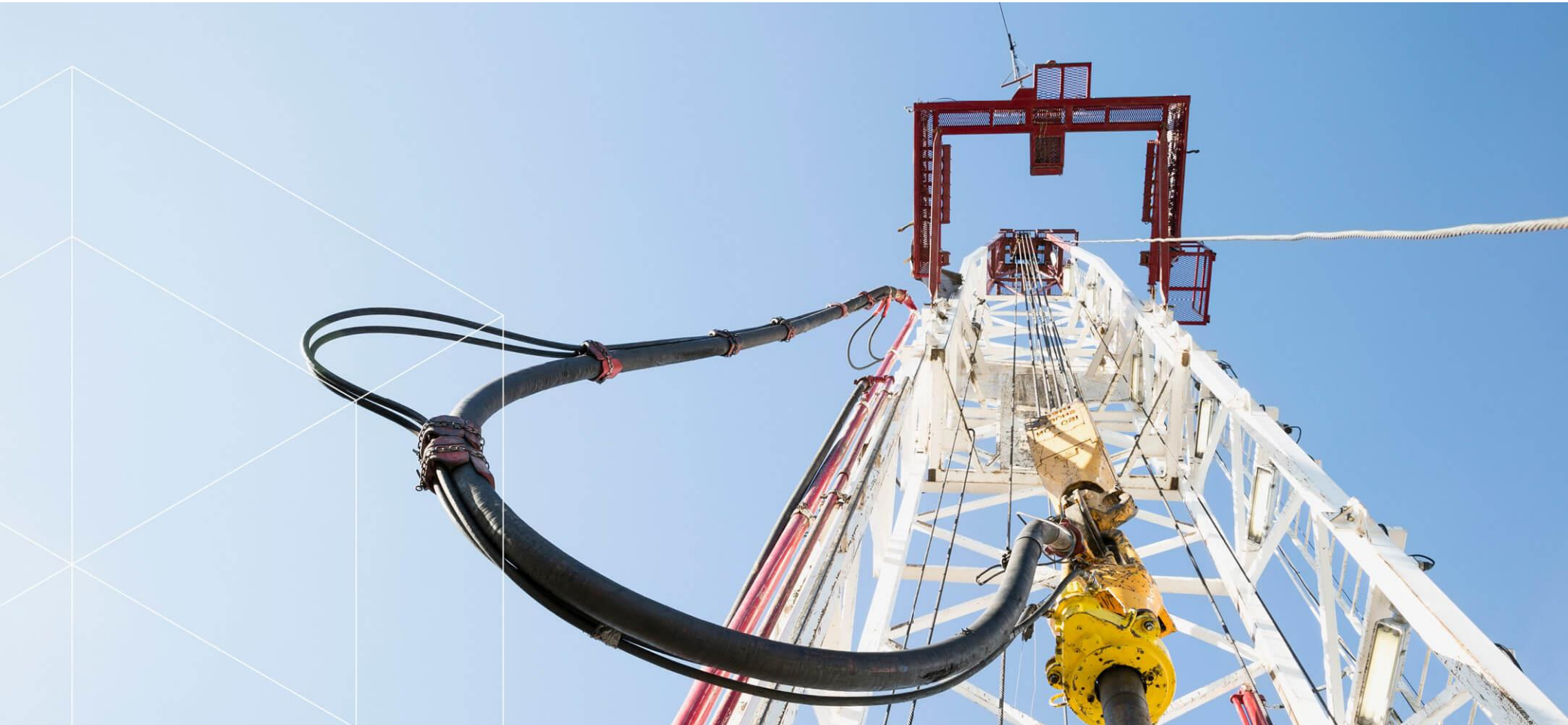


Permian sustainability and SCOOP/STACK competition

The battle to stay at the bottom of the cost curve

Robert Clarke, Research Director – Lower 48 Upstream

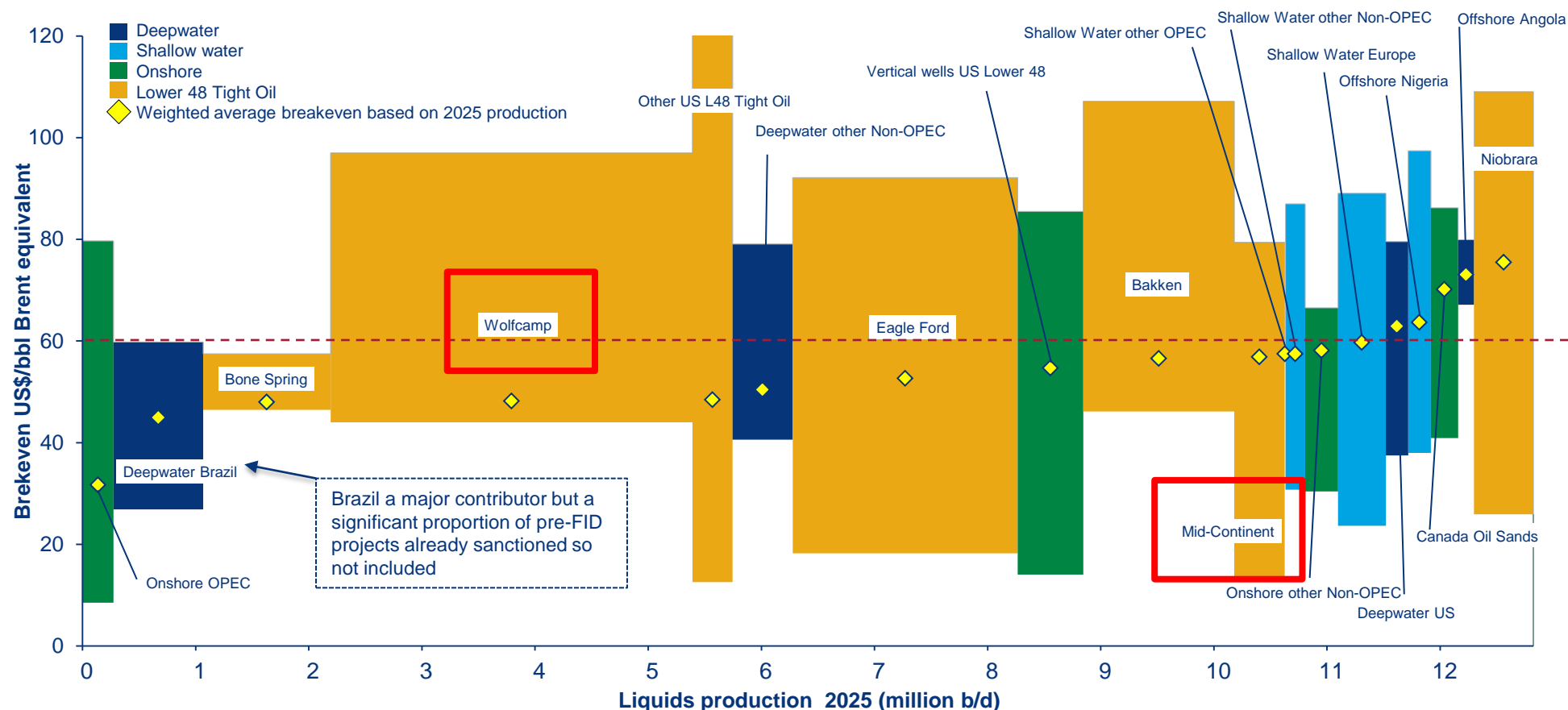




The pre-FID cost curve in 2025: Permian and Eagle Ford dominate

Other themes are competitive, but focus is needed on project execution

Pre-FID and US L48 future drilling production by breakeven in 2025 – by resource theme





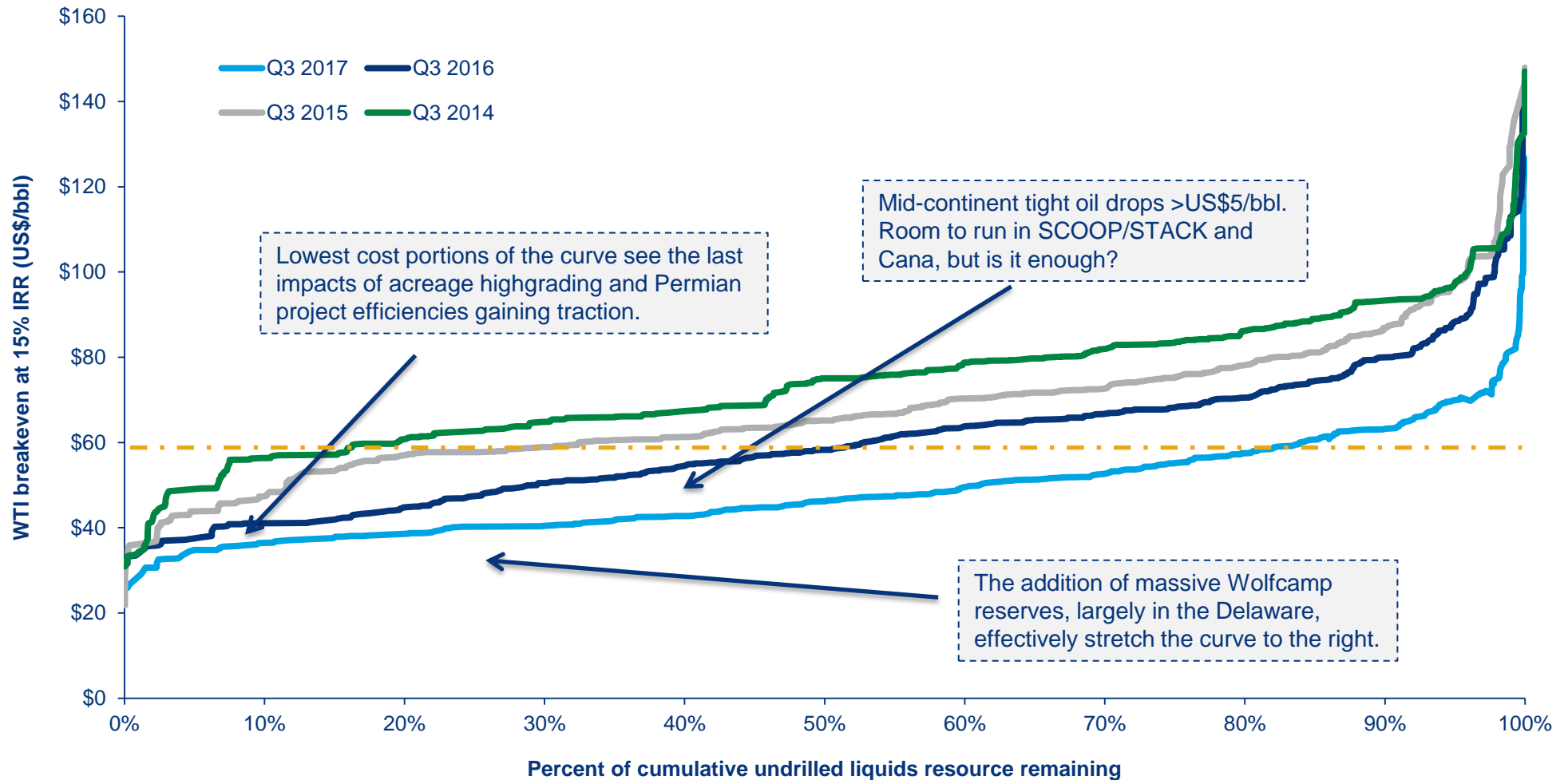
How did US tight oil move to bottom of the global cost curve?

More importantly, is its current position sustainable?

- For the first time ever, our models indicate that >50% of undrilled US tight oil resource breaks even below US\$50/bbl.
- The reduction was a story of two variables....costs and productivity.
- Using the Delaware Basin as an example, EUR per lateral foot doubled and development costs per barrel fell by nearly a half.
- Technology has had a double impact: tangible OFS equipment upgrades and big data analytical models.



Current Lower 48 liquids cost curve: Permian assets add volume and SCOOP/STACK sections of the curve drop

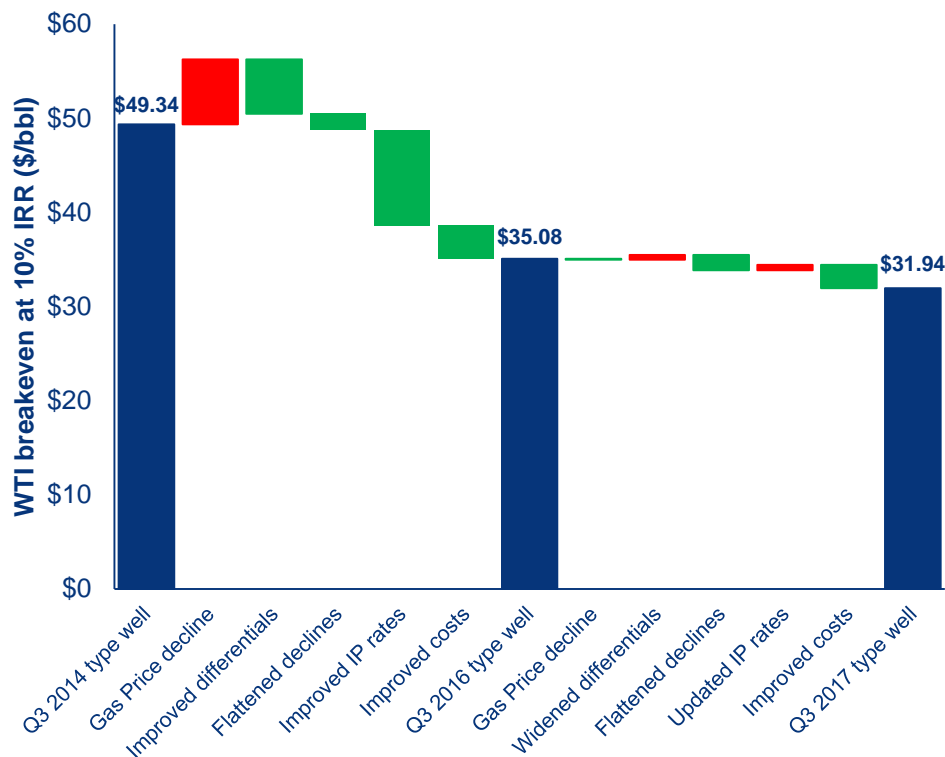




Higher costs stop the downward breakeven trend in core acreages

Asset in spotlight: Eagle Ford Karnes Trough

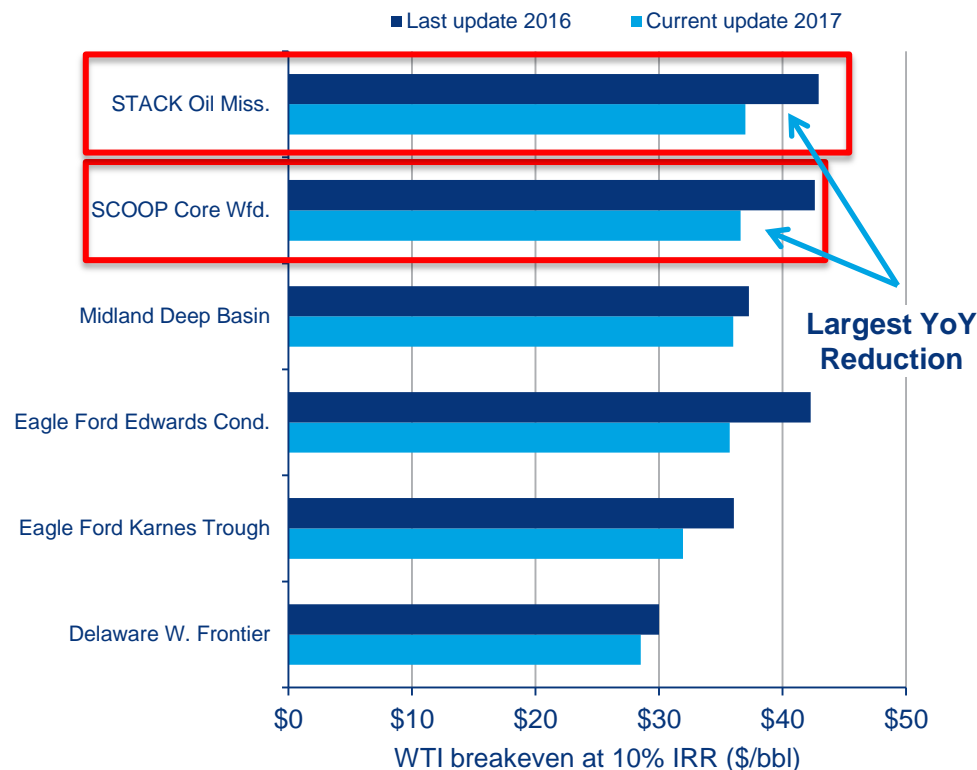
Activity recovery is multi-basin, but the magnitude of metrics evolution is not consistent across geographies. In a more established play like the Eagle Ford, changes in productivity slowed, so higher costs had a more measurable impact.



Source: Wood Mackenzie

Permian stable, Mid-con falling fast

The decrease was smallest for Permian sub-plays. Although productivity gains in these areas were substantial, the Permian is also seeing some of the highest cost inflation. Anticipate the Mid-con making up more ground in 4Q17.

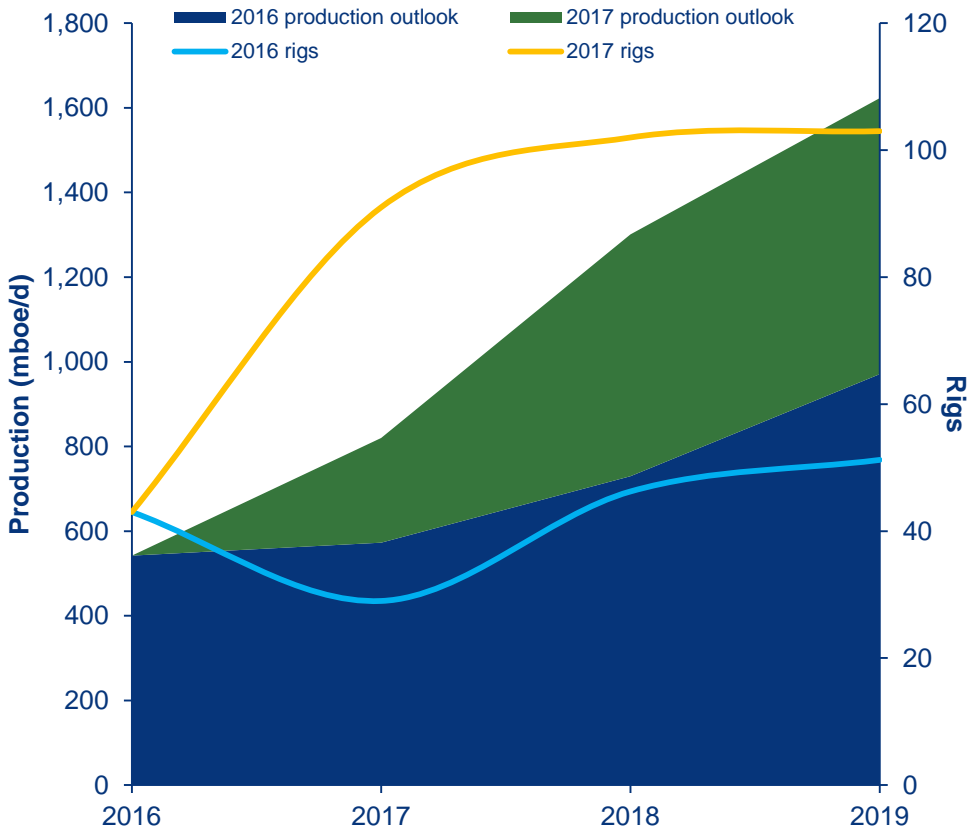


Source: Wood Mackenzie

SCOOP, STACK & Cana production, economics and running room

Tremendous shift in outlook

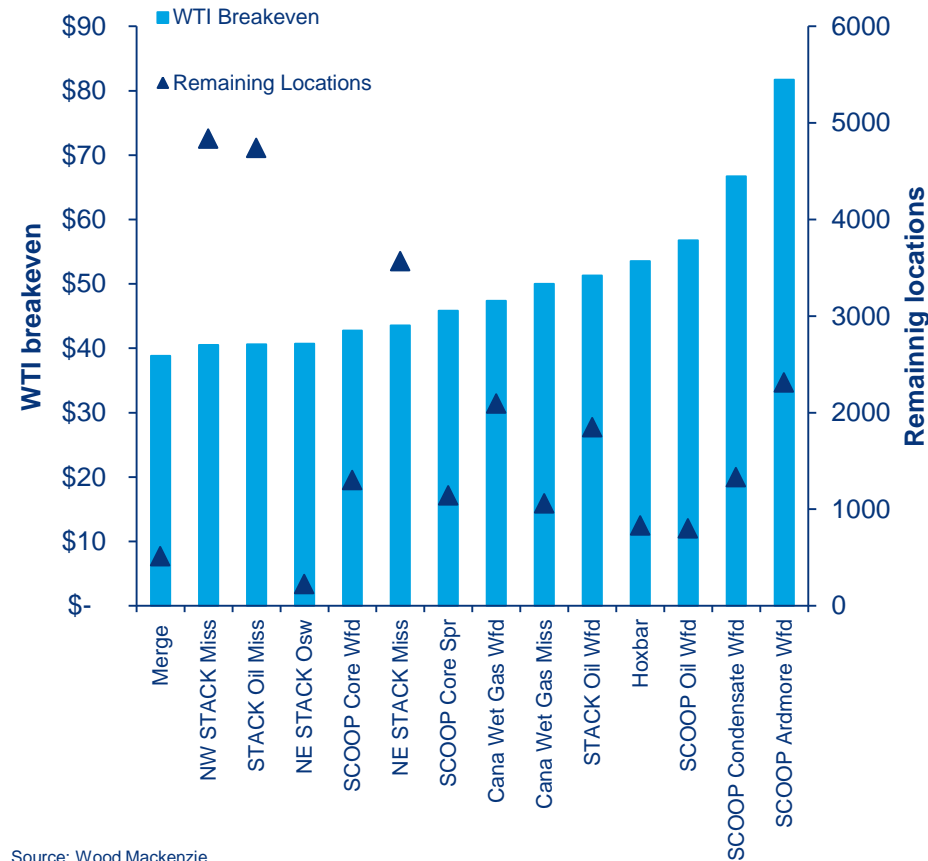
Given the subsurface variability in the play, our production forecast has traditionally been modest. However, with 2017 derisking efforts in large areas of the STACK, production in 2019 nearly doubles from what we modelled last year.



Source: Wood Mackenzie

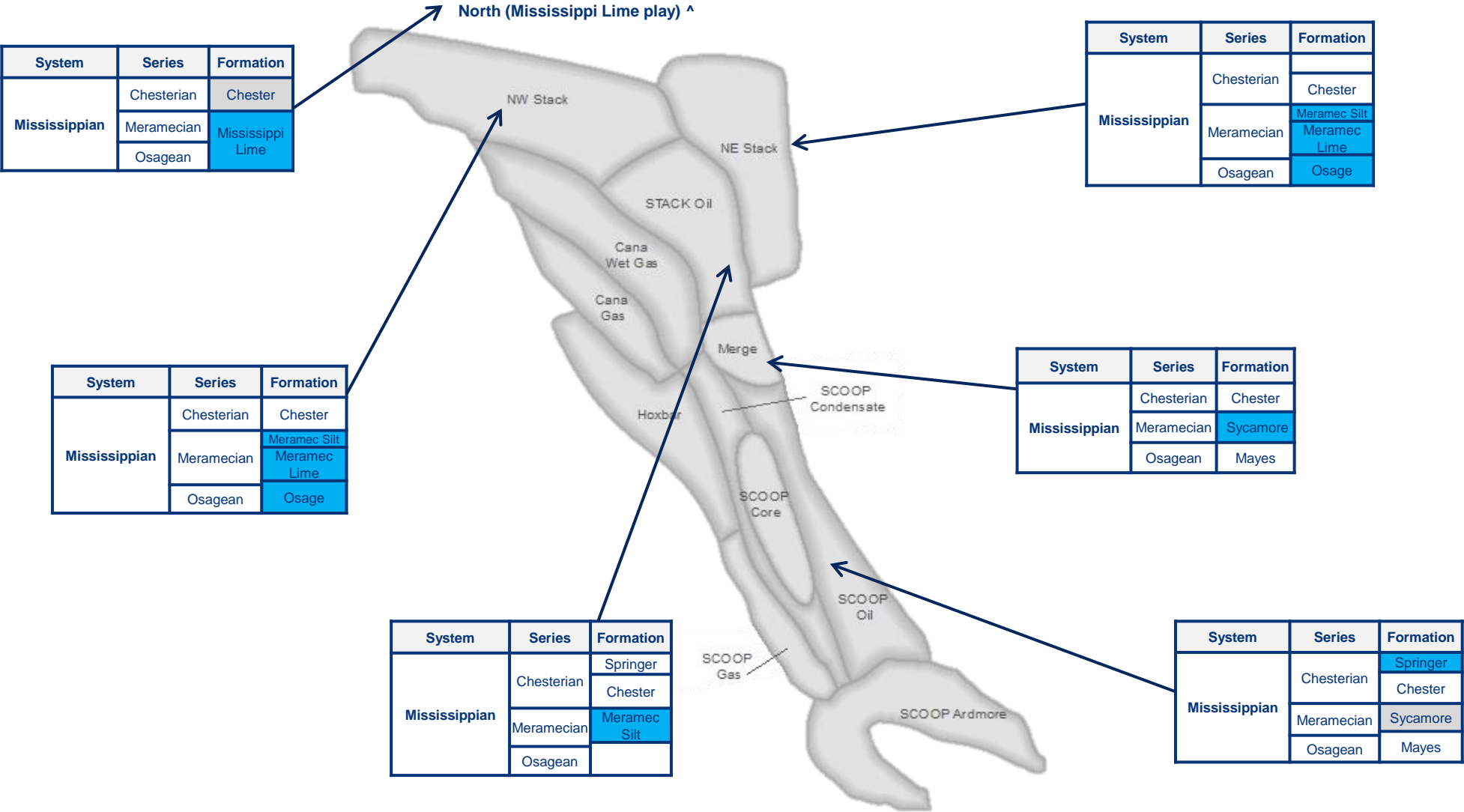
Breakevens and remaining locations

Quality gap between the core and non-core areas is massive though. The SCOOP has the most room for improvement if operators can successfully de-risk the larger areas.



Source: Wood Mackenzie

Mississippian variability: targets across play





**1.5
million
acres**

**New STACK acreage that
we now model economic
under US\$50/bbl WTI**

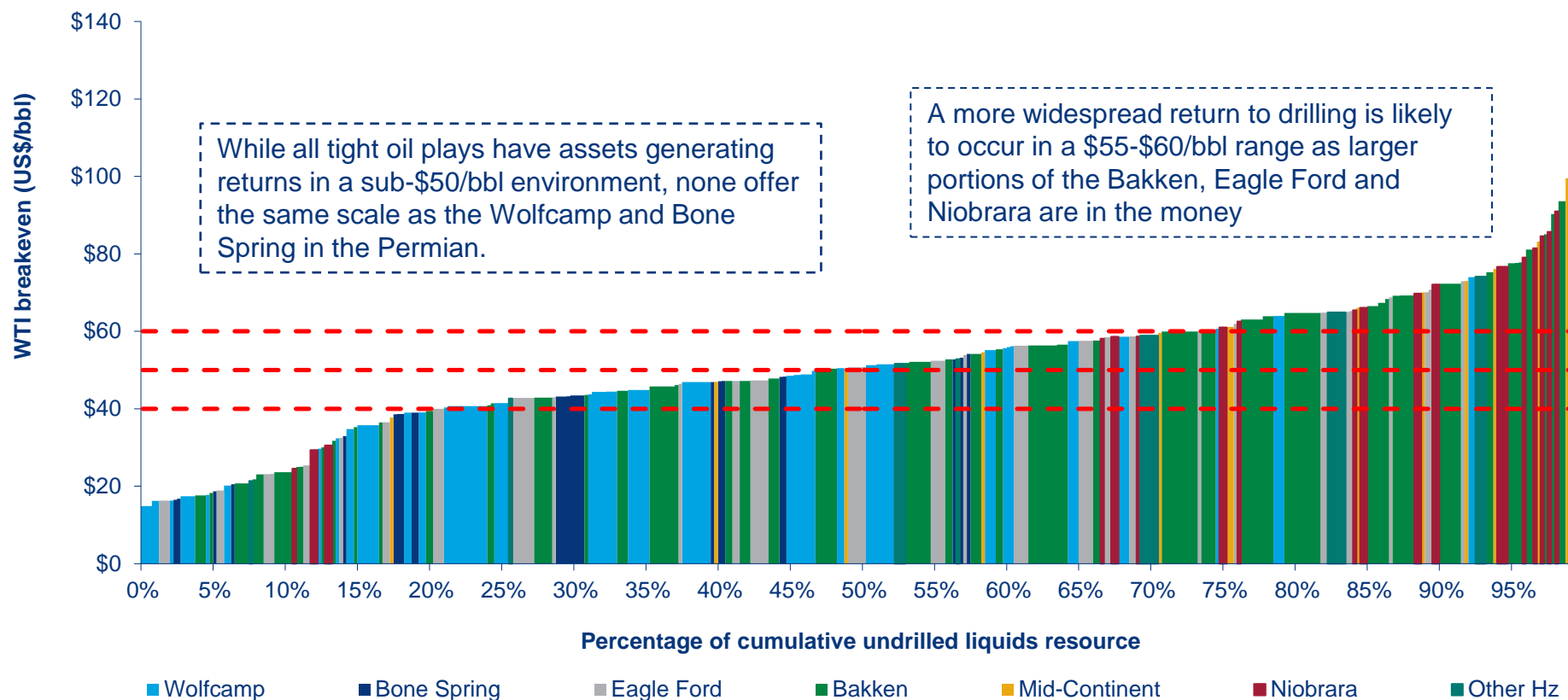




The Permian Wolfcamp and Bone Spring account for over half of the total economic Lower 48 resource below \$50/bbl (WTI)

Resource potential more than triples from \$40/bbl to \$60/bbl.

Lower 48 tight oil cost curve by play

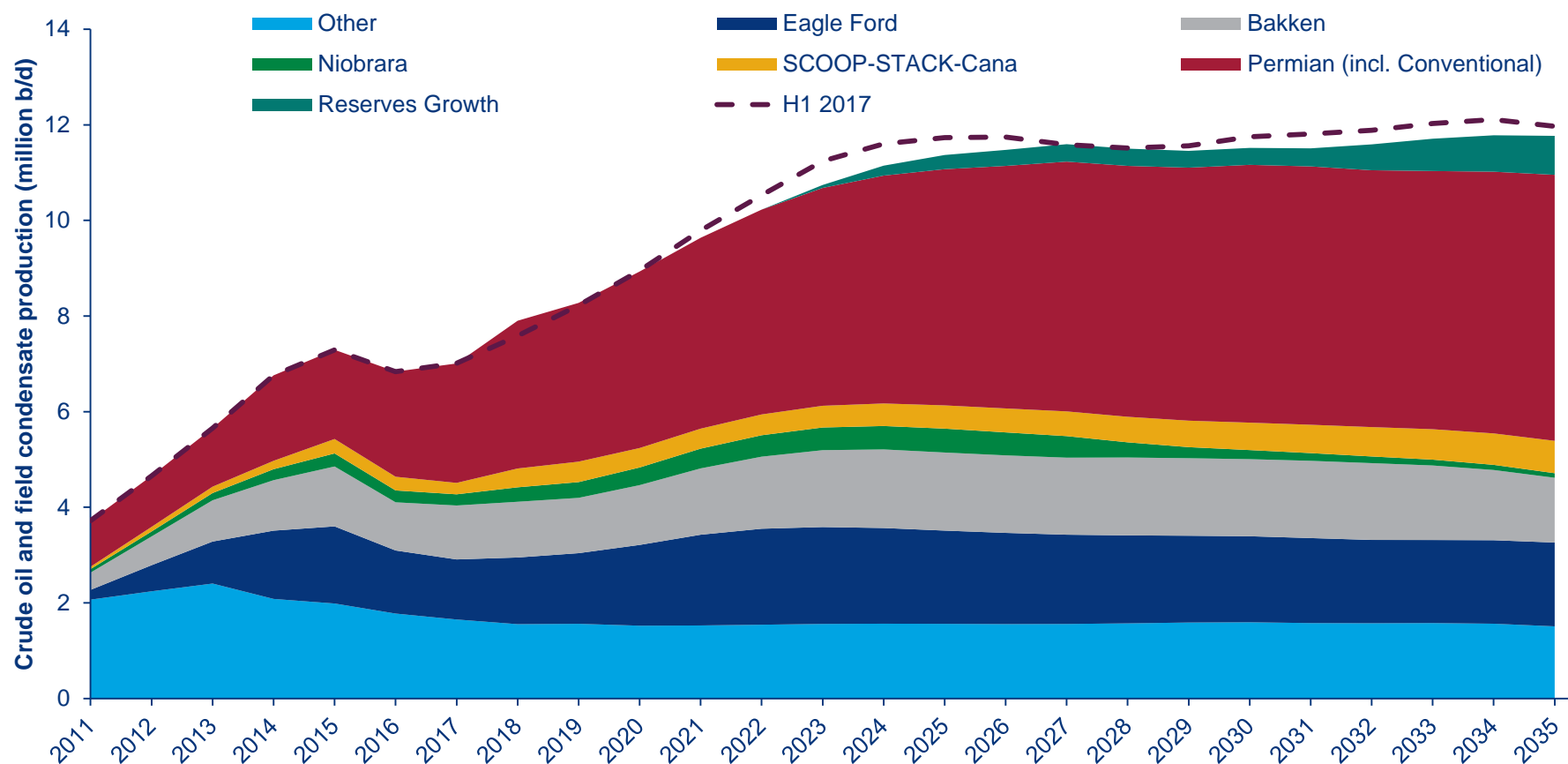




US Lower 48 crude oil supply reaches a broad plateau of 11.5 million b/d by 2026

Although the peak has been lowered by about 300 kb/d compared with H1 2017 forecast, we still see strong growth, driven by the Permian

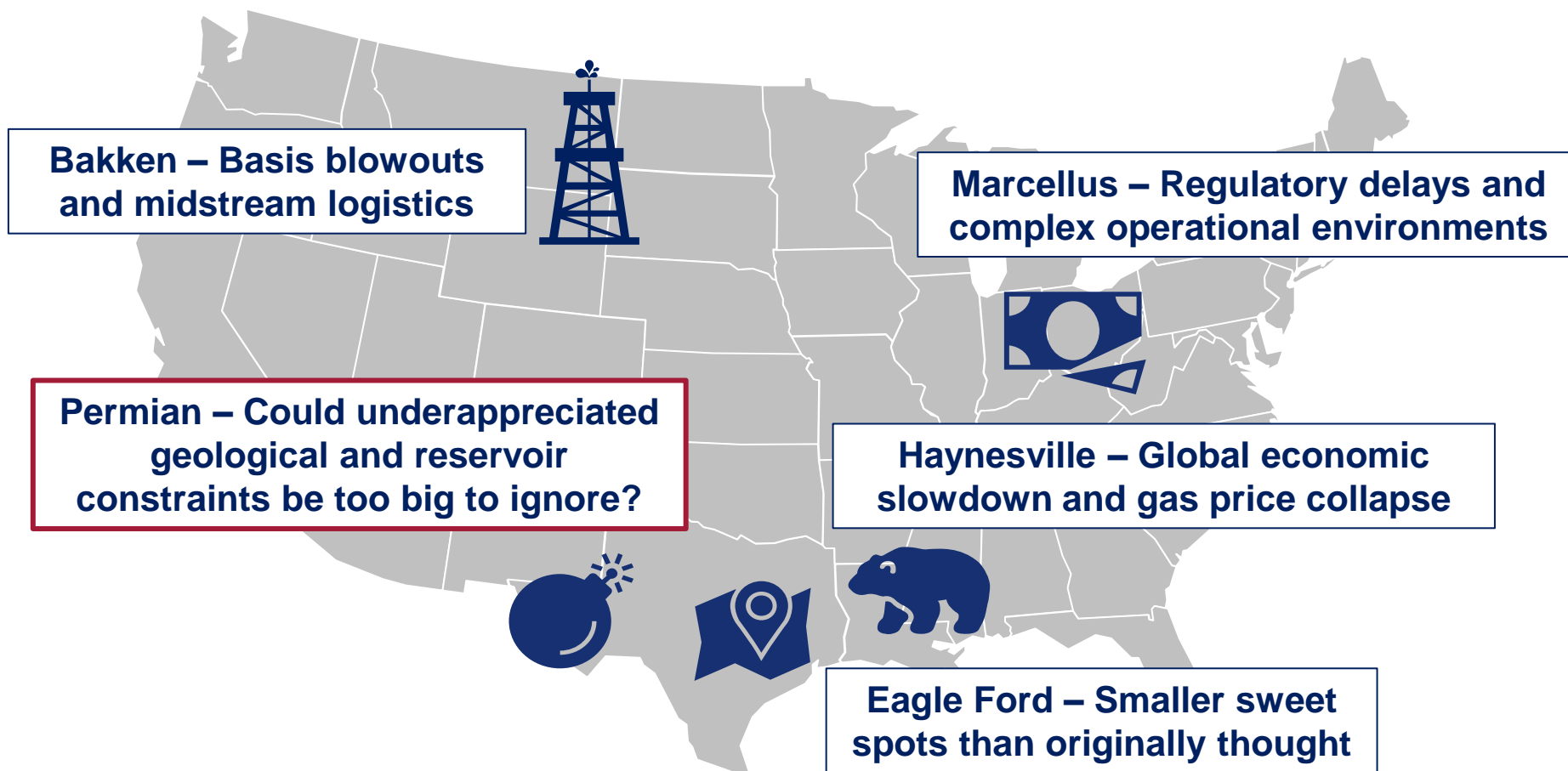
US Lower 48 crude and condensate production





Competition creates opportunity: virtually every mega shale play hit unexpected headwinds a few years in

Operators are setting up to develop the Permian harder than any shale play before



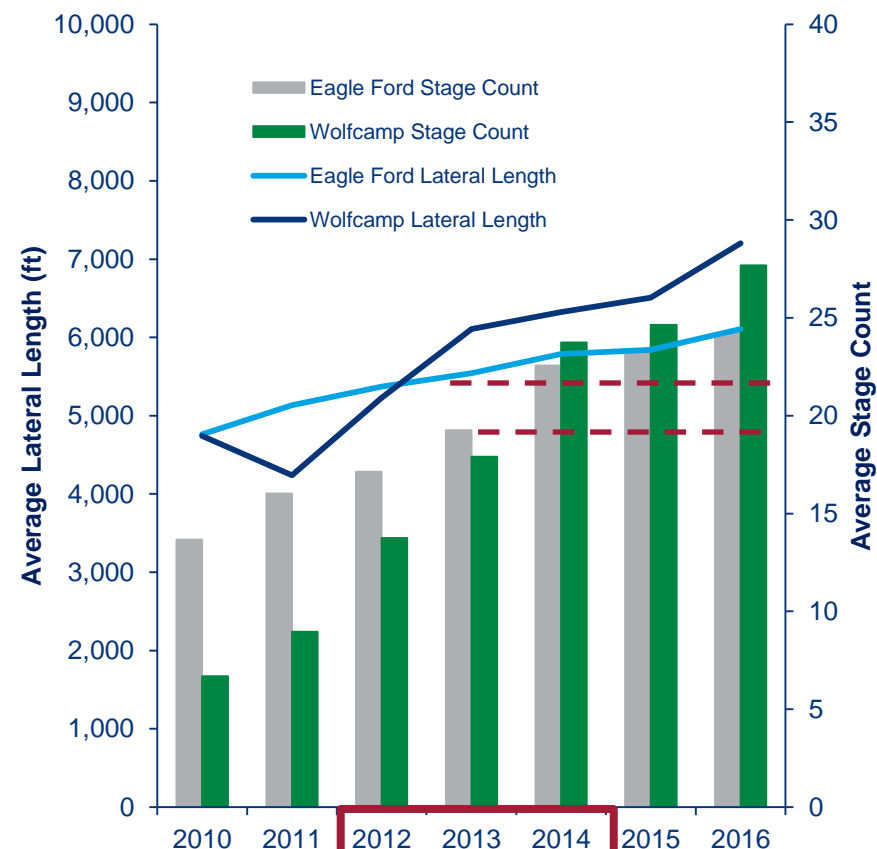
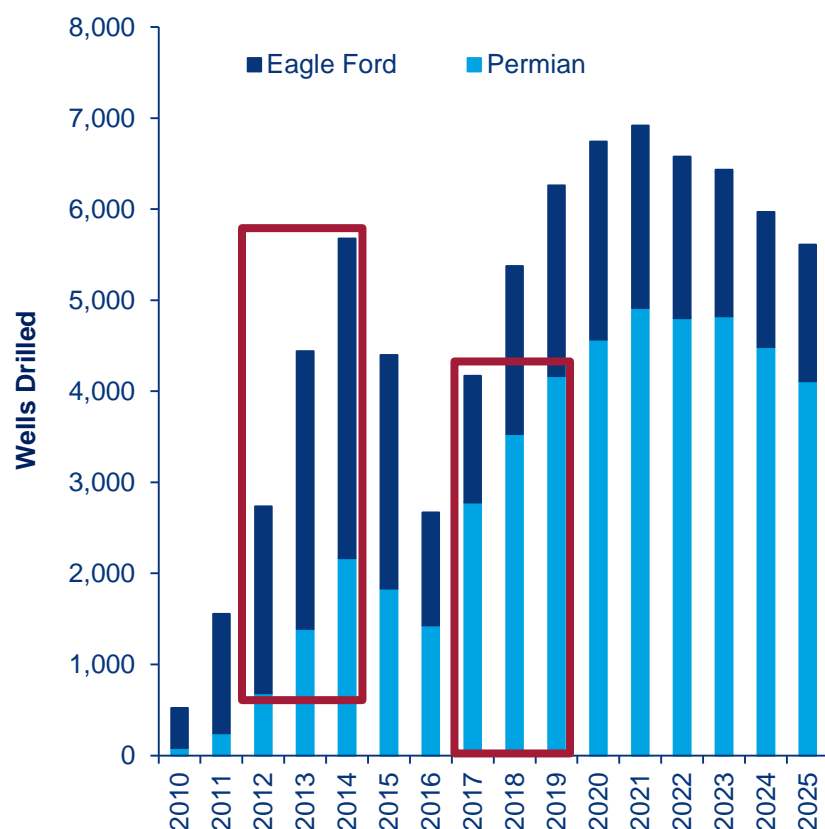


Permian: uncharted territory for stimulating a single play

More wells, longer laterals, more stages in a basin with known vertical communication

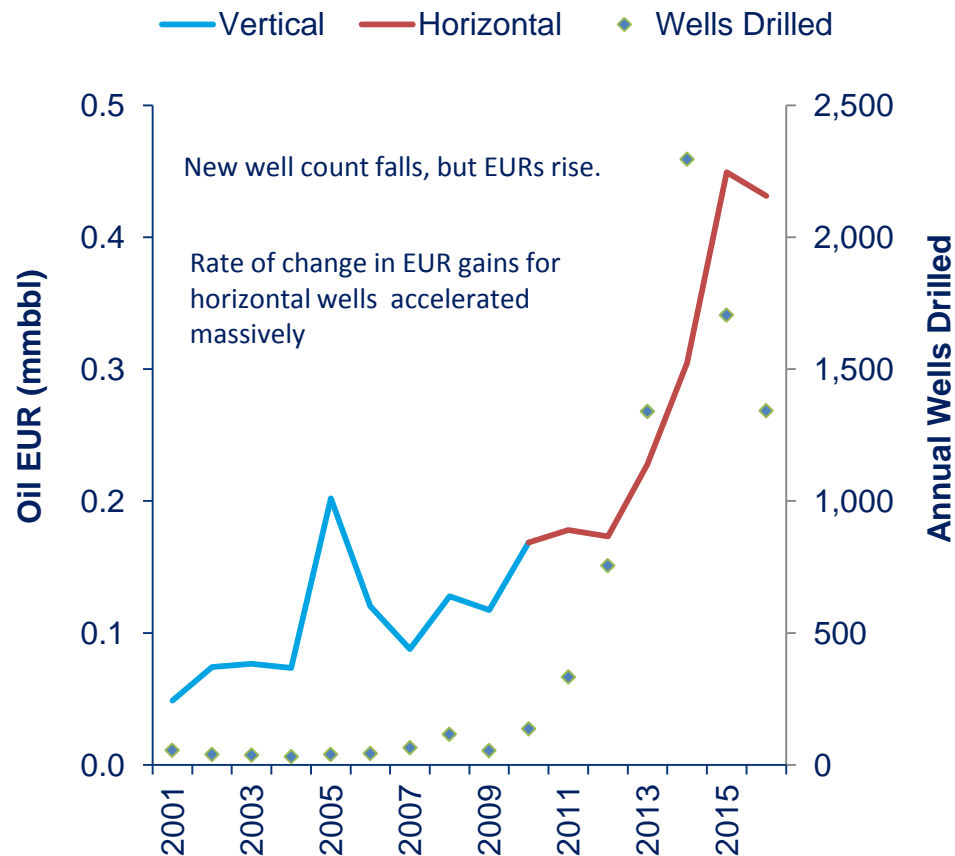
Permian drilling set to exceed Eagle Ford boom

Permian wells have more aggressive completions

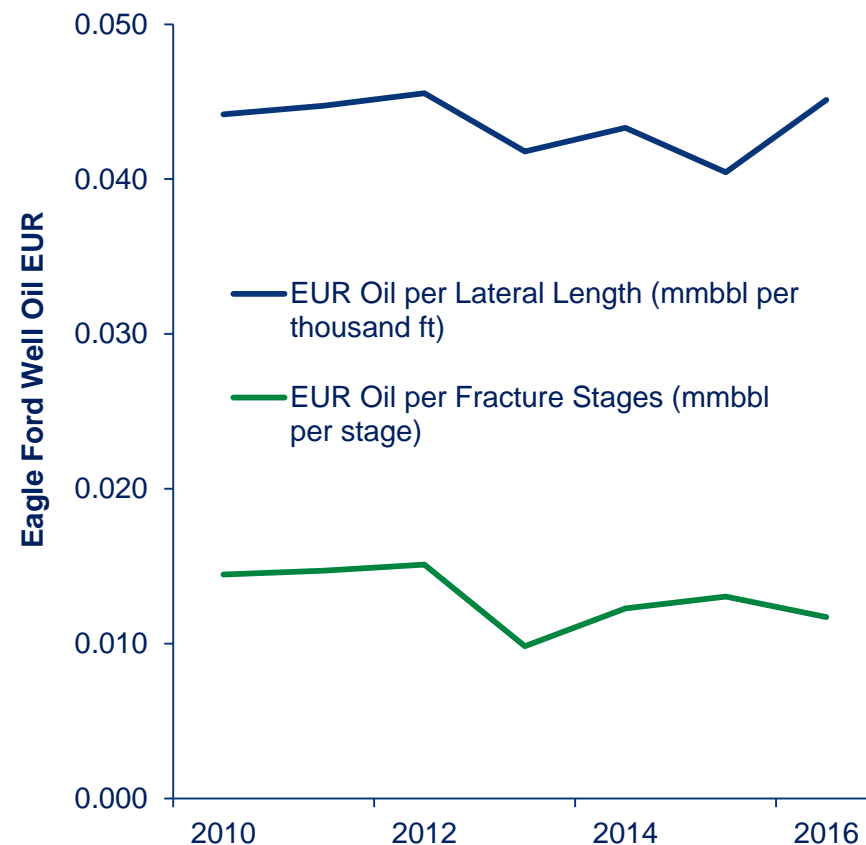


Well gains are remarkable, but sometimes that can be misleading

Wolfcamp EUR gains are explosive



But when we study history.....





This acts as a virtual tug-of-war between the technology and Permian geology debate

Why can't EURs go to 3 mmboe?

- The impact of “next wave” technology enhancements like low temperature diverters, smaller proppant sizes, and better lift systems are yet to be fully seen in production data.
- Fundamental changes in completion design work to create greater reservoir drainage and fracture complexity.
- The Wolfcamp is very early in its development still, so the “learning curve” runway is particularly long.

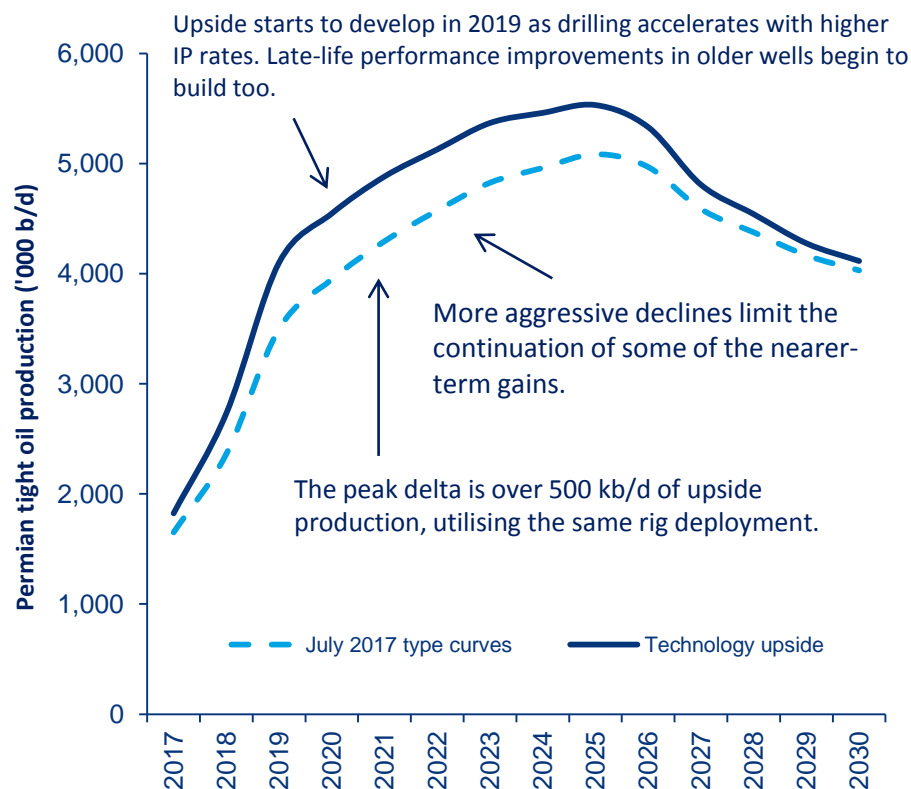
I already drilled my best wells.

- Better reservoir modelling meant that 2015-17 acreage highgrading was actually well highgrading.
- Tighter and tighter well spacing means that emerging issues like “child” well performance and frac hits will limit the ultimate size of commercial well inventories.
- Outsized production gains were actually from better lateral placement in the target zone, rather than better downhole completions.

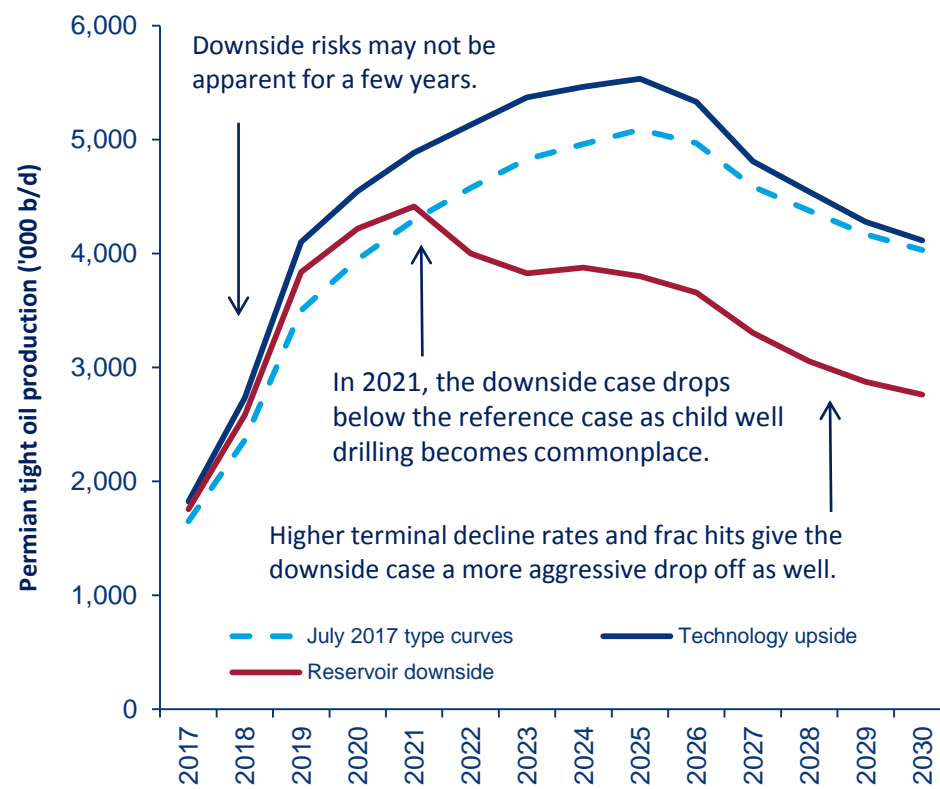
How could these issues impact Permian tight oil growth?

The gap between the bull and bear case is over 1 million b/d.

Technology upside case adds 500 kb/d



2021 peak in the reservoir downside case



Key takeaways



US tight oil is extremely competitive and the resource base is massive...and growing.



The Permian dominates today, but it will face some new challenges the next five years.



Mid-con STACK assets in particular are showing massive improvements in breakevens.



2021 could mark an inflection point in the US cost stack with companies undertaking inter-basin portfolio repositioning.



Robert Clarke

Research Director – Lower 48 Upstream

Biography

Robert Clarke has been with Wood Mackenzie since 2005, originally as a member of the company's initial US Lower 48 Upstream Research group in Houston. He has covered numerous US regions and led much of Wood Mackenzie's early shale research.

He managed the company's international shale, CBM, and tight gas research from 2009 to 2014 and has widespread experience benchmarking and valuing exploratory global unconventional assets. Internally, he oversees an upstream Knowledge Network for other analysts. He relocated to Dallas in 2015 and works closely with E&Ps, investors, and service companies specific to the North Texas market.

Robert specialises in geologic play description, portfolio valuation, production forecasting, analogue modelling, and sector trend analysis. He has worked on upstream consulting projects, ranging from asset opportunity screenings for E&Ps, to due diligence work for private equity-led M&A. Robert regularly contributes to written media and is a frequent speaker and panel moderator at industry conferences.

Prior to joining Wood Mackenzie, he worked as a Field Geologist for a private engineering and consulting firm in Houston, Texas. Robert graduated Cum Laude from Texas A&M University in 2001 with a BA in Geology, and received a MBA in 2005 from the Eller College of Management at the University of Arizona.

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