Skip York, Principal Analyst – Oils Research

“Evolving Dynamics in North American Oil & Gas Production”
North America’s hydrocarbon renaissance is impacting the integrated Oil & Gas value chains.

Oil Markets

Gas Supply

Gas Processing & Fractionation

Reformer & Aromatics

Steam Cracker

Demand

Net Balances & Trade

Economics

Global
Regional
PADD

Raw Crude Oil

Naphtha
LPG

Benzene
Toluene
Xylene

Natural Gas

Ethane
Propane
Butane

Ethylene
Propylene

Petrochemical Derivatives

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Petrochemical Derivatives
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› A brief global perspective

› North America production profiles

› Key drivers to capturing value by play

› What this means for construction activity
Growth trajectories in transport set the trend for OECD vs non-OECD

OECD Demand

Non-OECD Demand

Non-OECD > OECD by 10 mbd in 2020

Source: IEA Forecast Wood Mackenzie
Global oil fundamentals to 2020 shows rising supply and steady oil demand growth

Source: Wood Mackenzie
US shows massive growth with Brazil and Canada also strong for non-OPEC supply; biofuels drives unconventionals

**Non-OPEC production change from 2013 to 2020**

- Tight oil accounts for 2.7 million b/d
- Oil sands increases 1.0 million b/d

**Forecast of Unconventionals to 2020**

- Oil Shale
- Gas-to-liquids
- Coal-to-liquids
- Biofuels

**Source:** Wood Mackenzie
Wood Mackenzie’s forecast shows moderate downward pressure to 2017 with Brent at $90 per barrel real.

Annual average for Brent and WTI in real and nominal terms to 2020

- Break even prices of high cost producers help define floor
- Political risk could lift prices higher despite ample non-OPEC growth
- OPEC spare capacity increases
- US continues to limit crude oil exports
- Weaker economic growth would escalate the oversupply

Source: History – Thomson Datastream, Argus, Forecast – Wood Mackenzie
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Supply gains in Canada are driven by oil sands and diluent requirements

Forecast of total Canadian oil supply by type or location

Source: Wood Mackenzie
US liquids growth driven by tight oil and NGLs

Tight oil growth of 2.7 mmbd by 2020

NGL growth of 0.9 mmbd by 2020

Forecast of Total US Liquids Oil Supply to 2020

Source Wood Mackenzie
US volume recovery started in the Permian and spreads to the Gulf of Mexico.

Forecast of Lower-48 Crude Oil Supply to 2020:

- Permian growth since 2006 is 1.6 million b/d.
- US GoM growth to 2020 is 0.5 million b/d.

Source: Wood Mackenzie
US tight oil still dominates the non-OPEC growth story...and 8 counties dominate the US tight oil story

- Eight counties in the Bakken and Eagle Ford account for 75% of growth since 2009
- Gains in US tight oil average almost 390,000 b/d per year between now and 2020.
- US tight oil contributes 50% of non-OPEC growth in 2015 and more than 25% in subsequent years.

Source: Wood Mackenzie
Majority of gas drilling remains highly economic at prices below $4/mmBtu

- Over 95% of new production in 2014 will have a breakeven below $4/mmBtu
- Associated gas to add 1.5 bcfd on new-gas volumes in 2014
- Costs have continued to decline in gas-prone areas like the ArkLaTex basin as drilling efficiencies continue to improve and pad-drilling spreads
- Lower realized NGL prices and has increased gas breakevens in some Mid-Continent plays as well as widening basis points in the Northeast

Source: Wood Mackenzie
The price spread of oil to gas encourages demand growth through substitution.

Source: NYMEX, Argus Media, Wood Mackenzie
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Persistent pipeline “choke points” keep inland differentials wide; as routes south from Canada remain “choked.”

- Pipeline Routes Running at Full Capacity
- Pipeline Routes with Spare Capacity

West Canada

Superior

Cushing

Bakken
Growing rail infrastructure on the coasts results in greater optionality for inland barrels.
Expanding logistics offer optionality around destination markets

- PNW $91.00/bbl
- California $93.75/bbl
- Gulf Coast $86.50/bbl
- Chicago $90.00/bbl
- East Coast $90.50/bbl
Assay comparison reveals value drivers and further opportunities

- Lighter Eagle Ford barrels sell at a discount to LLS:
  - Lower potential distillate yield
  - Volatility in crude quality remains an transaction advantage for refiners

- Brent and LLS should sell close to parity, but US export policy forces LLS quality discount

<table>
<thead>
<tr>
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<th>Yield Cut, wt %</th>
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<tr>
<td>Eagle Ford</td>
<td>LPG</td>
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<tr>
<td>Bakken</td>
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Saturation of PADD III with domestic light and medium crudes expected to result in domestic crude refining value discounts

Value of Light Houston Sweet

PADD 3 crude slate

Source: Wood Mackenzie
Destination market refining value and transportation to that market are key drivers to allocating North America inland crude oil.
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New sources of North America gas demand growth, but prices remain moderate

Source: Wood Mackenzie
Chemical expansions: More than just infrastructure constraints

Chemical renaissance is based on:
- Geology, technology, & infrastructure that support large volumes of cheap ethane availability
- Stable investment climate / economy
- Existing & expandable infrastructure from the wellhead in the Eagleford to the polyethylene exporter in the US Gulf Coast

Risks to the renaissance are:
- Sustainability of the gas/crude differential
- Ethane deliverability infrastructure
- Environmental permitting, capital costs escalation, construction resources
- Availability of international market demand & trade

Delivering commercial insight
$100+ billion in chemical related investments by 2020
Capturing the North America energy value opportunity requires capital...and a lot of it

Capital Spending by Value Chain Segment

US$ Billions

Source: Wood Mackenzie
Black Swans??

› Oil demand evaporates

› US saturates petroleum product export markets

› Oil prices collapse below wellhead break-even
Gasoline accounts for almost half of US oil demand but its dominance is fading. Current stabilization is temporary.

Source: Wood Mackenzie
Shift to natural gas is slow this decade but accelerates post 2020, with LNG displacing primarily diesel/gasoil

Oil Demand Displaced by Natural Gas

US Diesel/Gasoil Demand

Source: Wood Mackenzie
Black Swans??

- Oil demand evaporates
- **US saturates petroleum product export markets**
- Oil prices collapse below wellhead break-even
Atlantic Basin is surplus gasoline and fuel oil if all refining centres operate at historical utilisation rates and yields.

Atlantic Basin “isolated” balances

Source: Wood Mackenzie
Black Swans??

› Oil demand evaporates

› US saturates petroleum product export markets

› Oil prices collapse below wellhead break-even
Breakeven for new developments help set a floor for oil prices

Breakevens for new developments

International plays are uncertain compared to North America

Source: Wood Mackenzie
Thus there is a limit to how low prices can fall... a third of new oil developments requires more than $80 per barrel to breakeven.

Production from new oil developments by breakeven range in Brent terms real

Source: Wood Mackenzie
Skip York is a Principal Analyst in Wood Mackenzie’s Oils Research Team responsible for cross-segment integration of petroleum market and infrastructure issues for North America. With over 20 years of worldwide experience across the energy value chain, he has deep expertise in petroleum market economics and price-setting mechanisms including valuing non-fungible crudes across a number markets, NGLs, and leveraging technologies for competitive advantage.

- Specializes in strategy, transaction support, asset valuation, and commercial optimization. Recently he has been focusing on the implications of logistic constraints on market-clearing dynamics and prices for Canadian heavy crude oil and NGL production growth from unconventional plays.

- Prior to joining Wood Mackenzie, Skip worked for ExxonMobil in a variety of strategic planning assignments. He held roles as the global expert on joint venture negotiation best practices, managing new business development downstream opportunities in Asia Pacific, and leading research teams on studies of the economic impact of large-scale oil investments on the economy of Russia. He also has consulted for clients at McKinsey & Company and Charles River Associates.

- Skip holds a PhD Economics from the University of Virginia, as well as, a Masters of Science and Bachelor of Science also in Economics from the University of Wyoming.
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