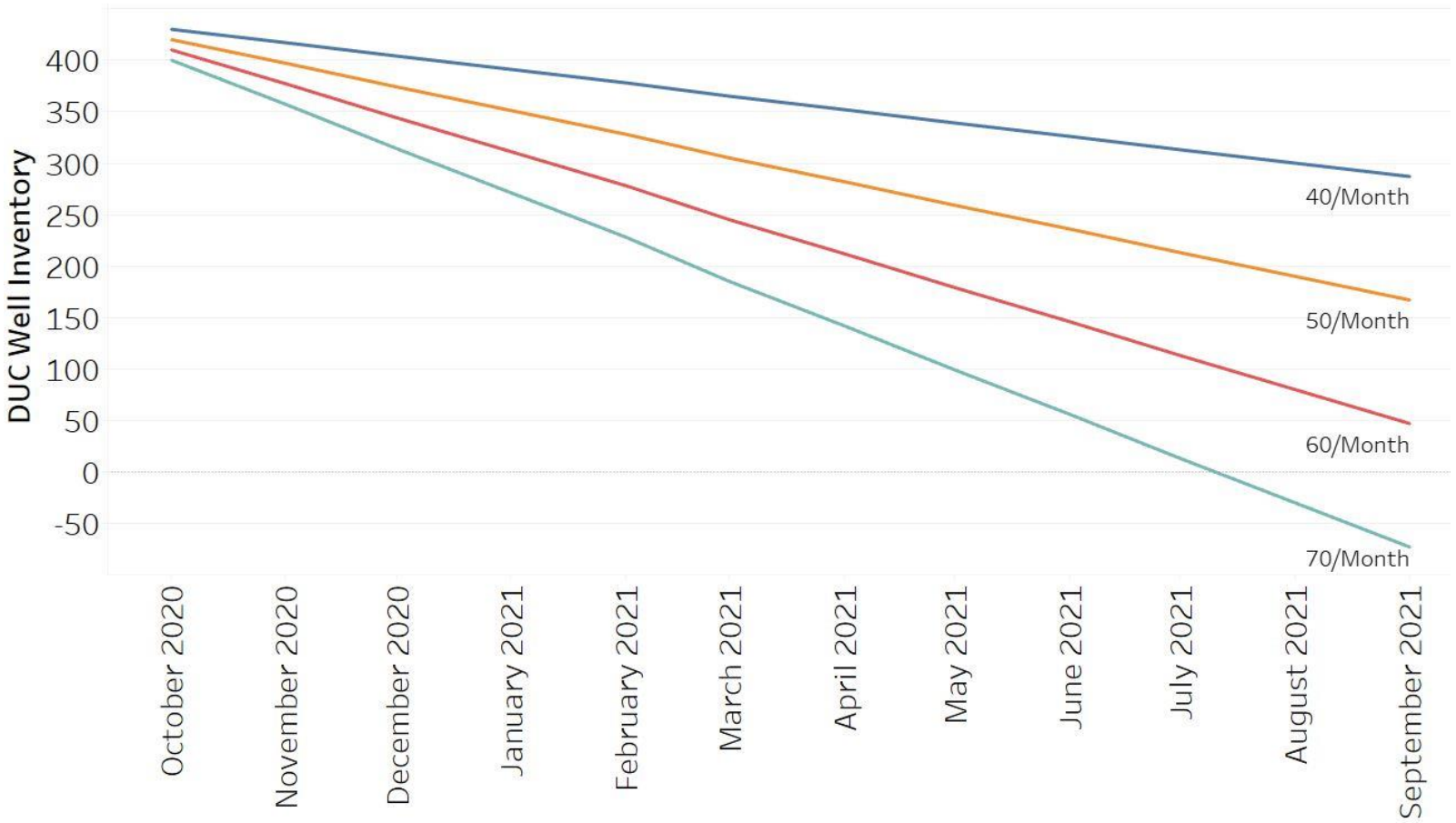
Bakken Formation

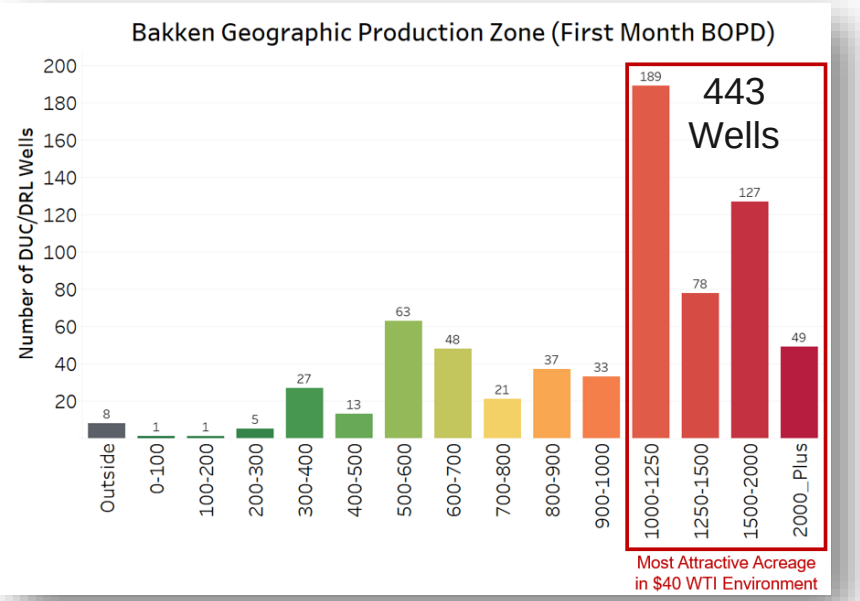


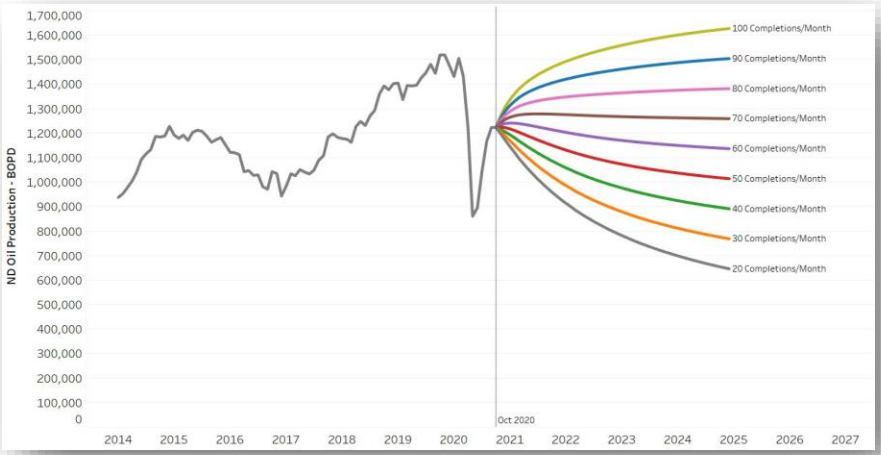


Most Attractive Acreage in $40 WTI Environment

Completion Scenarios & DUC Inventory*

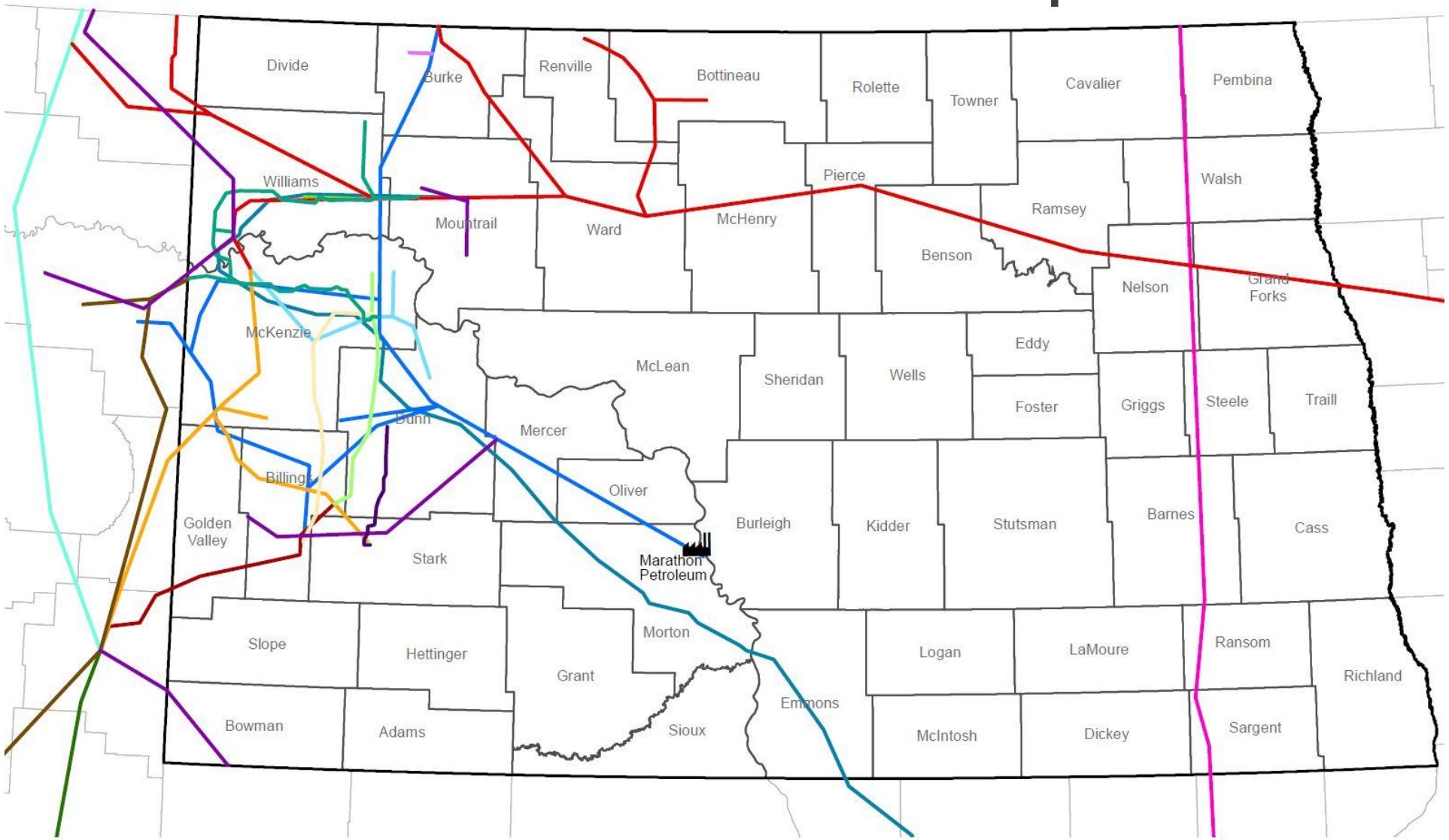




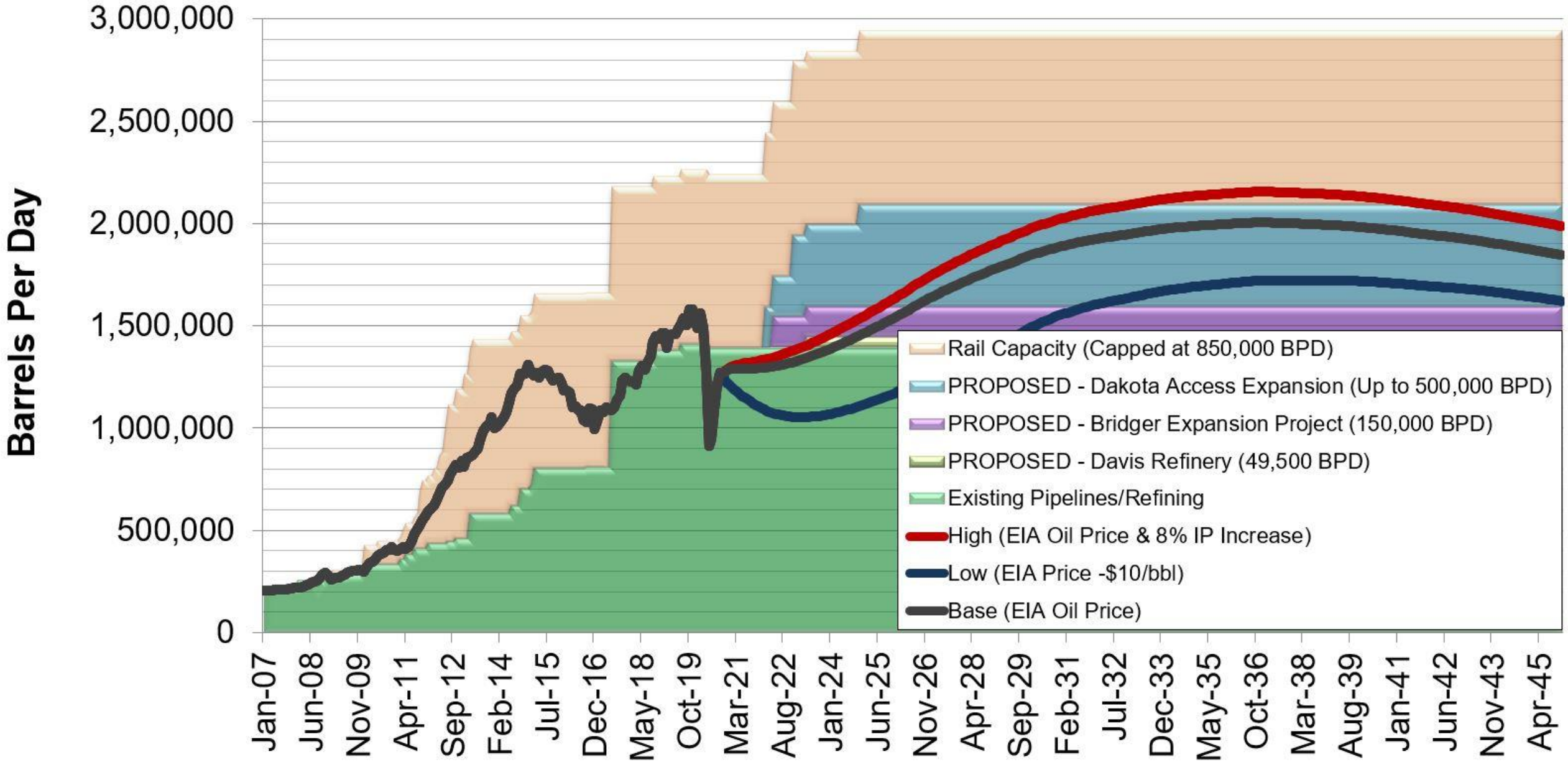


*Assumes 15 Rigs @ 1.8 New Wells Per Month

North Dakota Oil Transmission Pipelines



Williston Basin Oil Production & Export Capacity, BOPD



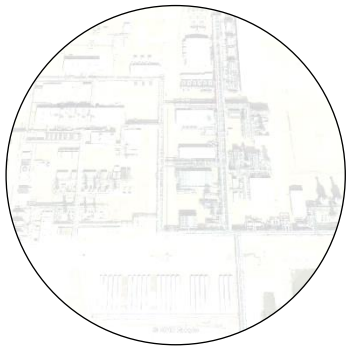
Natural Gas Update

Production

- Technology
- Markets

Gathering

- Capacity
- Connections



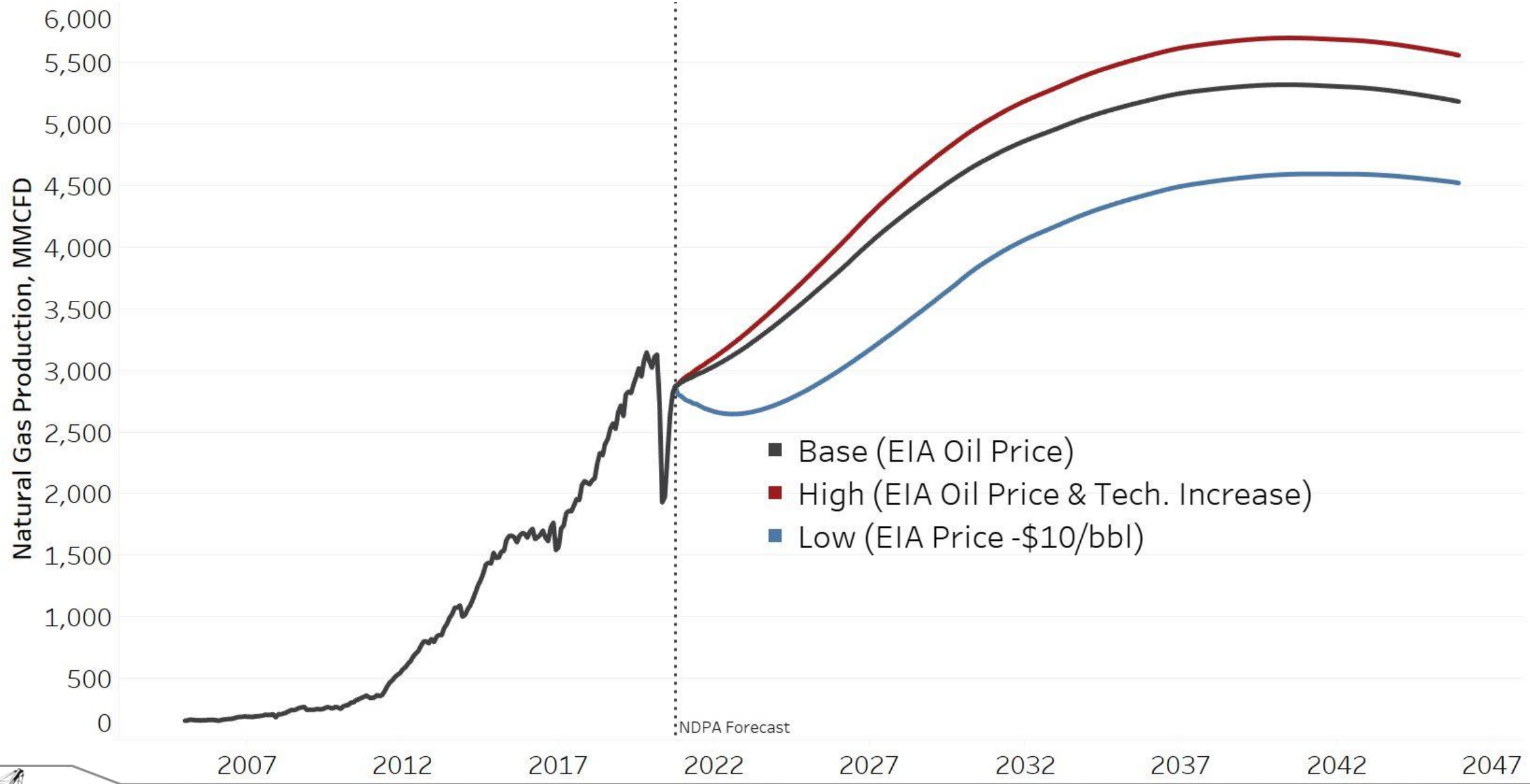
Processing

- Capacity
- Location

Transmission

- Dry Gas
- Natural Gas Liquids

ND Gas Production: EIA Price Deck



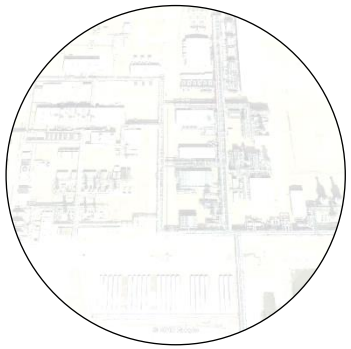
Natural Gas Update

Production

- Technology
- Markets

Gathering

- Capacity
- Connections



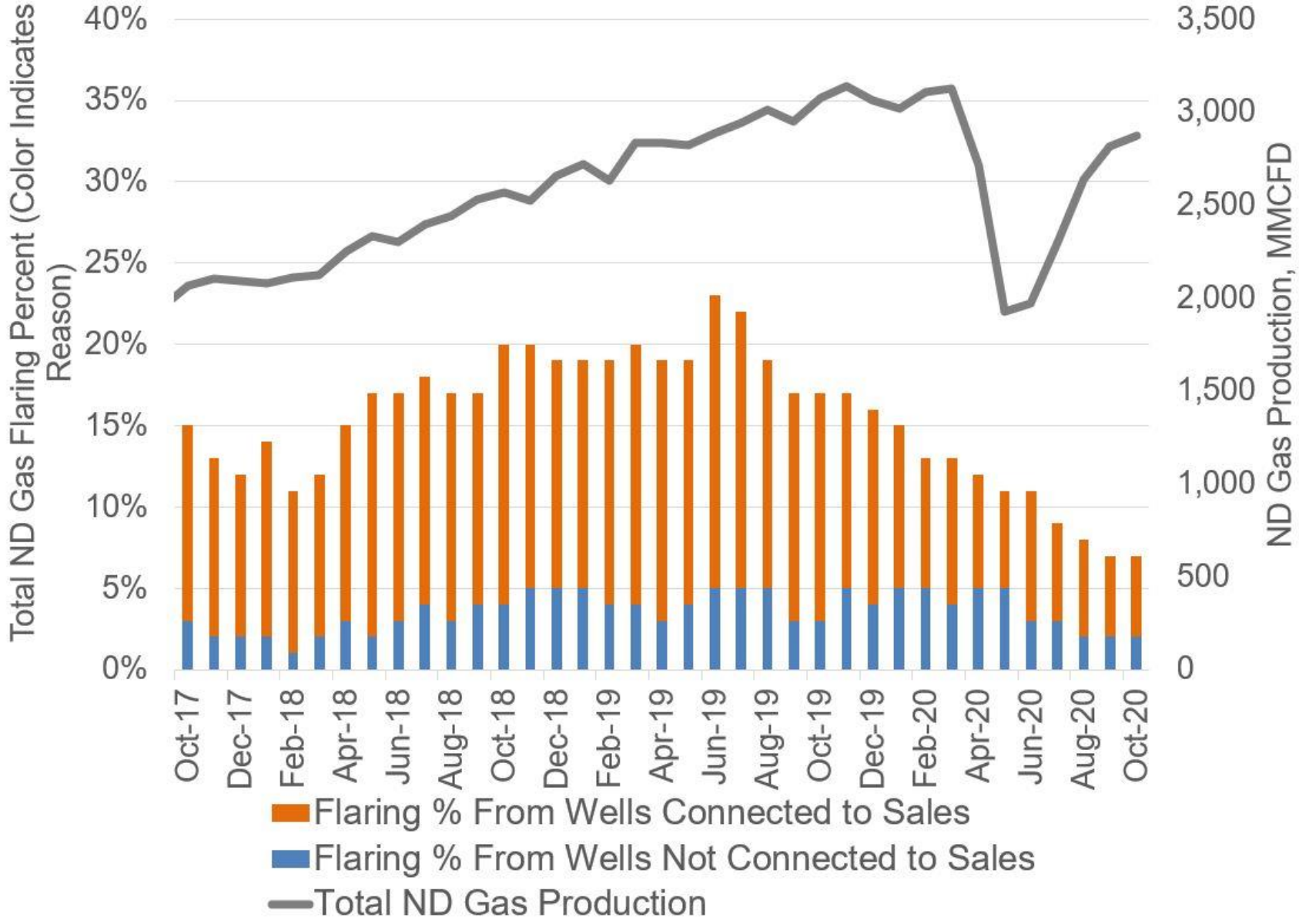
Processing

- Capacity
- Location

Transmission

- Dry Gas
- Natural Gas Liquids

Solving the Flaring Challenge



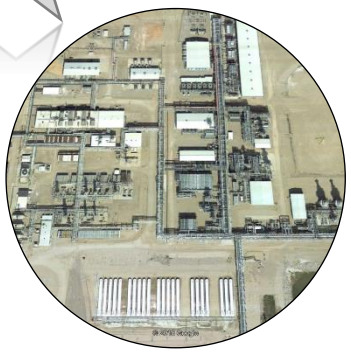
Natural Gas Update

Production

- Technology
- Markets

Gathering

- Capacity
- Connections



Processing

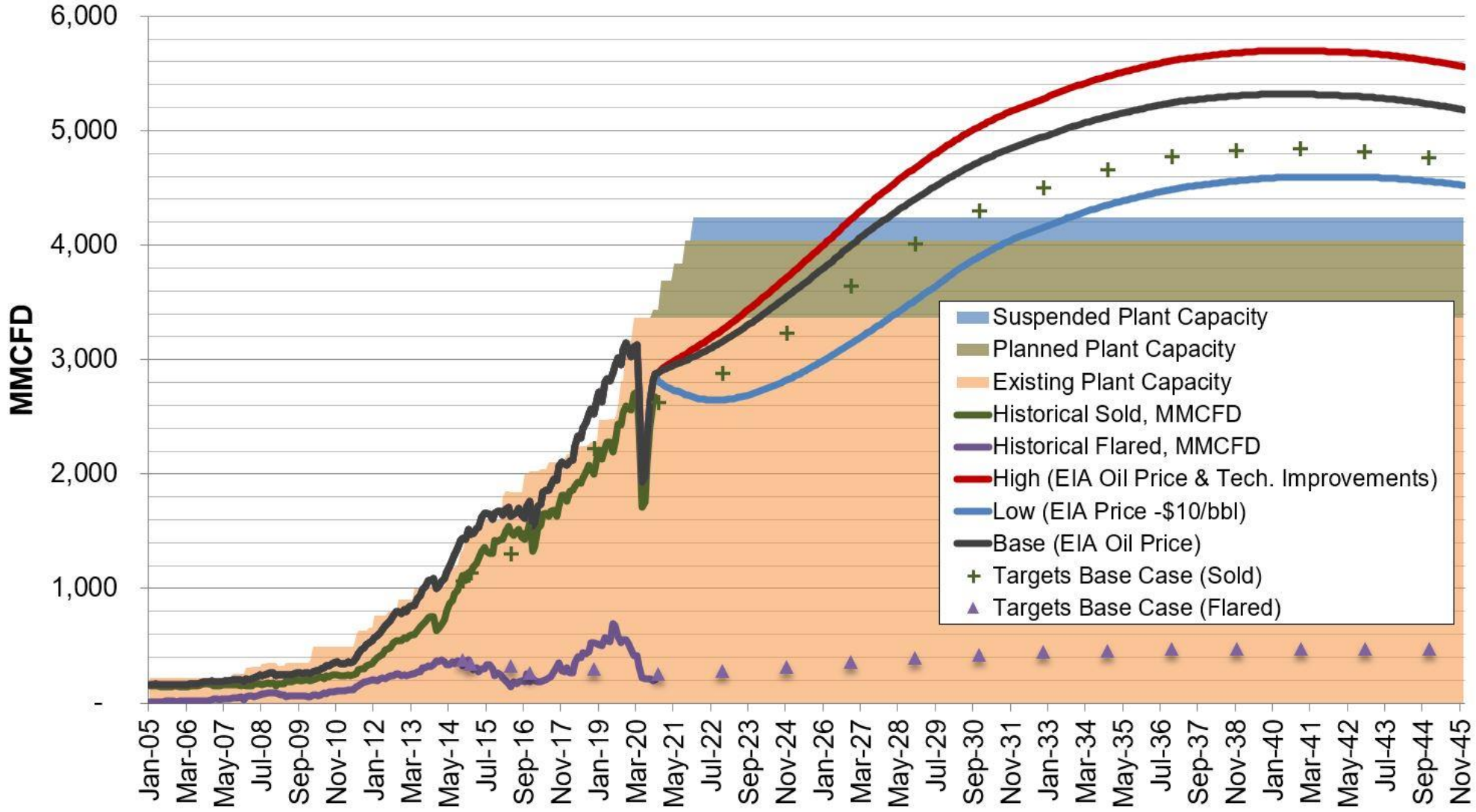
- Capacity
- Location

Transmission

- Dry Gas
- Natural Gas Liquids

Solving the Flaring Challenge

Assumes Current Technology – Enhanced Oil Recovery Not Included



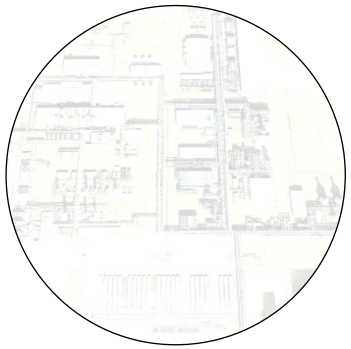
Natural Gas Update

Production

- Technology
- Markets

Gathering

- Capacity
- Connections



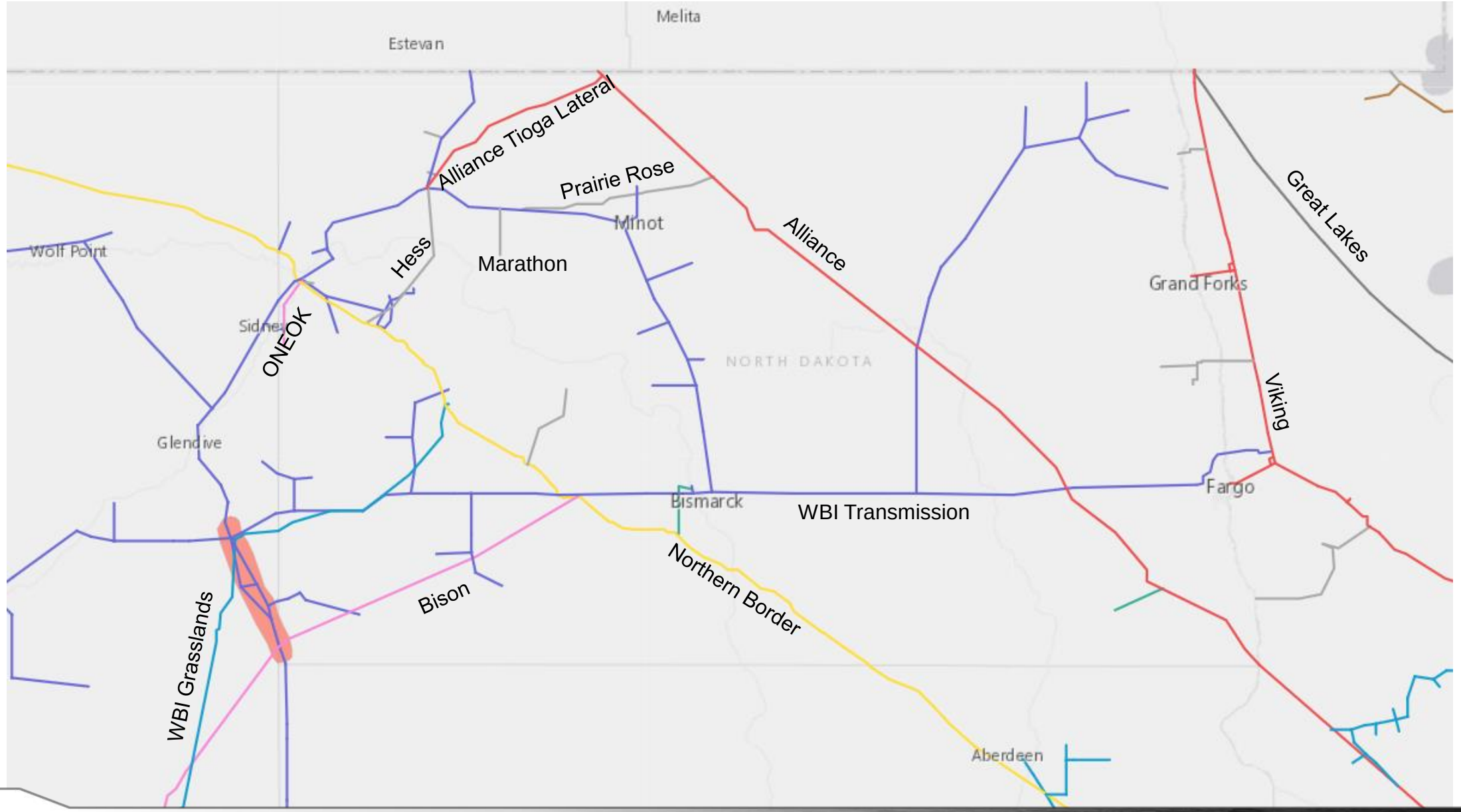
Processing

- Capacity
- Location

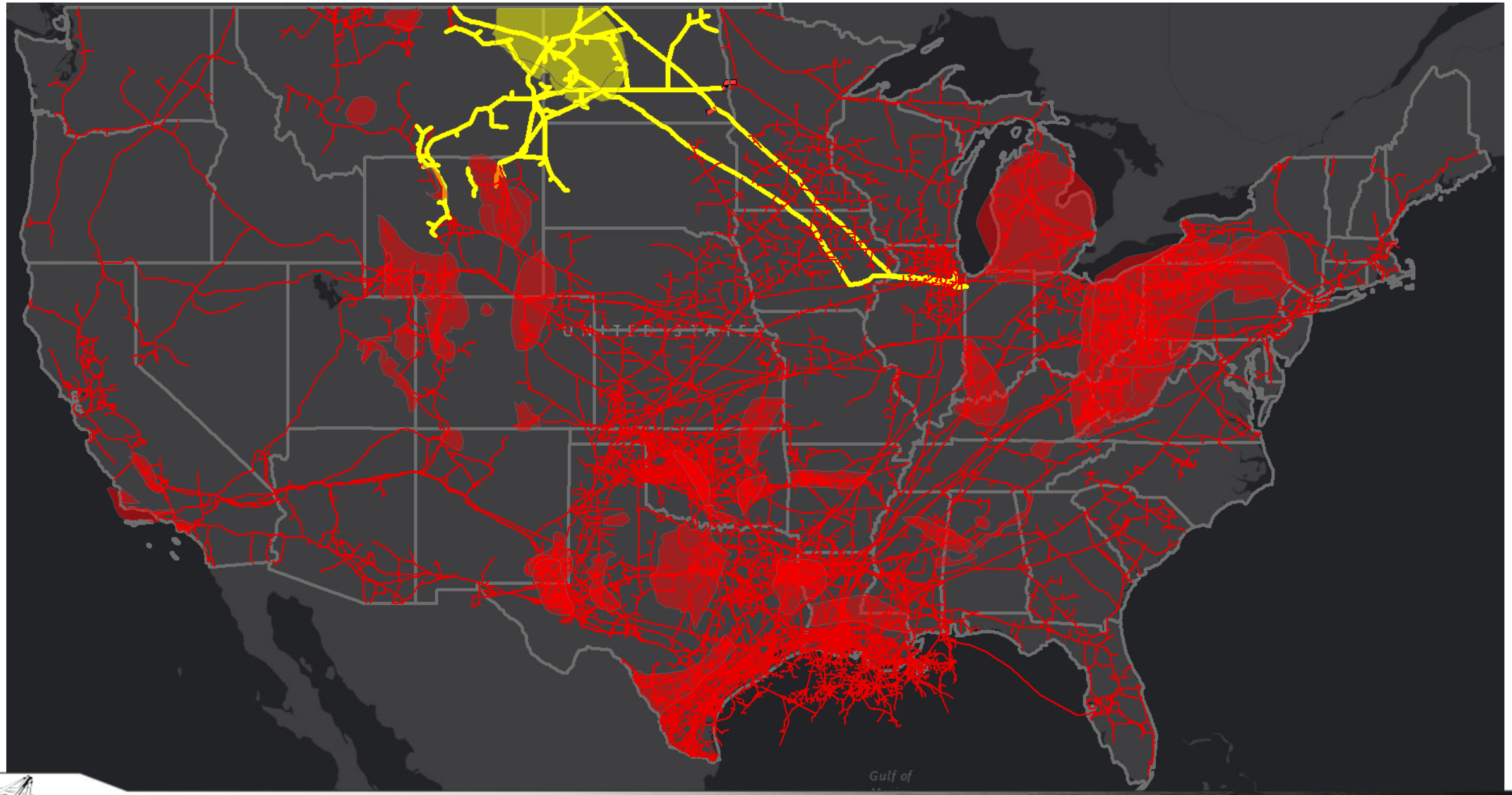
Transmission

- Dry Gas
- Natural Gas Liquids

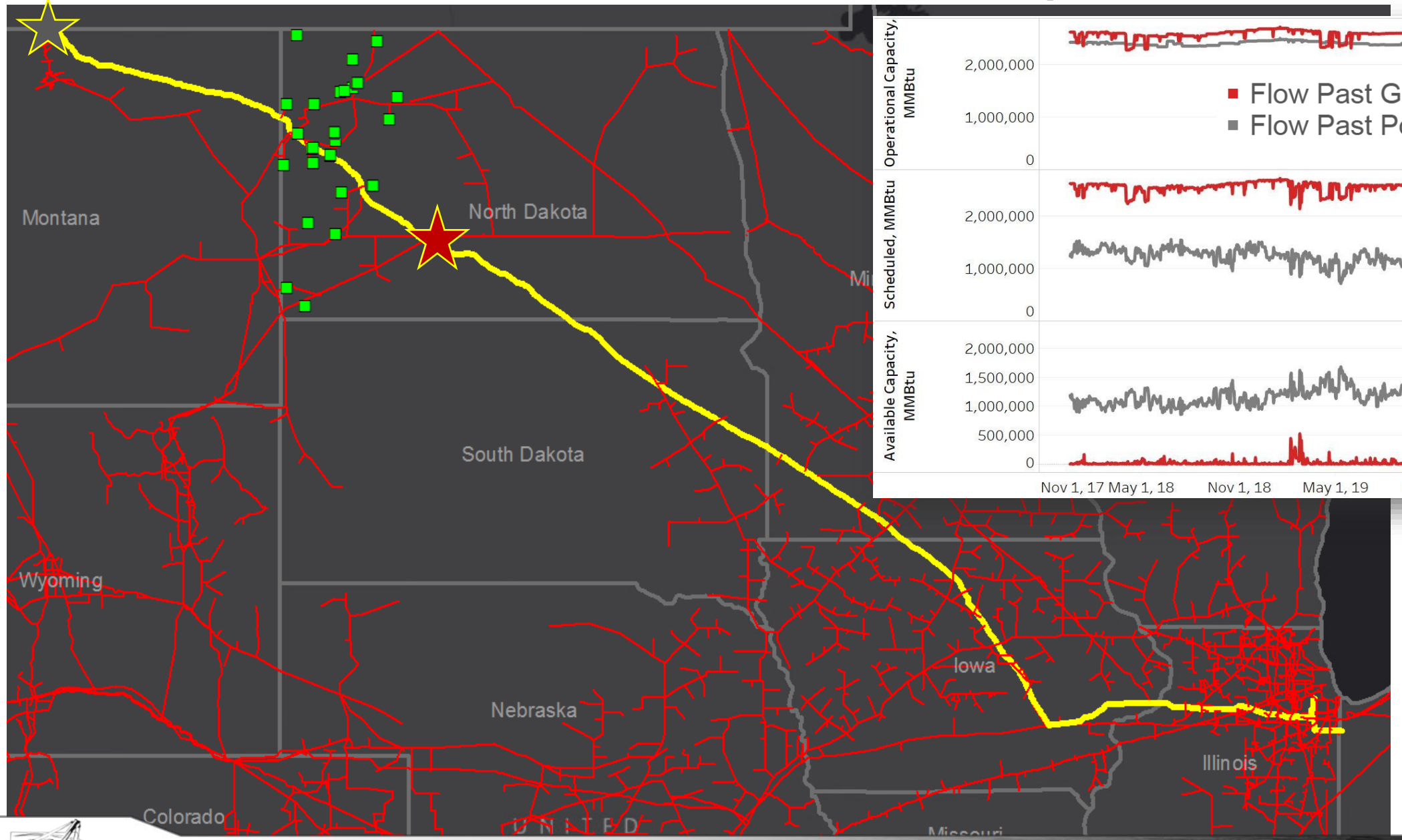
Major Gas Pipeline Infrastructure



Bakken Natural Gas Infrastructure

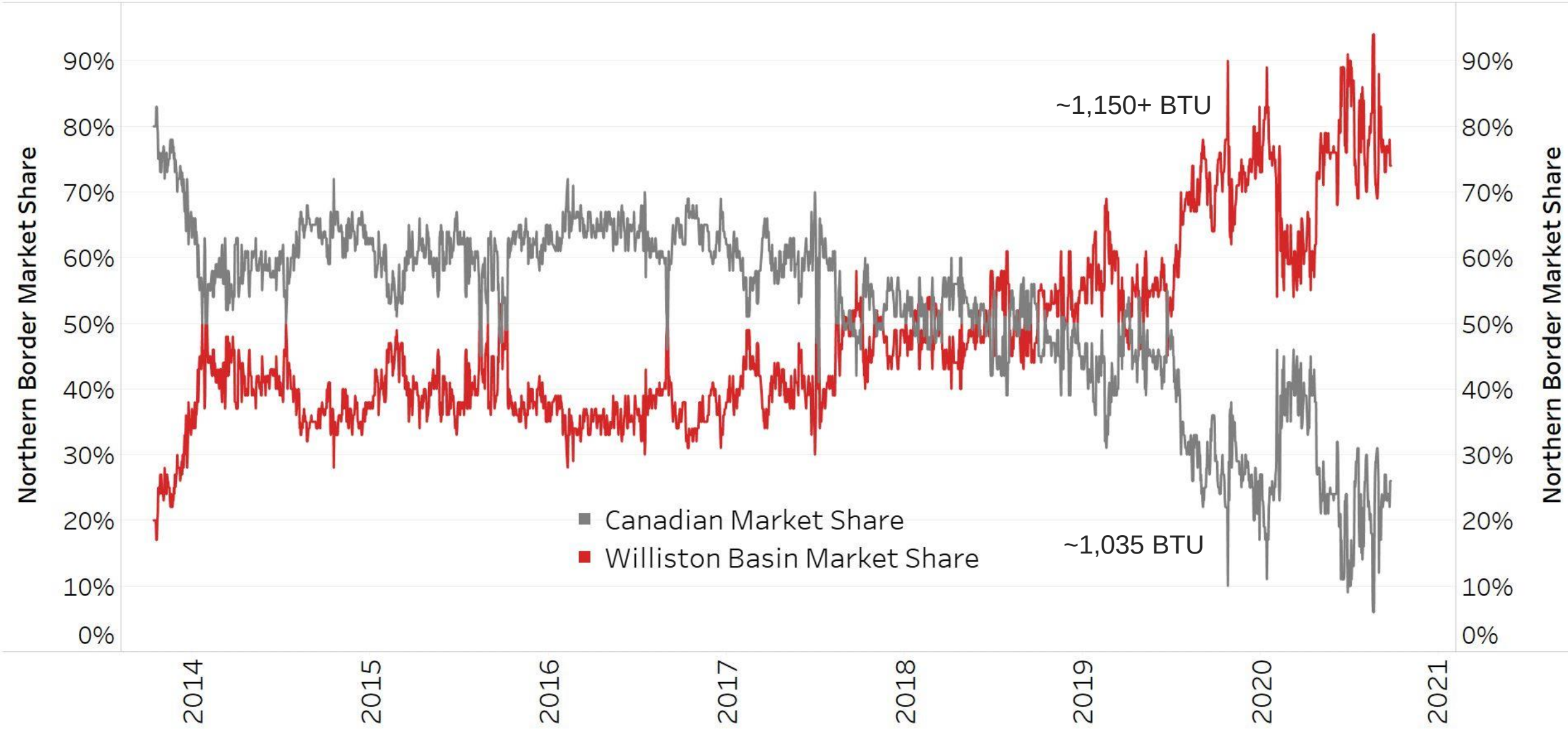


Northern Border Pipeline

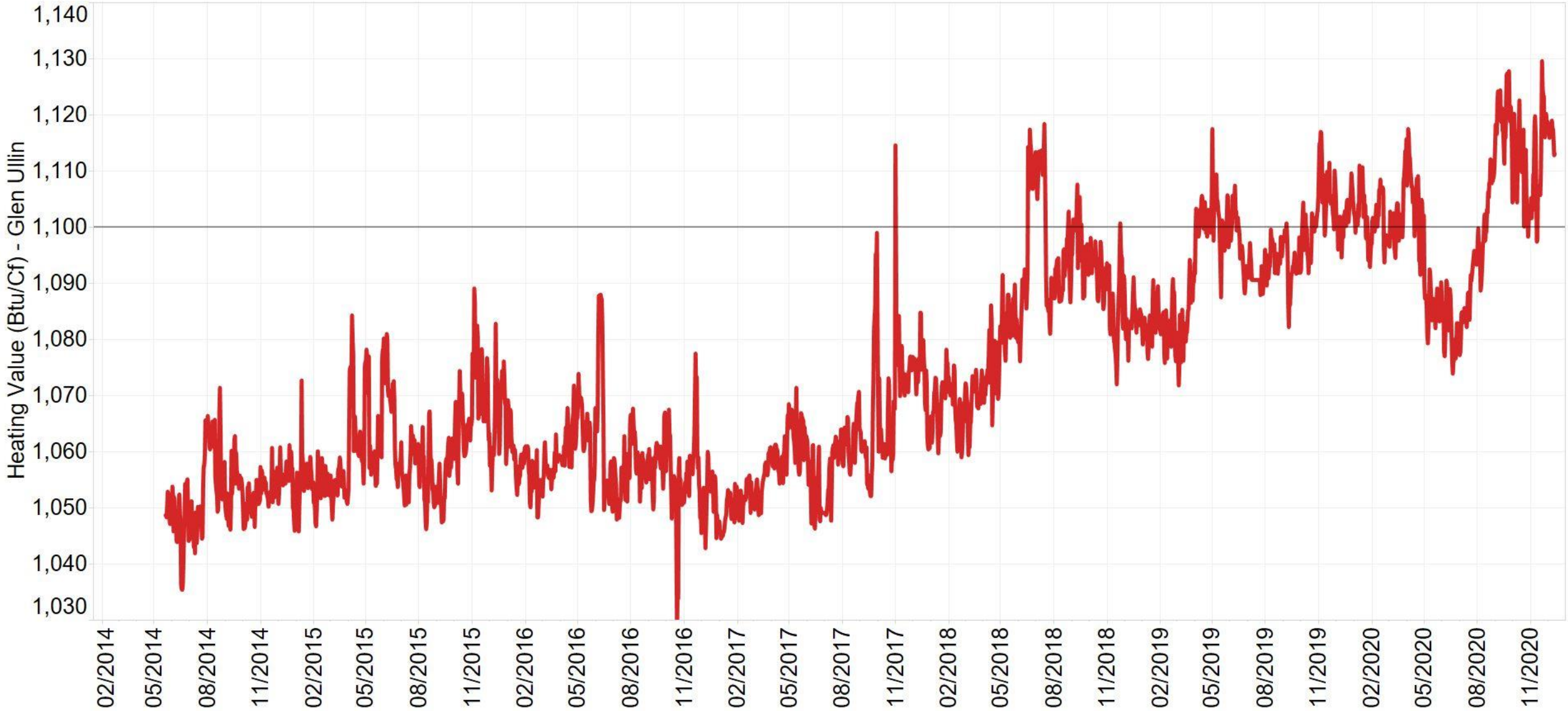


*Data Source: Northern Border

Northern Border Pipeline Market Share

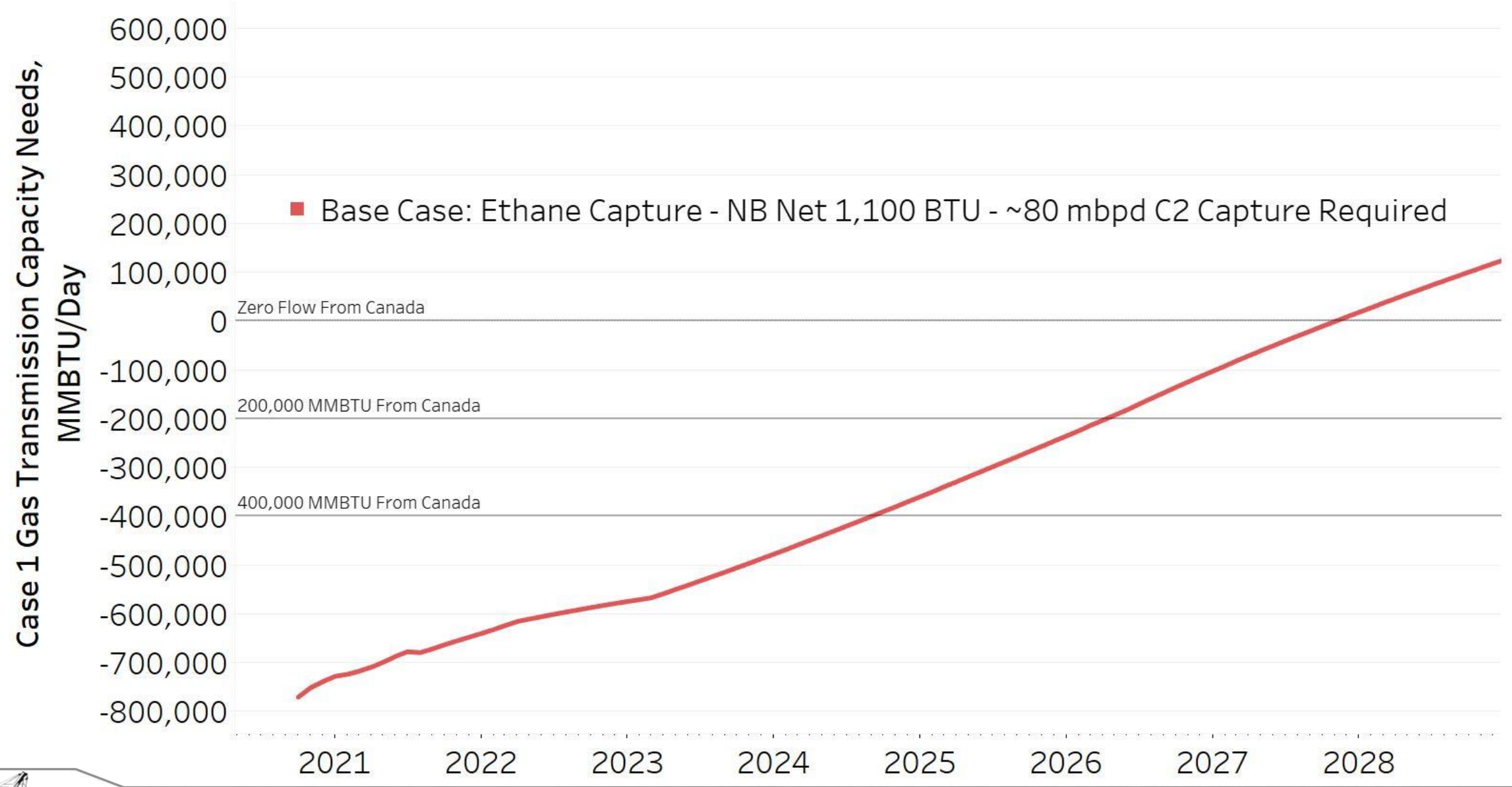


Northern Border BTU at Glen Ullin, ND



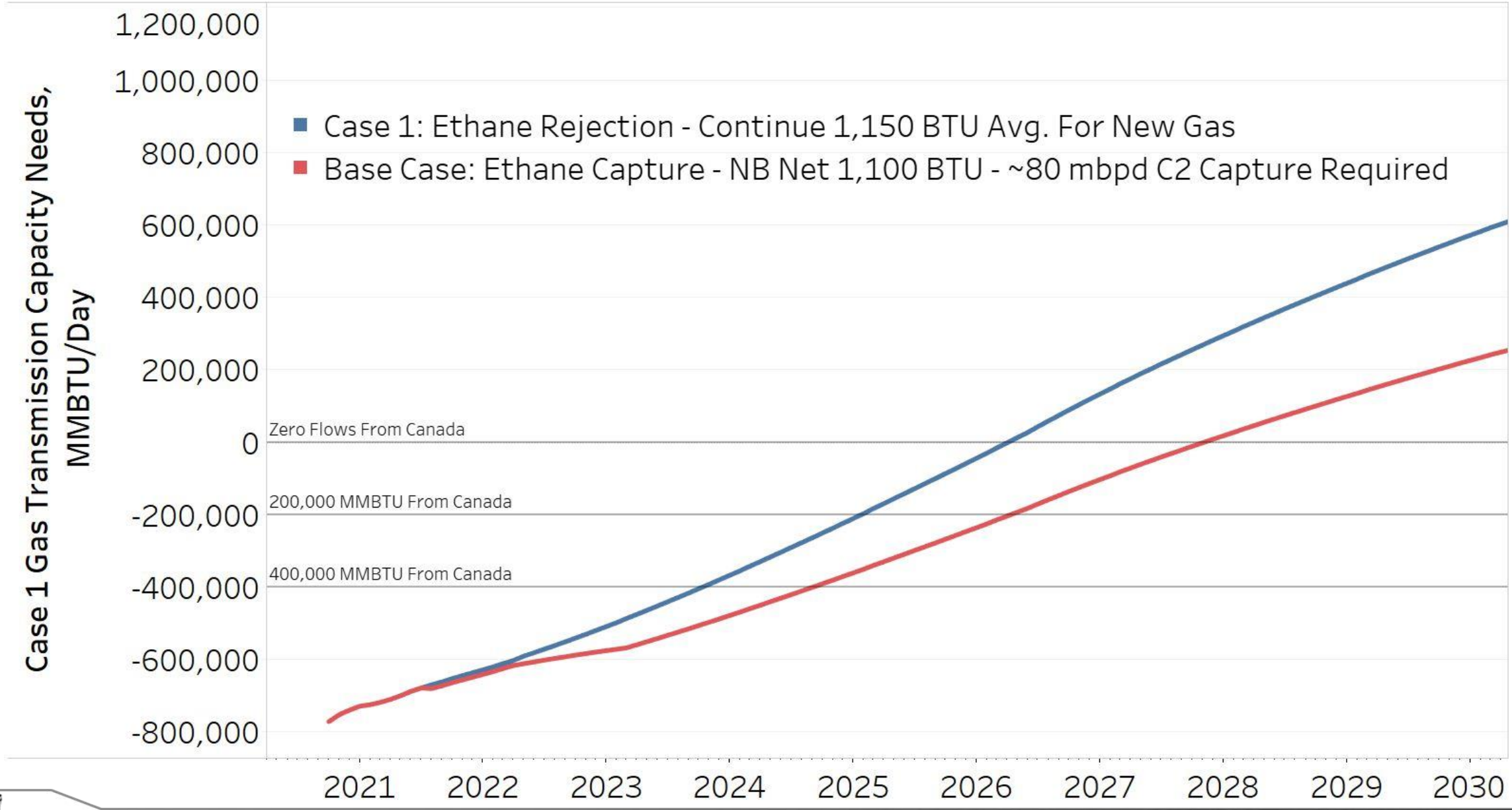
*Data Source: Northern Border

Northern Border – BTU Calculations*



*Includes Updated Tariff Timeline to 1,100

Northern Border – BTU Calculations*

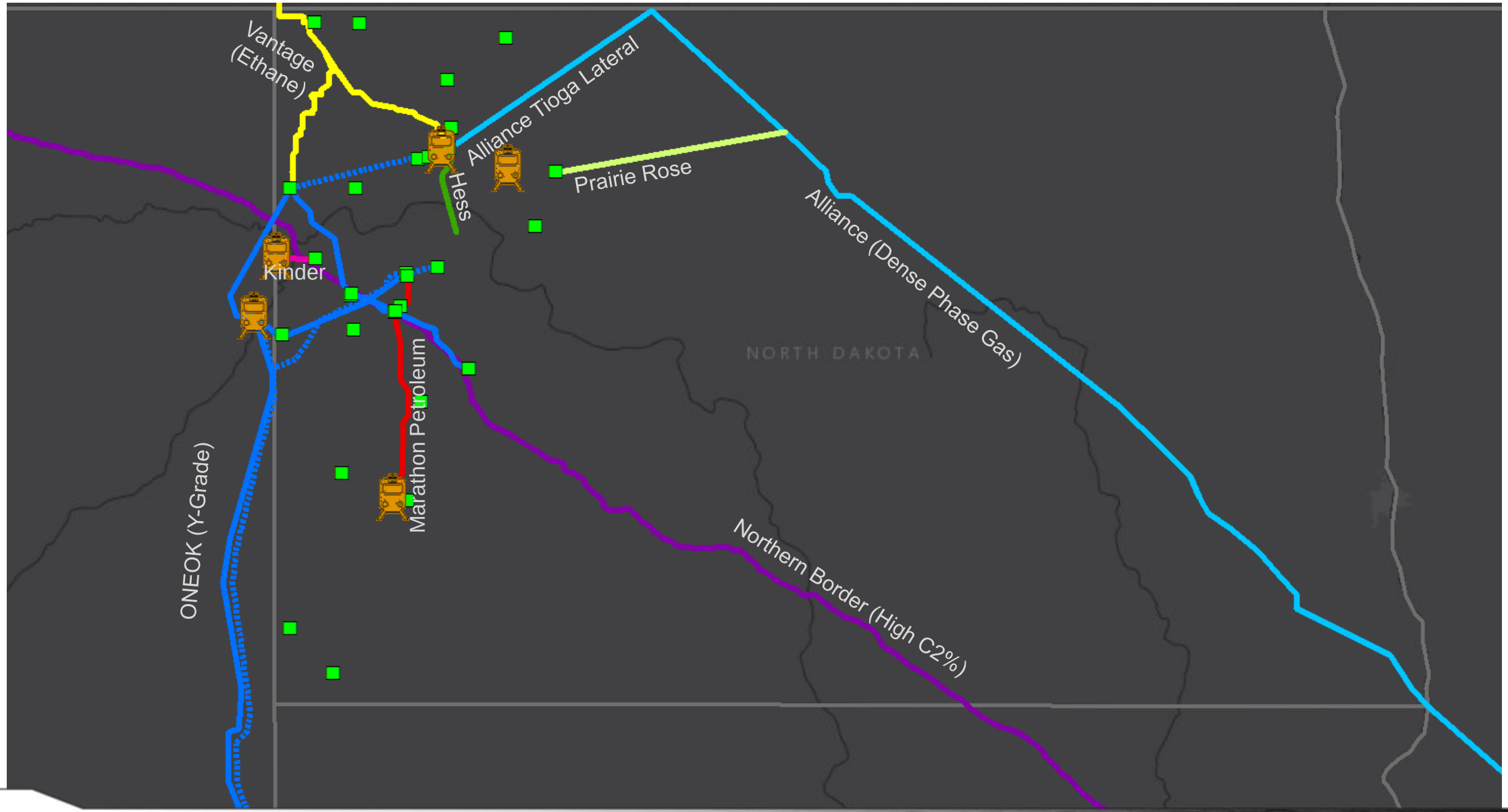


*Includes Updated Tariff Timeline to 1,100

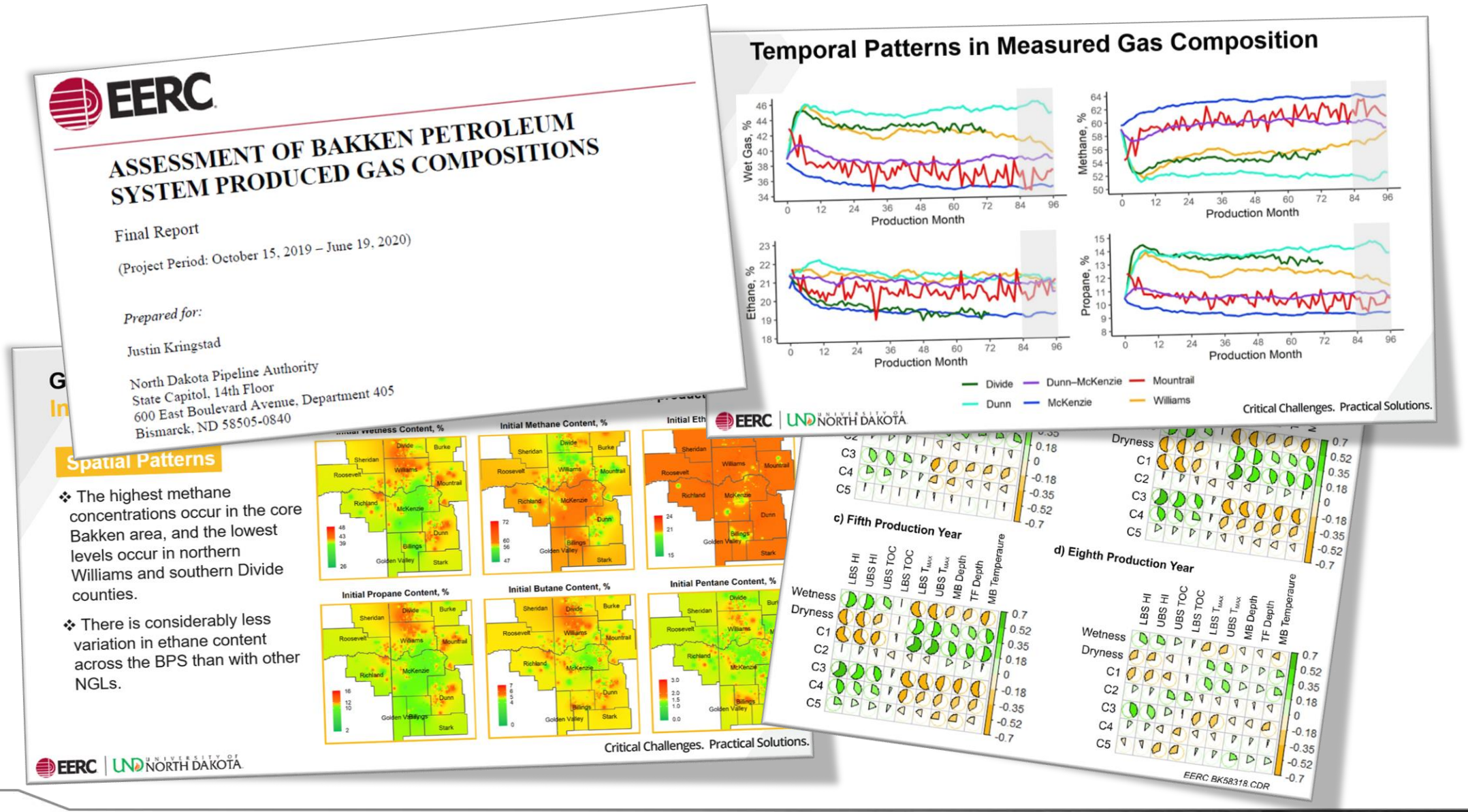
Bakken & Three Forks Natural Gas Liquids Chemistry

EERC Study Completed

Regional NGL Infrastructure



NGL Chemistry Study - 2020



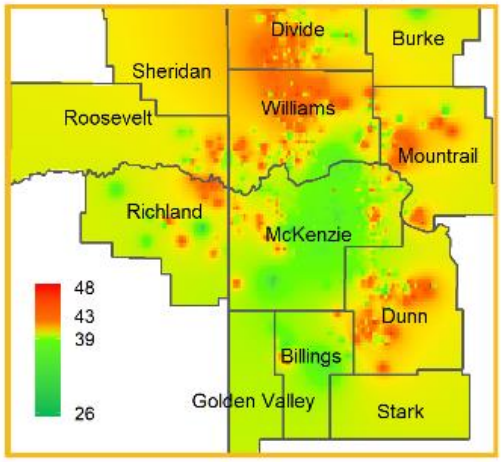
Gas Compositions During Initial Well Production

Spatial Patterns

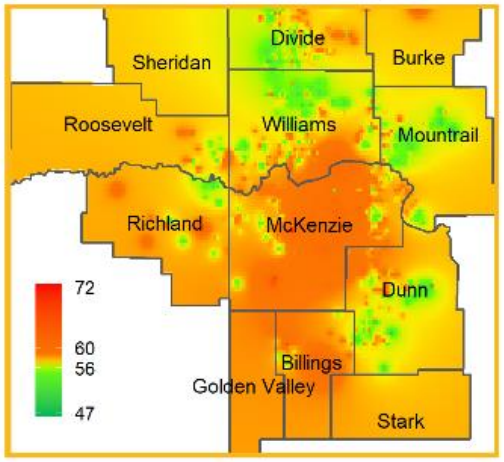
- The highest methane concentrations occur in the core Bakken area, and the lowest levels occur in northern Williams and southern Divide counties.
- There is considerably less variation in ethane content across the BPS than with other NGLs.

Spatial distribution of methane, ethane, propane and wetness levels (mol %) during the initial stages of well production

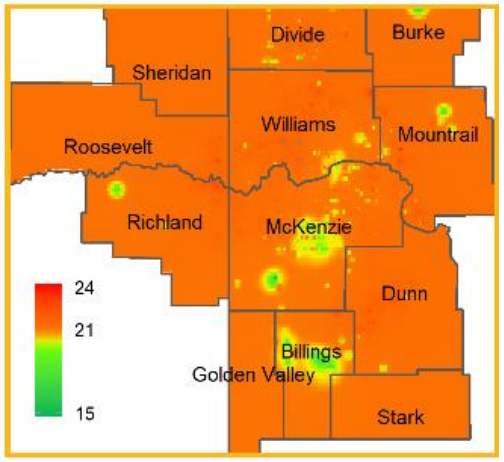
Initial Wetness Content, %



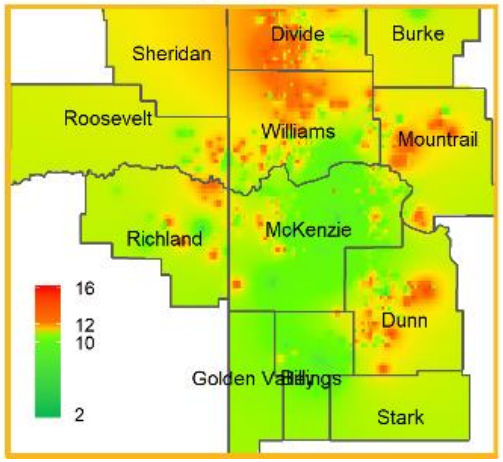
Initial Methane Content, %



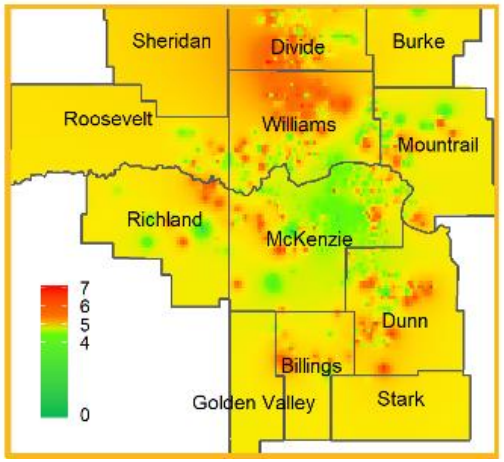
Initial Ethane Content, %



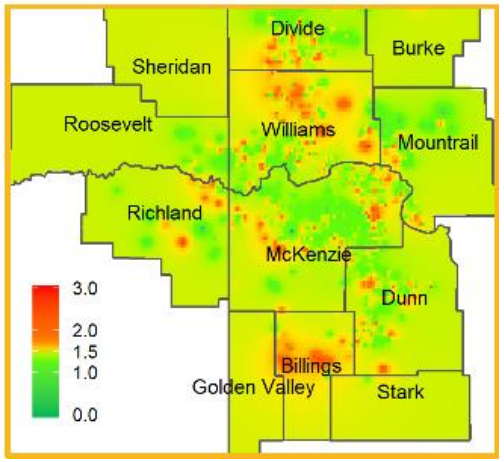
Initial Propane Content, %



Initial Butane Content, %



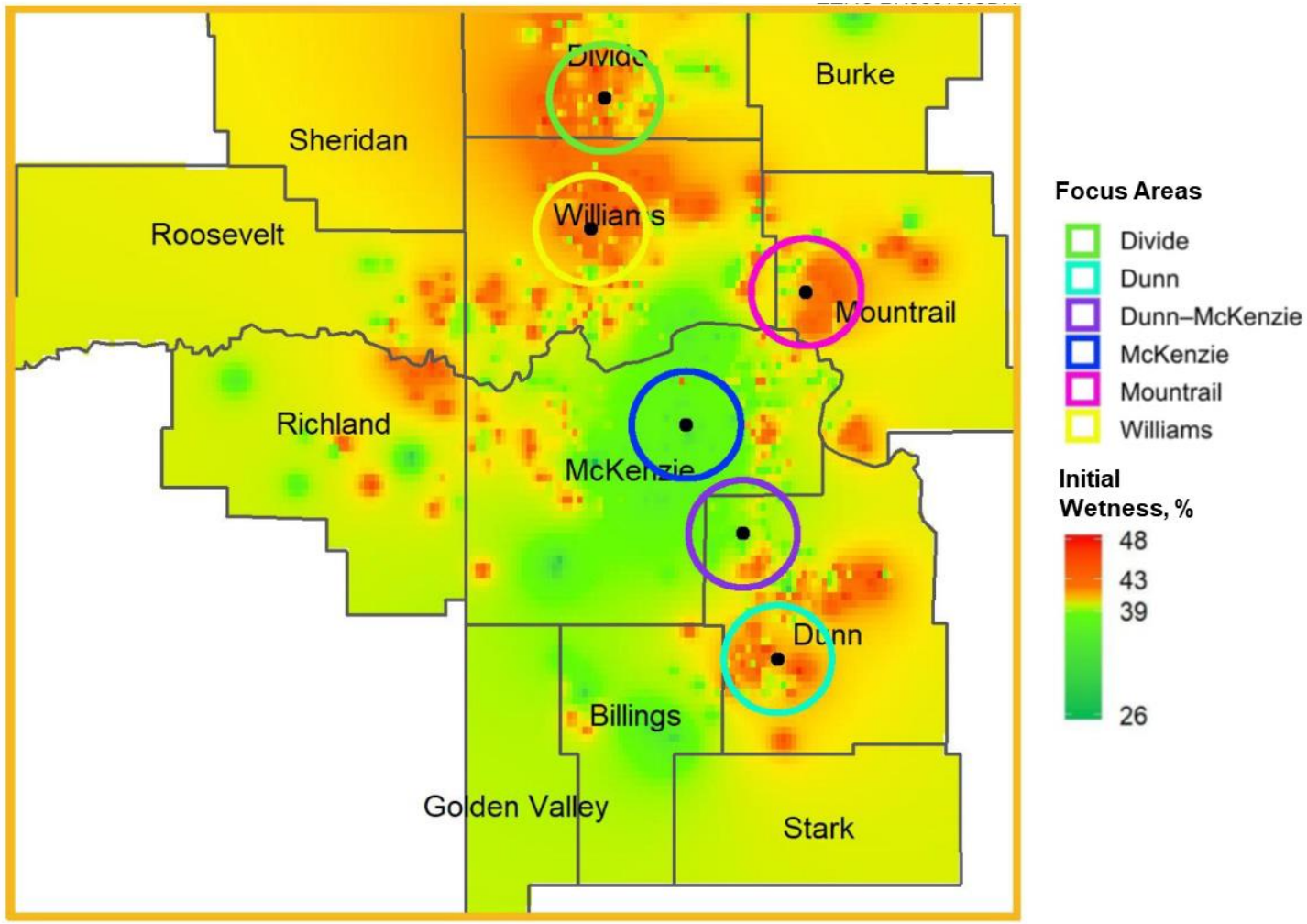
Initial Pentane Content, %



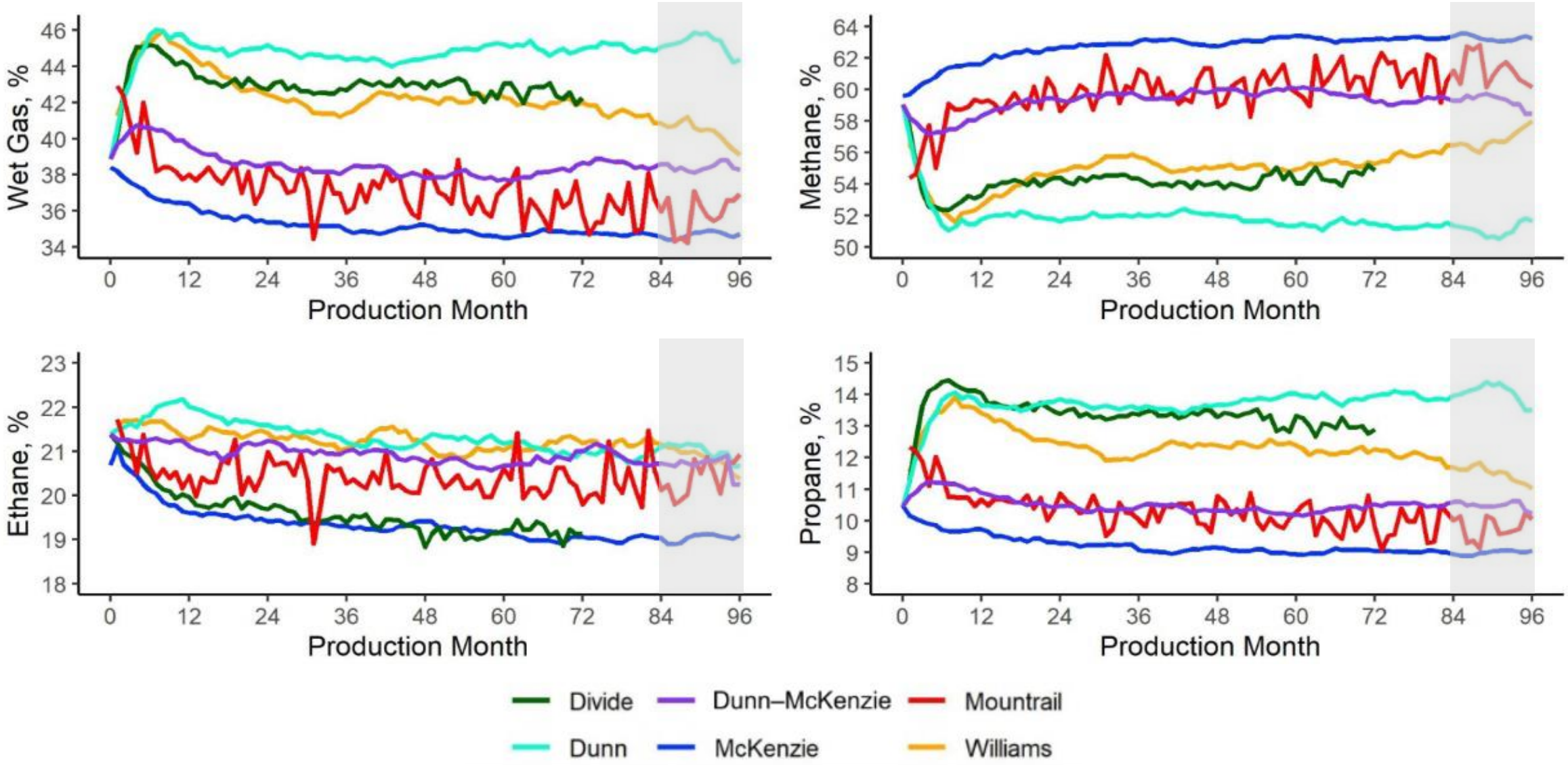
Temporal Analysis

Locations

- Gas composition data from wells located in six areas were evaluated for temporal trends in gas composition.
- Very few wells had complete time-series data, thus data from multiple wells located within the circled areas were aggregated based on production month.

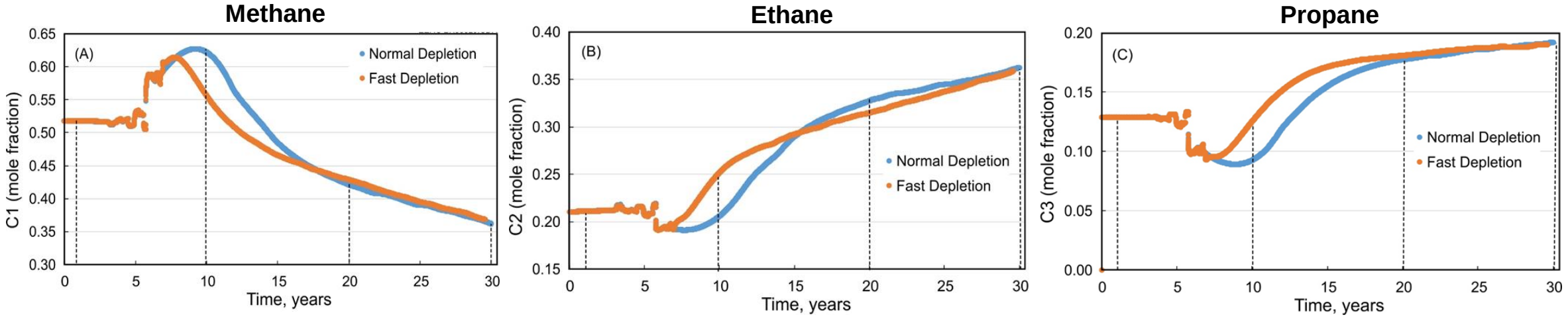


Temporal Patterns in Measured Gas Composition

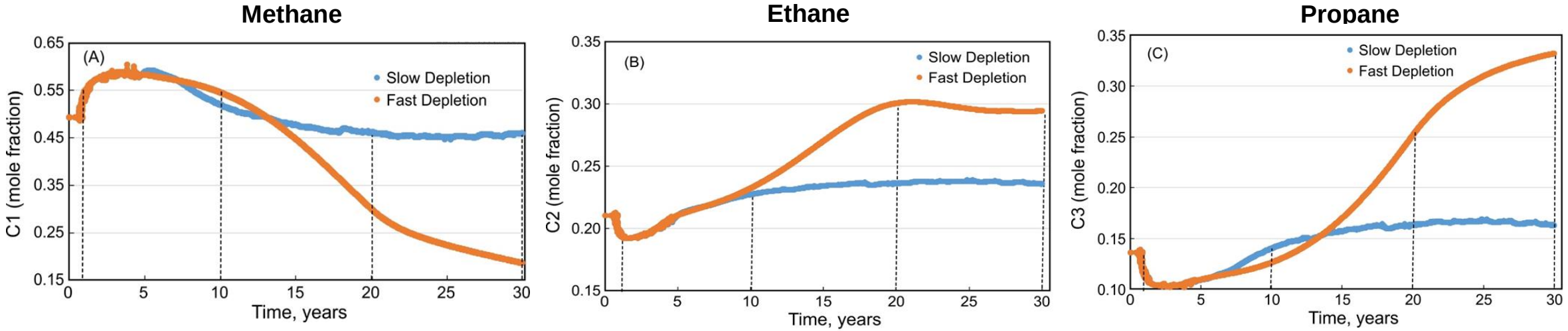


Predicted Gas Composition Change: Primary Production

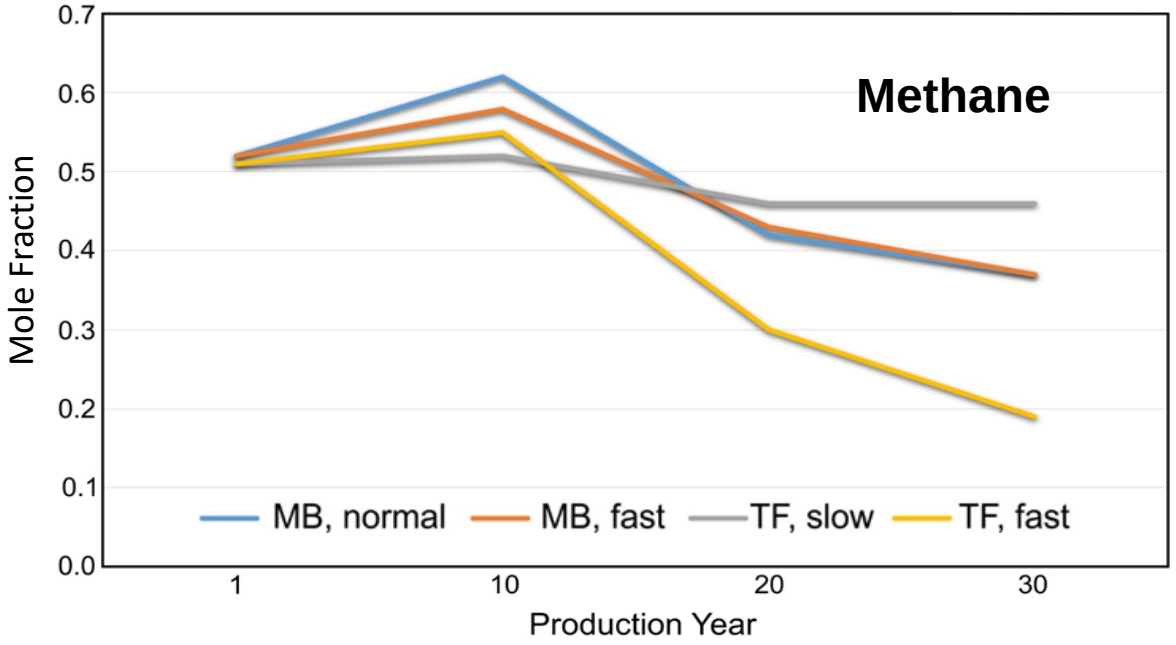
Gas composition change in the MB well over 30 years of normal and fast pressure depletion

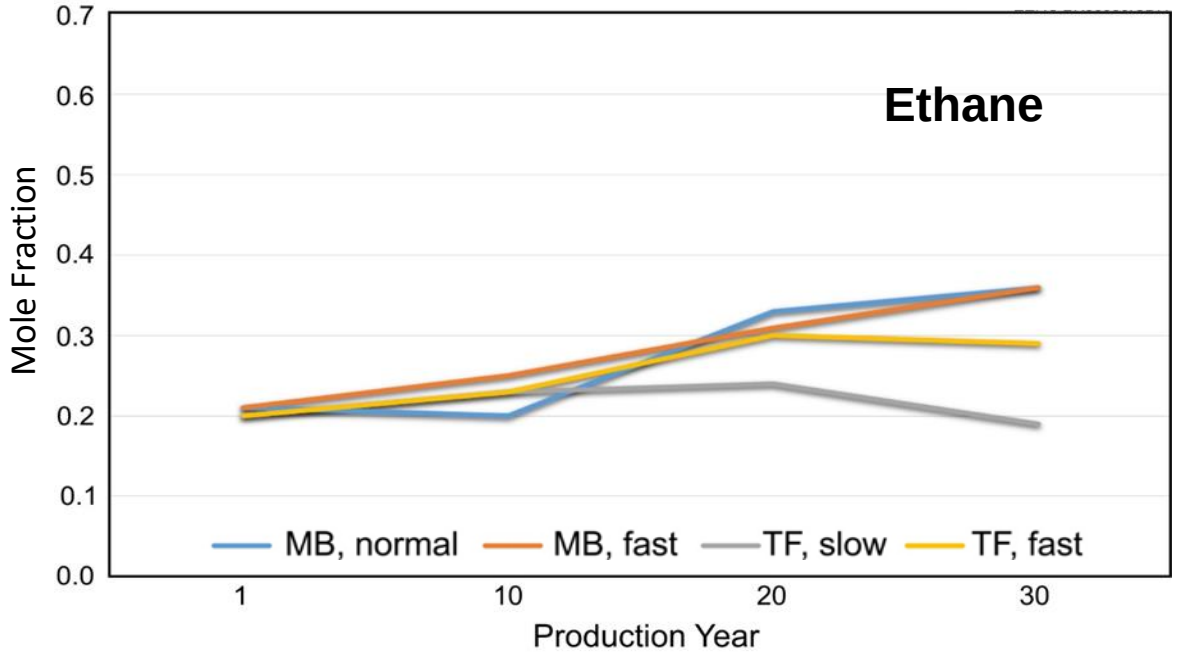


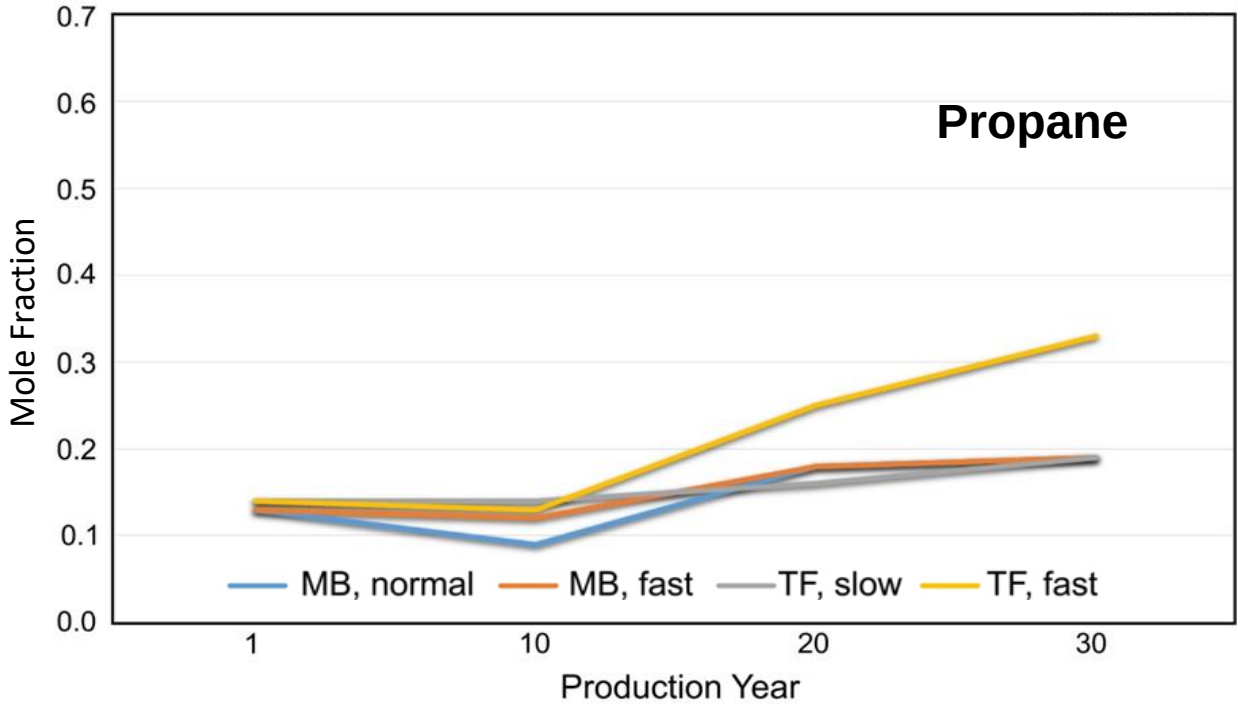
Gas composition change in the TF well over 30 years of slow and fast pressure depletion



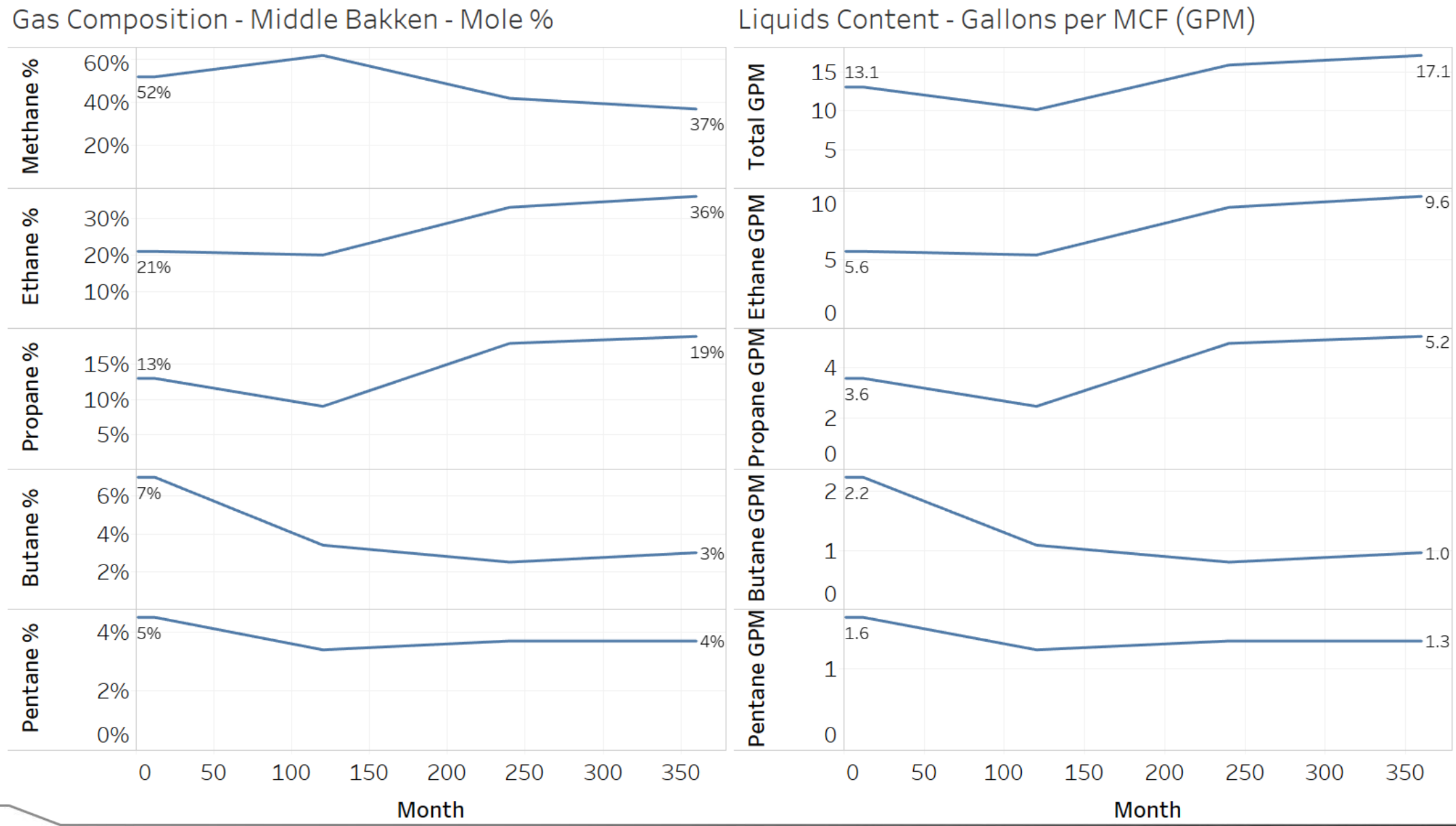
Forecast of Future Gas Compositions



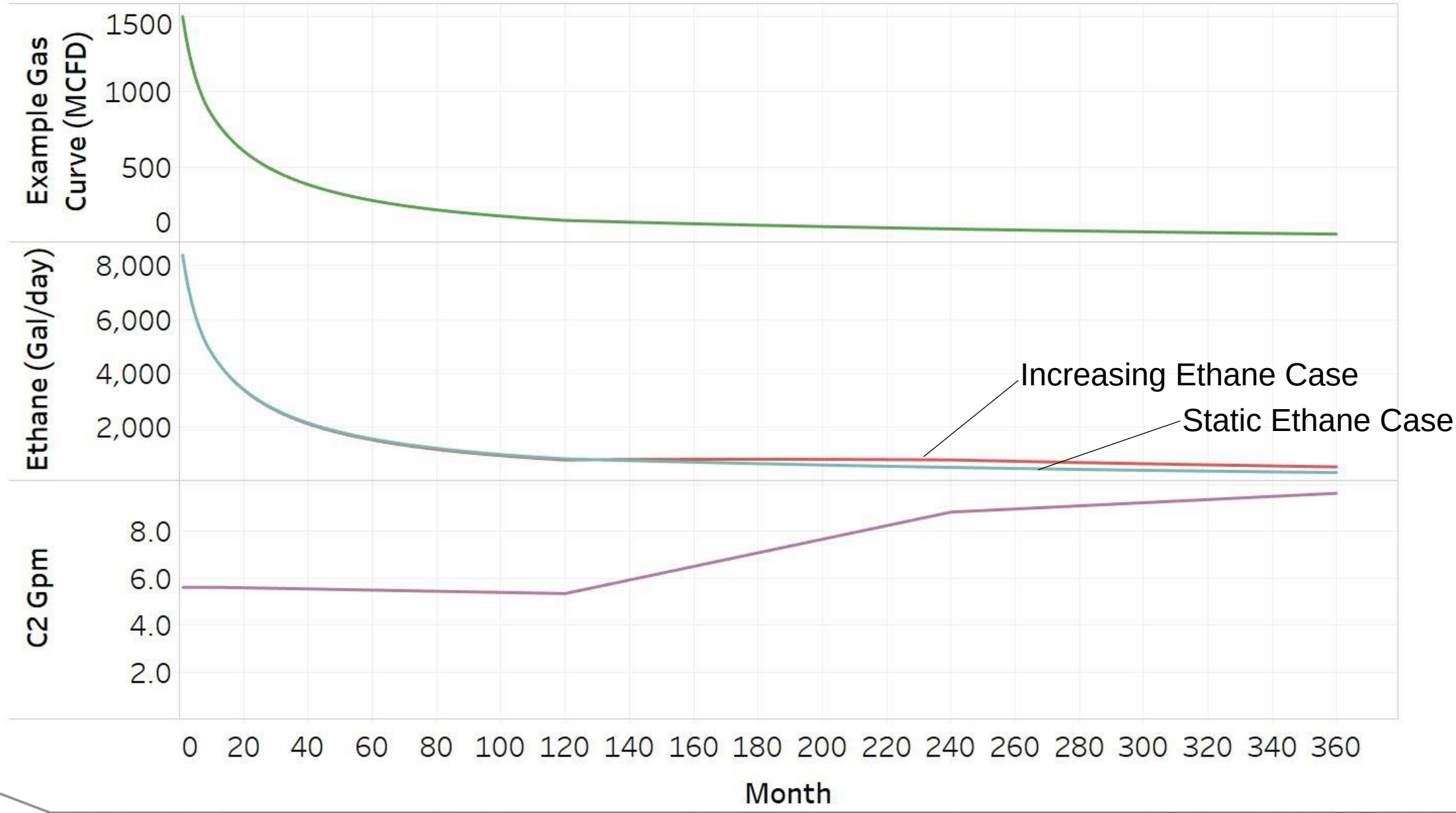




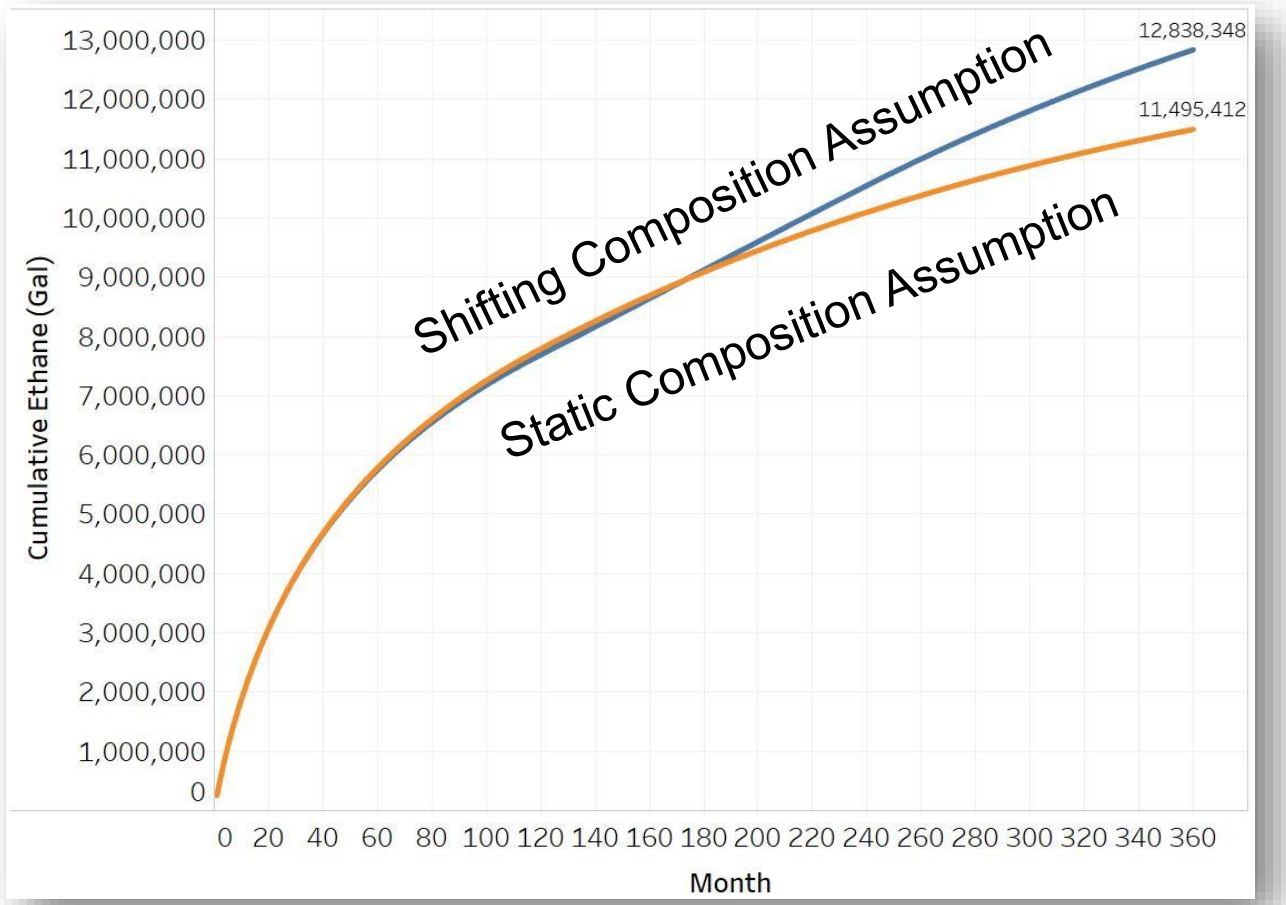
Overview of NGL Chemistry Study – Middle Bakken

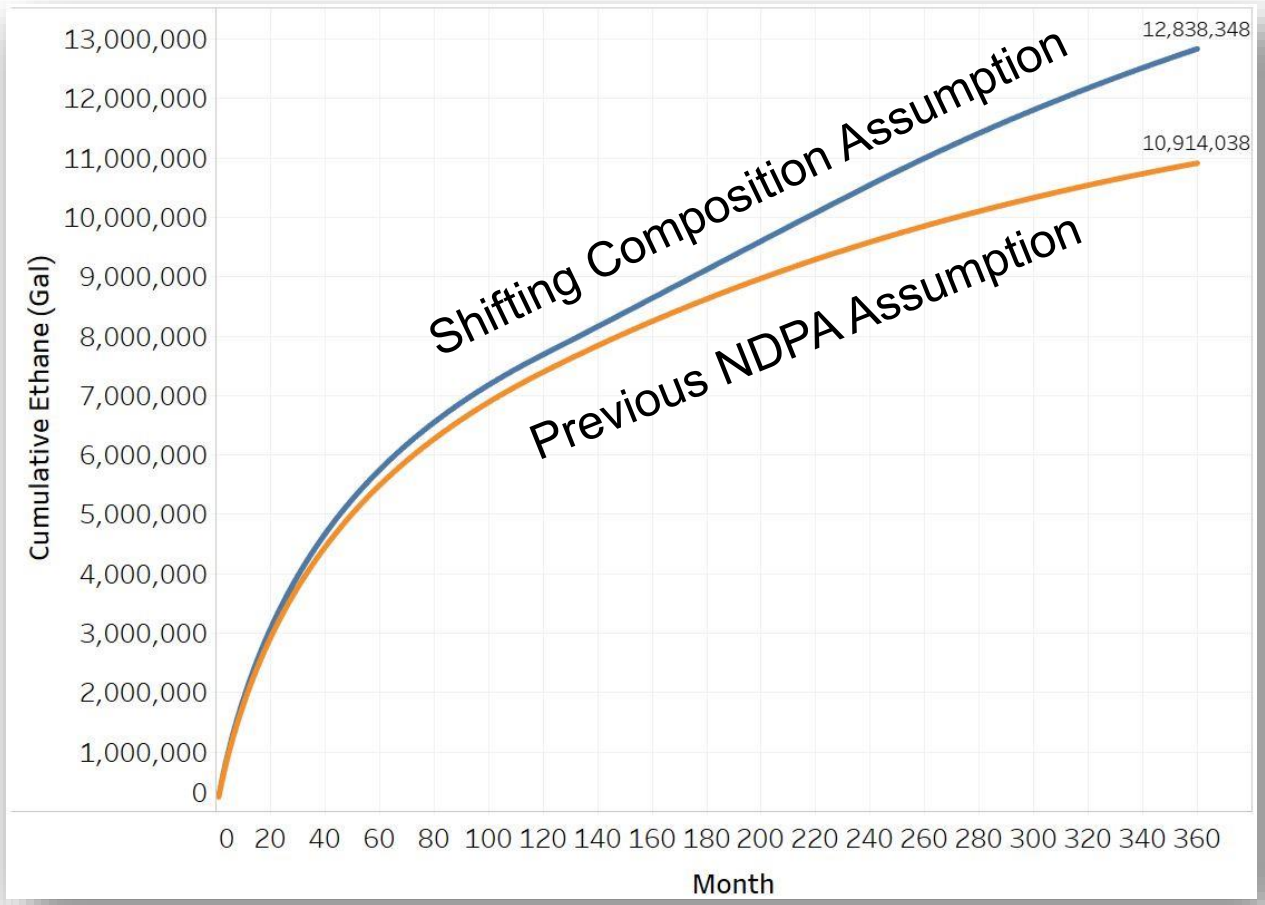


Estimates Using NGL Chemistry Study – Middle Bakken

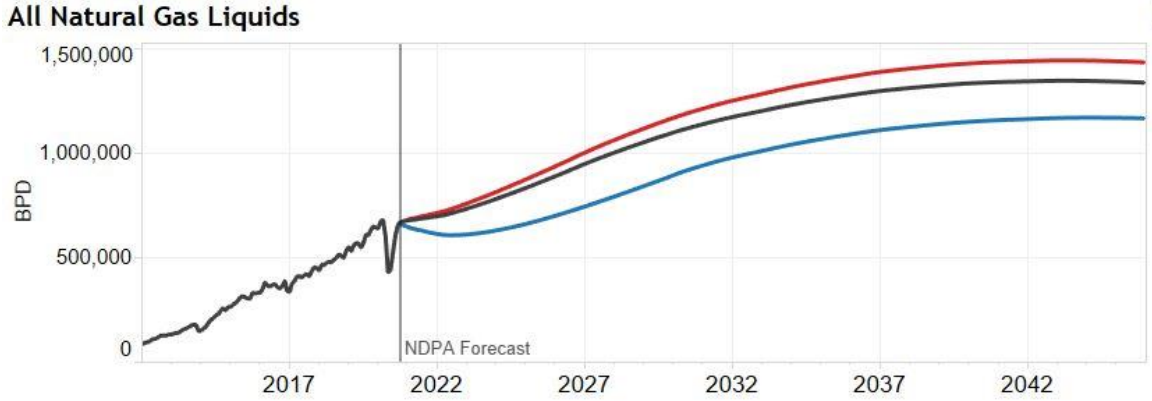


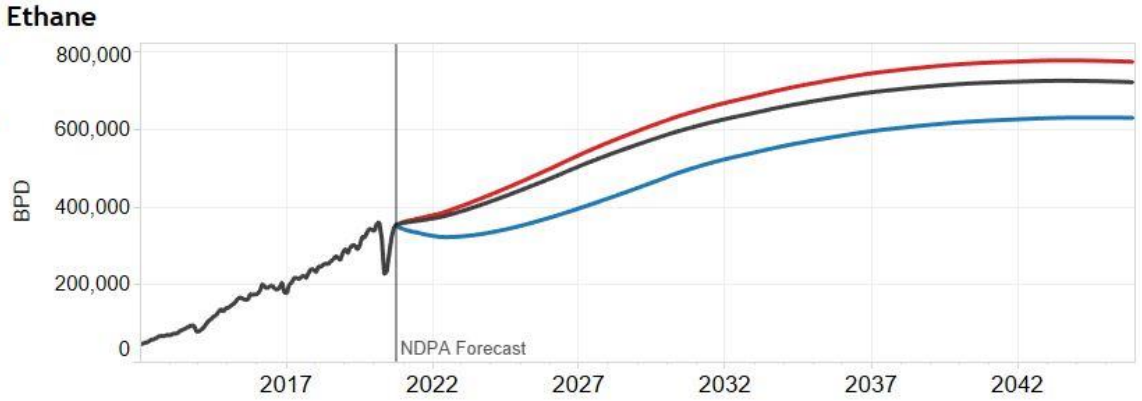
Cumulative Ethane Production Comparisons

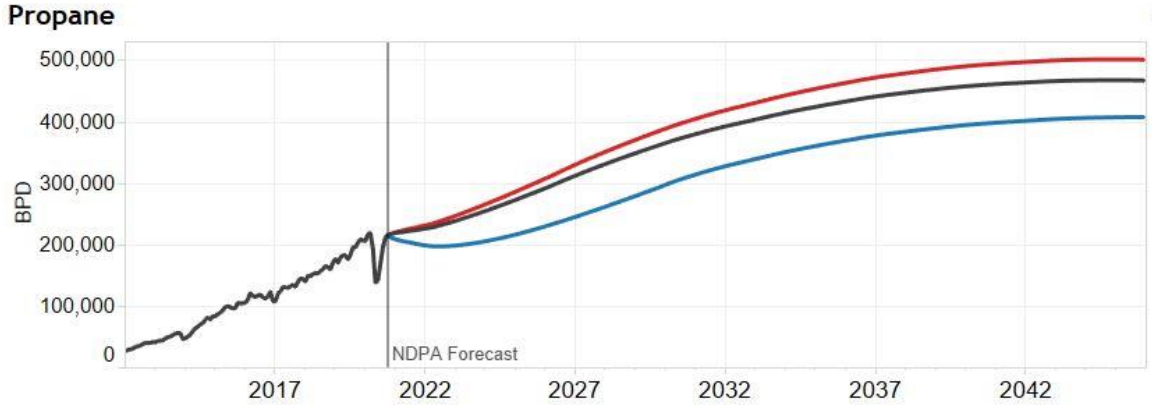


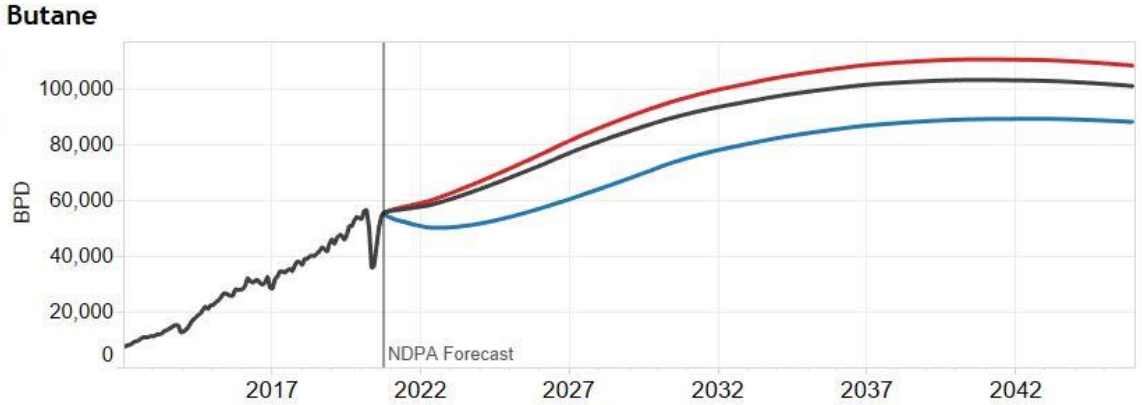


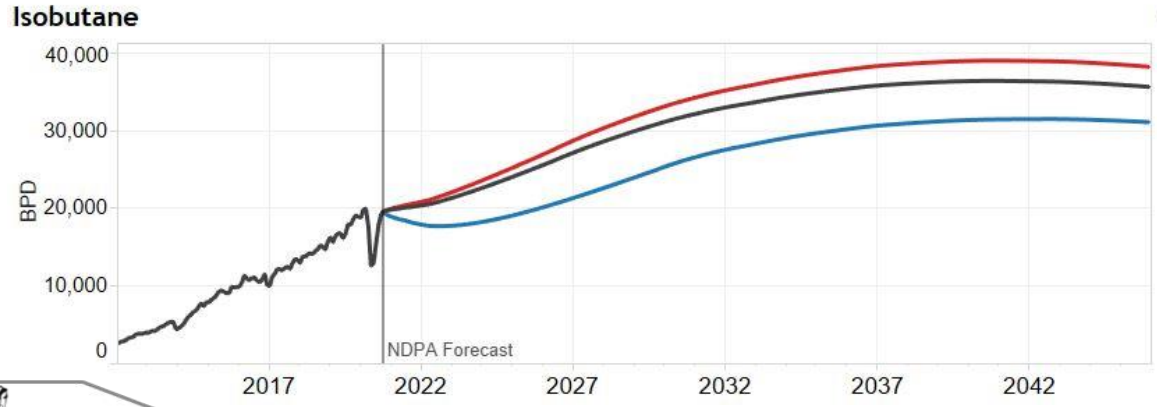
North Dakota Captured* NGL's

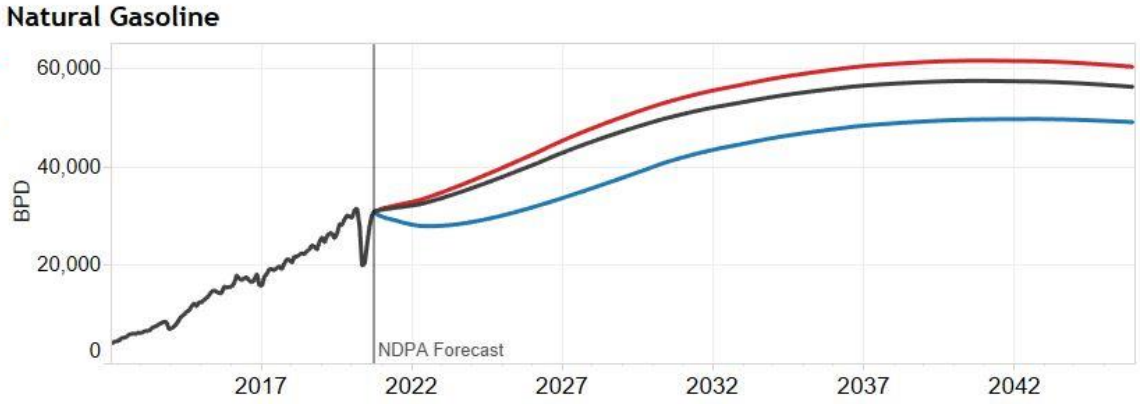




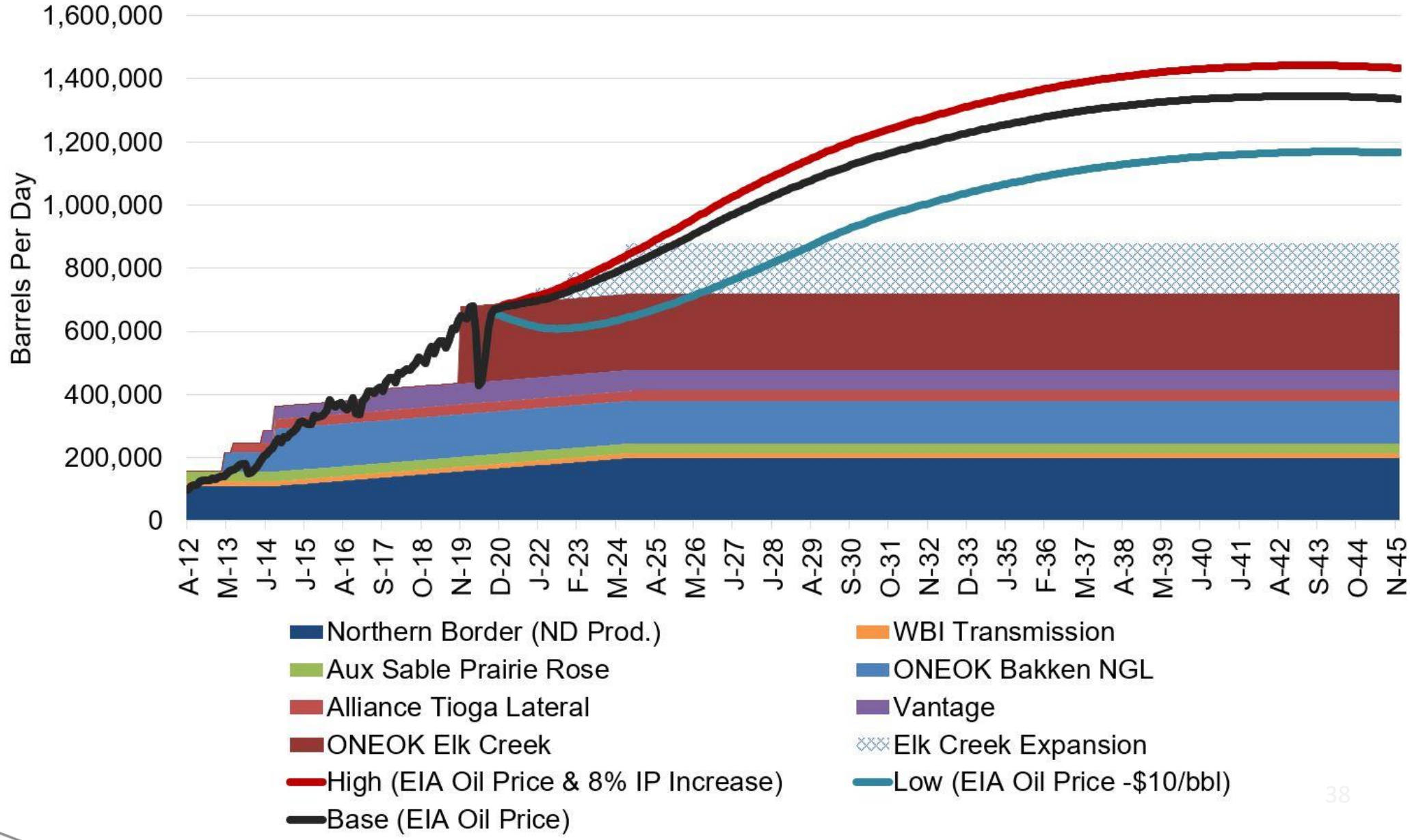




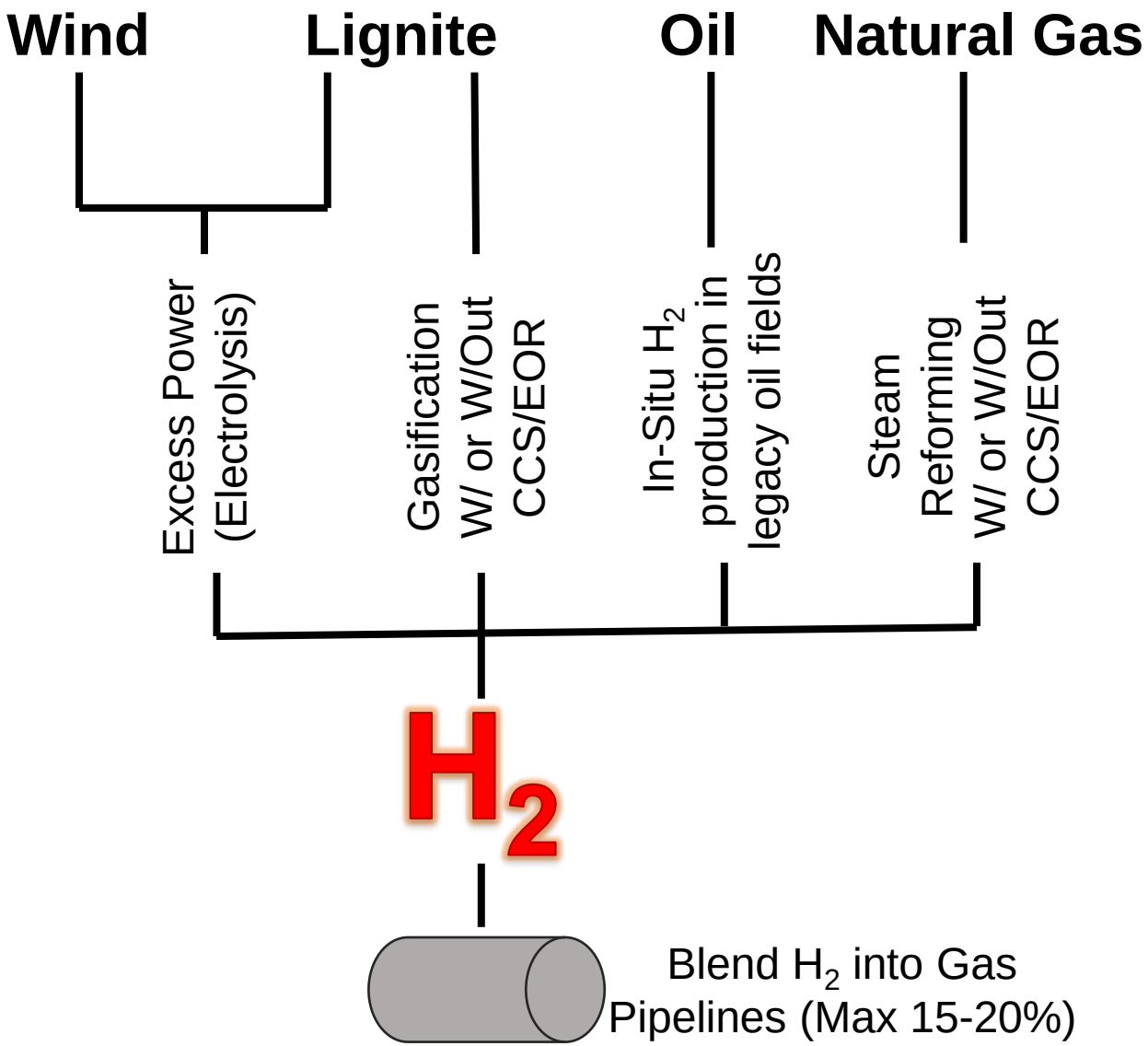




NGL Pipeline Takeaway Options



Exploring Hydrogen Solutions



Electric Generation

- Large and Immediate Market for Excess Power in Regional Pipelines
- Excess Electrons Sold for H_2 BTU Value in Gas Markets
- Gas Pipelines Could Support Intermittent Deliveries
- Gasification Options for Lignite

Gas Pipelines & Petroleum

- Lowers Pipeline BTU
- Possible Support for Expansion Efforts
- Gas Marketing Advantages with Renewable or Carbon-Free Sources of H_2
- In-situ H_2 production in legacy fields
- Natural Gas Steam Reforming W/CCS or EOR Options

North Dakota

- Grows the "Energy Pie"
- Supports Current and Future Jobs
- First Step in Hydrogen Bridge for New Industries (Petchem, Fertilizer, Renewable Natural Gas, vehicles, etc.)
- ESG Benefits?

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