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Upstream Forum

May 11, 2017

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Oil Price Outlook: Conventional vs. unconventional and the role of OPEC

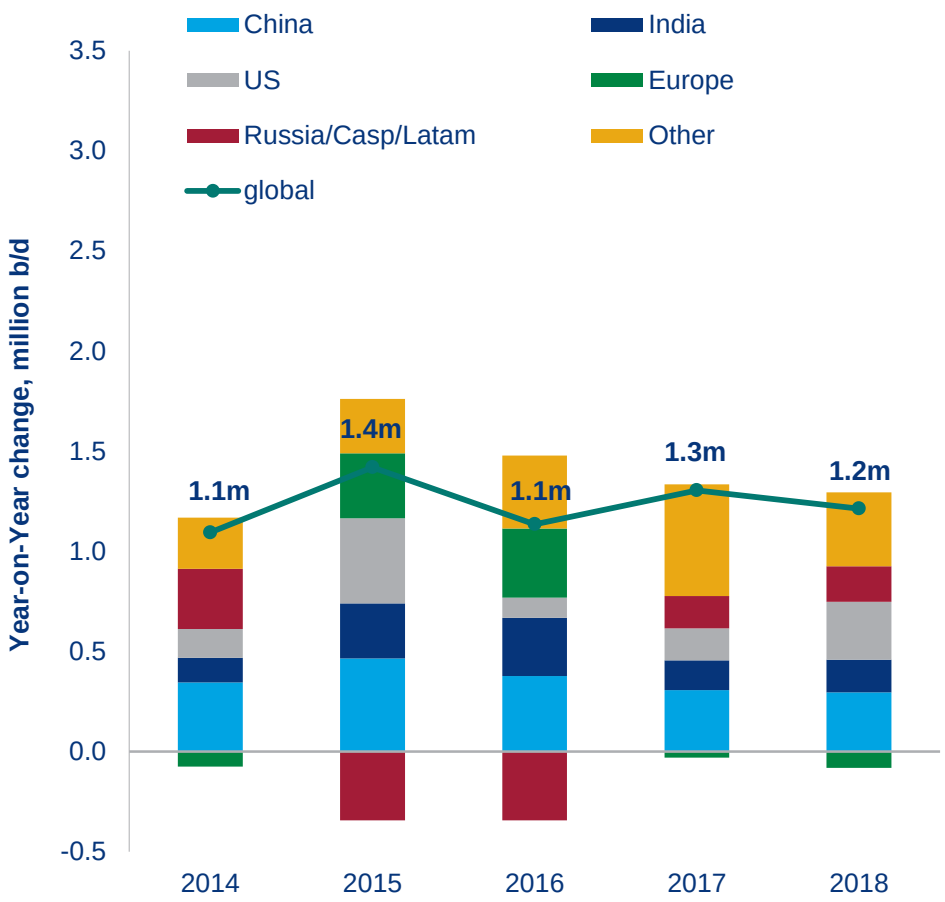
Ed Rawle

May 11, 2017

Upstream Forum

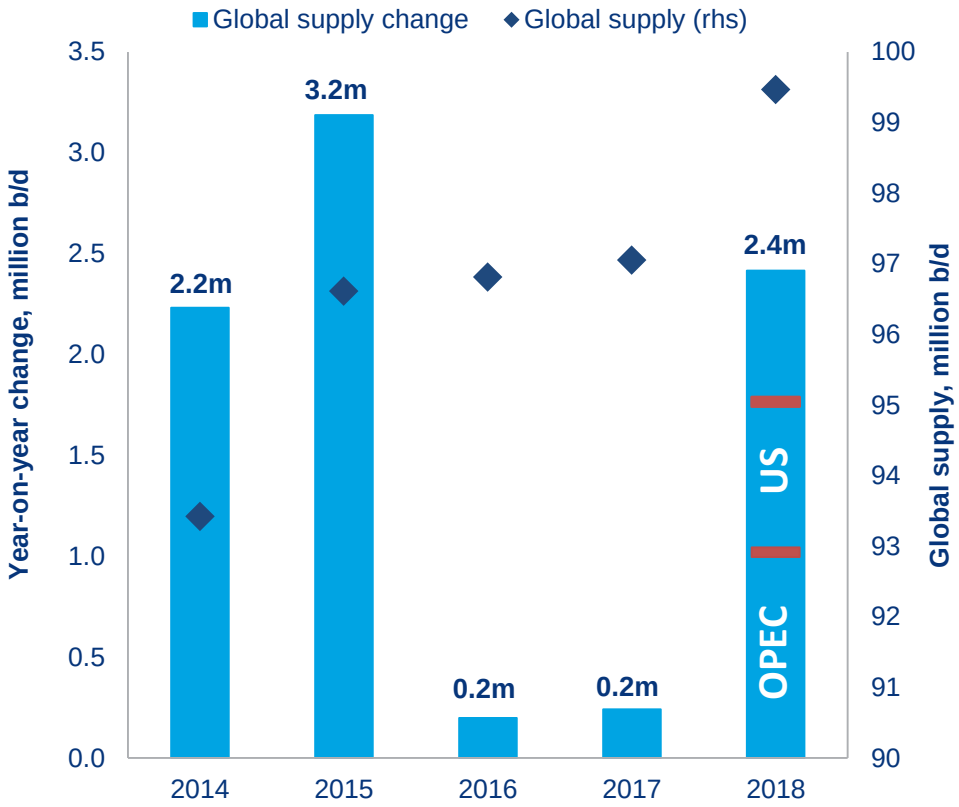
OPEC dilemma: global supply will surge in 2018 if production cut is not extended

Global oil demand



Source: IEA MODS, EIA, country statistics (history), Wood Mackenzie (forecast)

Global oil supply



Source: Wood Mackenzie's Oil Supply Tool, IEA MODS, EIA, country statistics, Wood Mackenzie forecast

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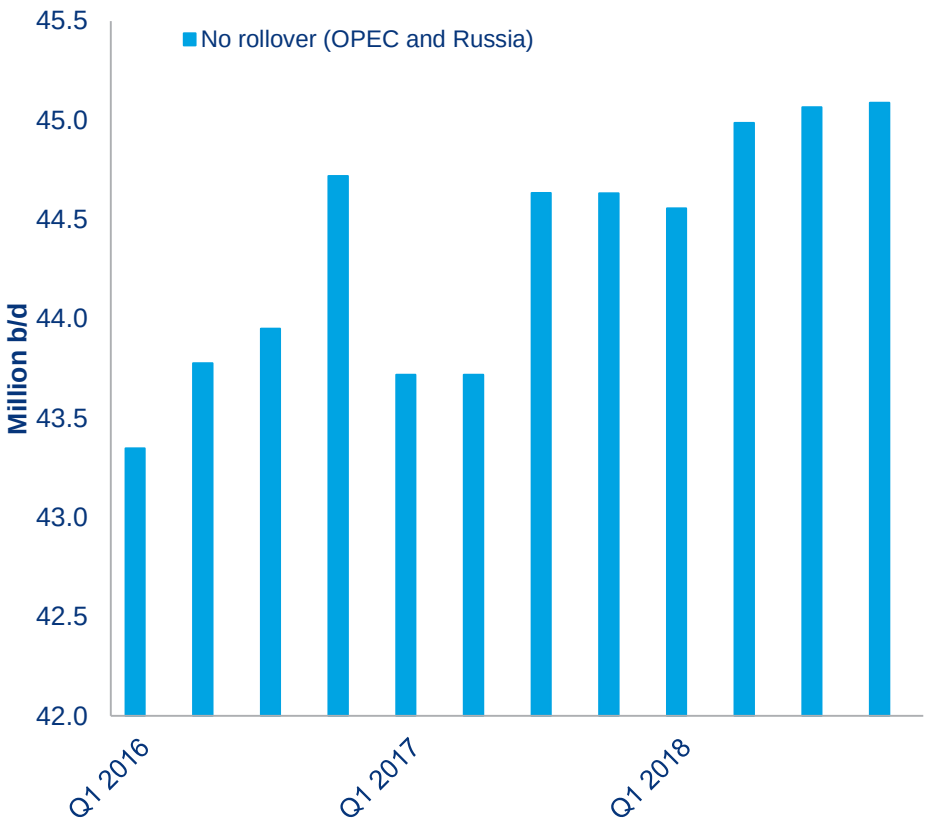
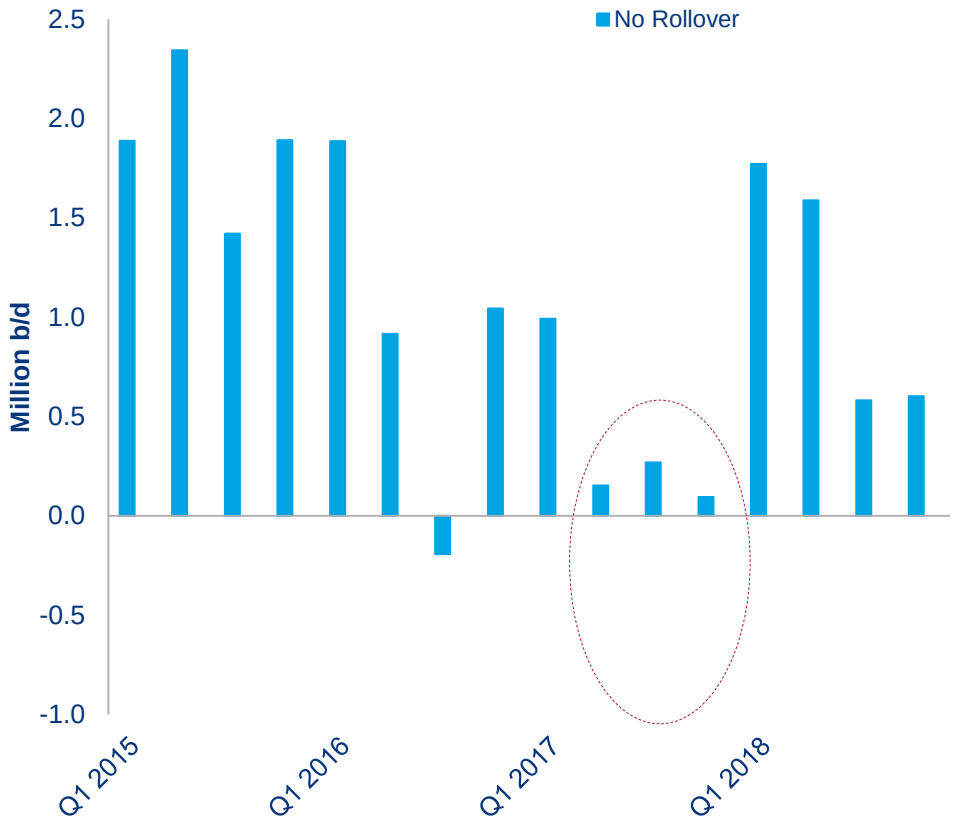
Without a May extension to OPEC's production cut there is no implied stock draw and no market rebalancing

Rollover results in OPEC crude oil production falling by 290k b/d this year

Production impact of rollover



Implied global stock change



Source: Wood Mackenzie. Includes OPEC crude oil production and Russia total liquids production

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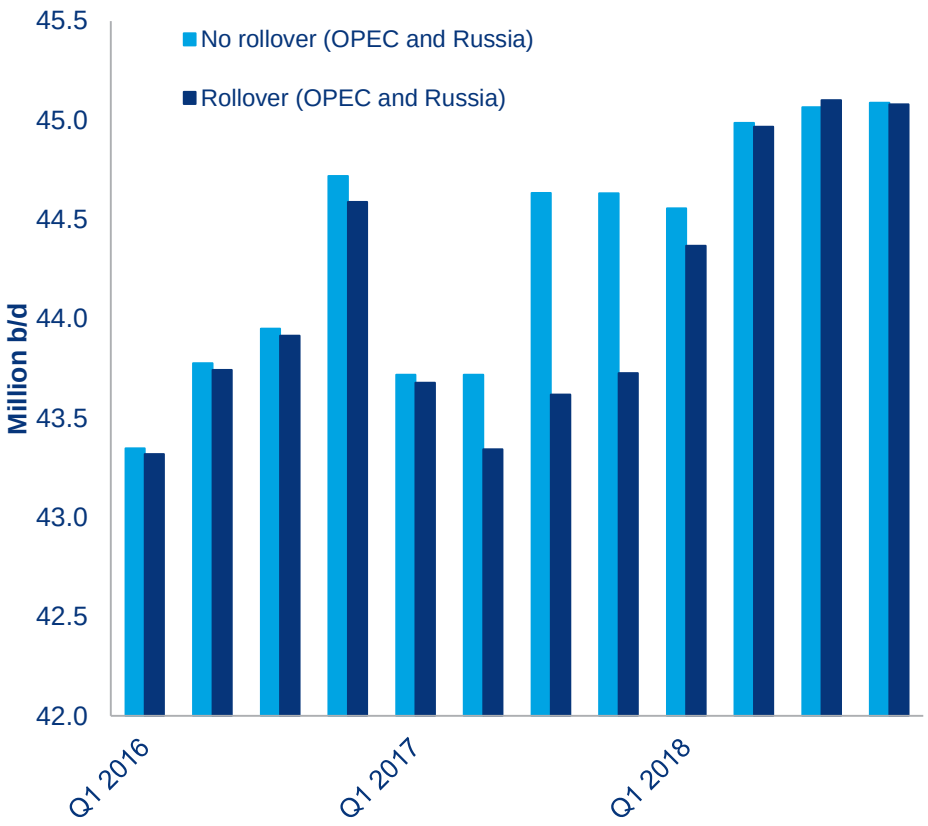
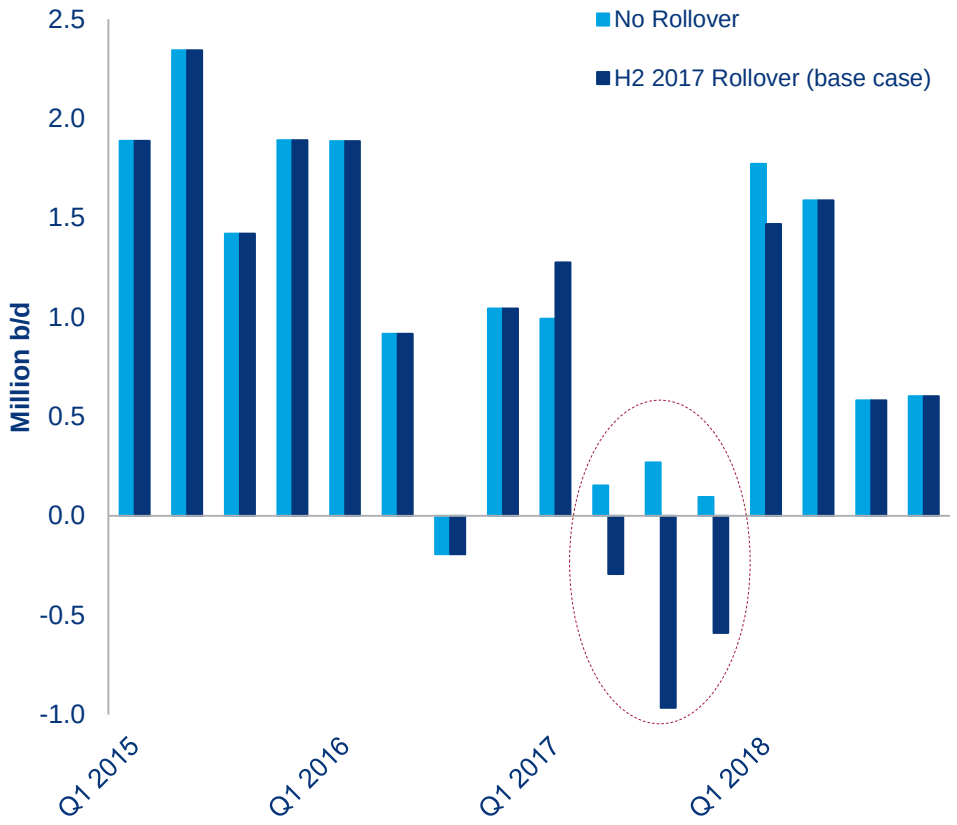


Implied global stock change



Source: Wood Mackenzie. Includes OPEC crude oil production and Russia total liquids production

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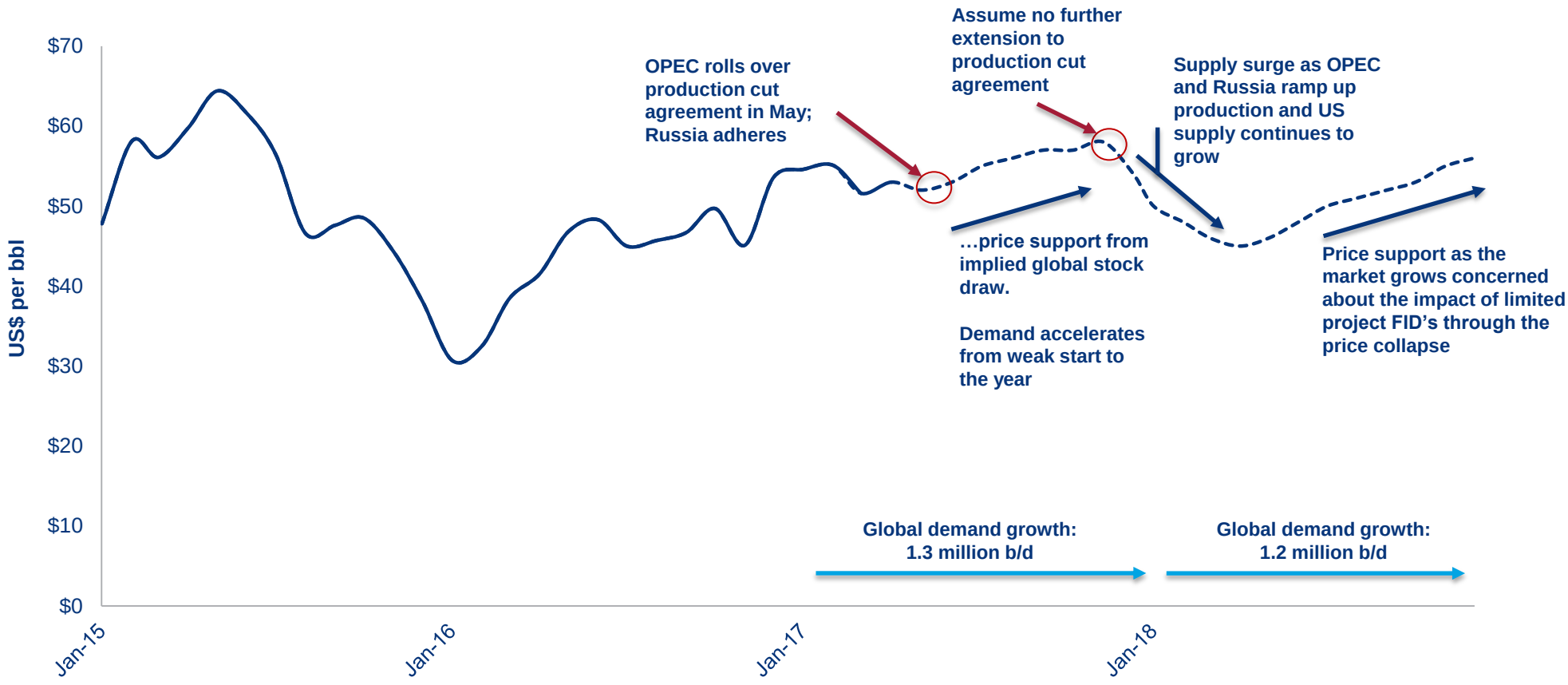
Likewise, if there is no extension into 2018, the market will become oversupplied again

Base case Brent forecast at $55 in 2017, falling to $50 in 2018 if OPEC supply returns

Brent price outlook (nominal)



Source: Wood Mackenzie

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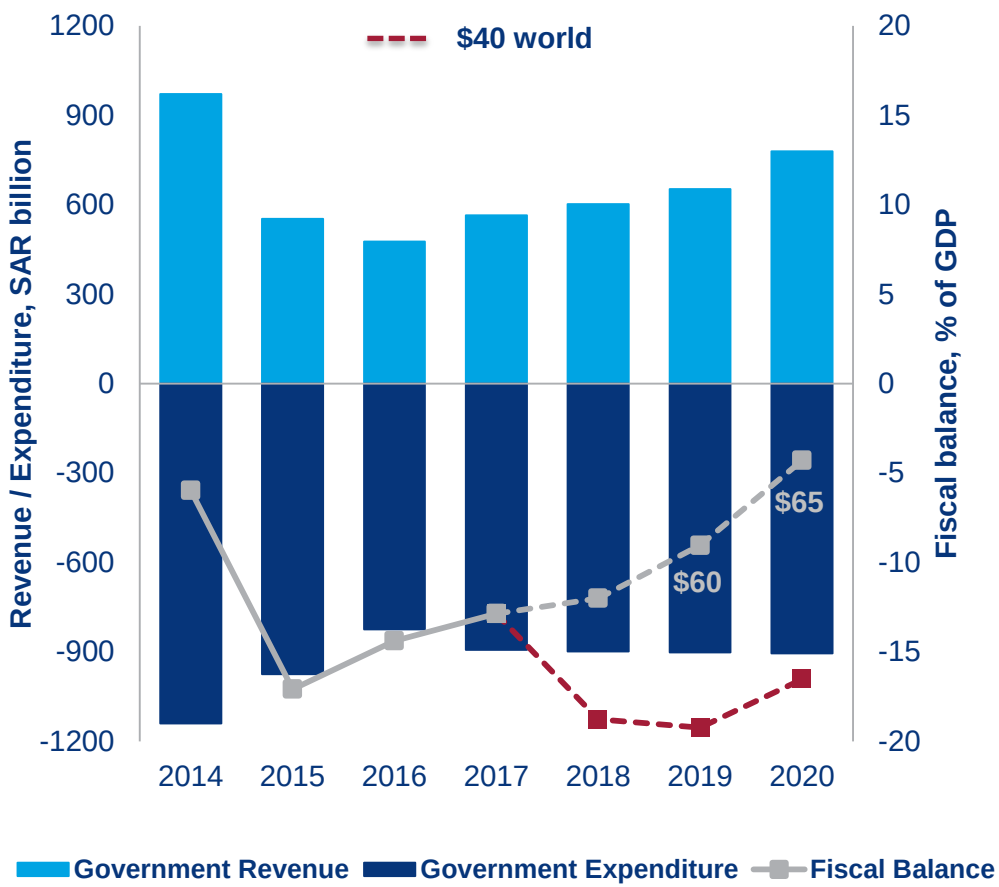
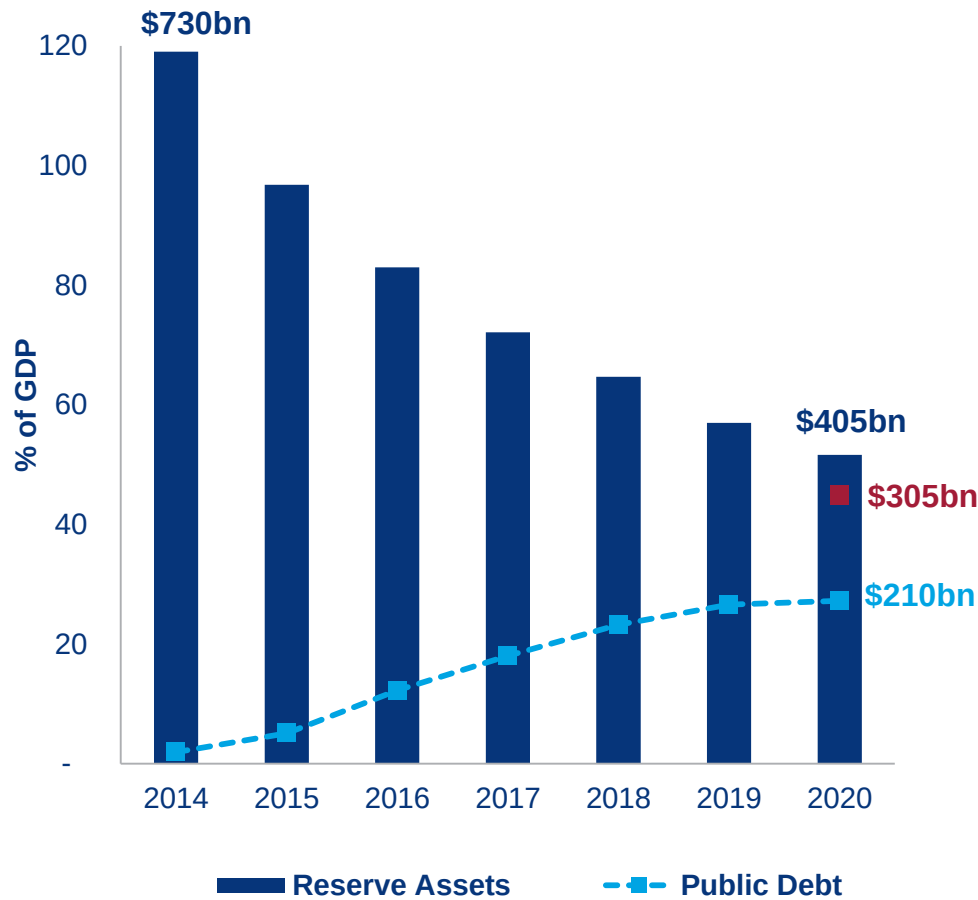
Saudi Arabia: what price do they need?

Saudi hopes to reduce its oil dependency under 'Vision 2030'. It needs to invest.

Saudi fiscal balance



Saudi reserve assets and debt



Source: Wood Mackenzie

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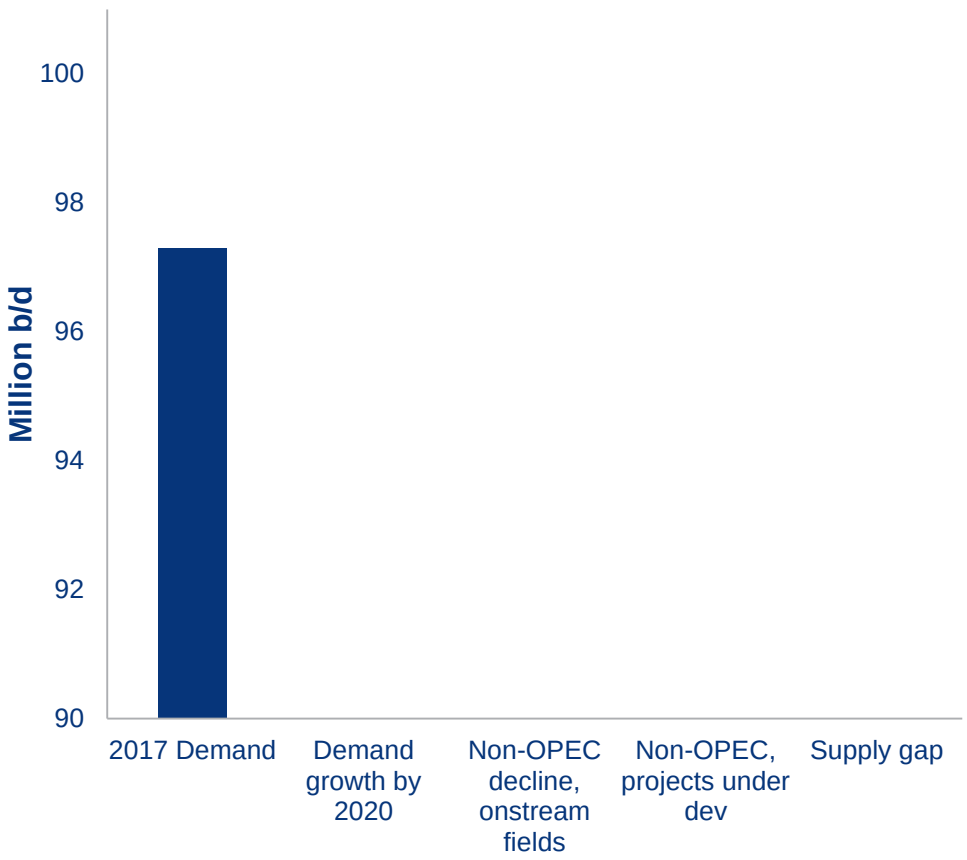
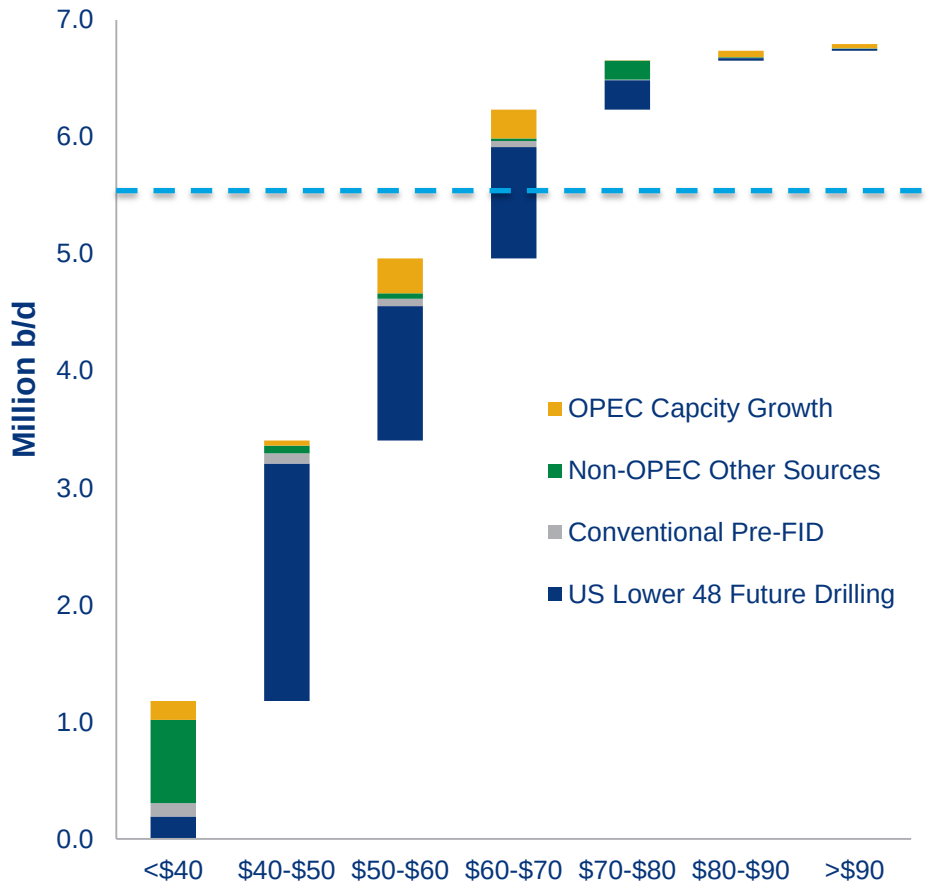
How much new supply is needed to meet demand by 2020? At what cost will it be produced?

~5.5 million b/d of new supply is required to fill the supply gap to 2020

Supply Gap to 2020



Cost of new supply



Source: Wood Mackenzie, Point forward Breakevens, Onshore and Offshore at 15% discount rate

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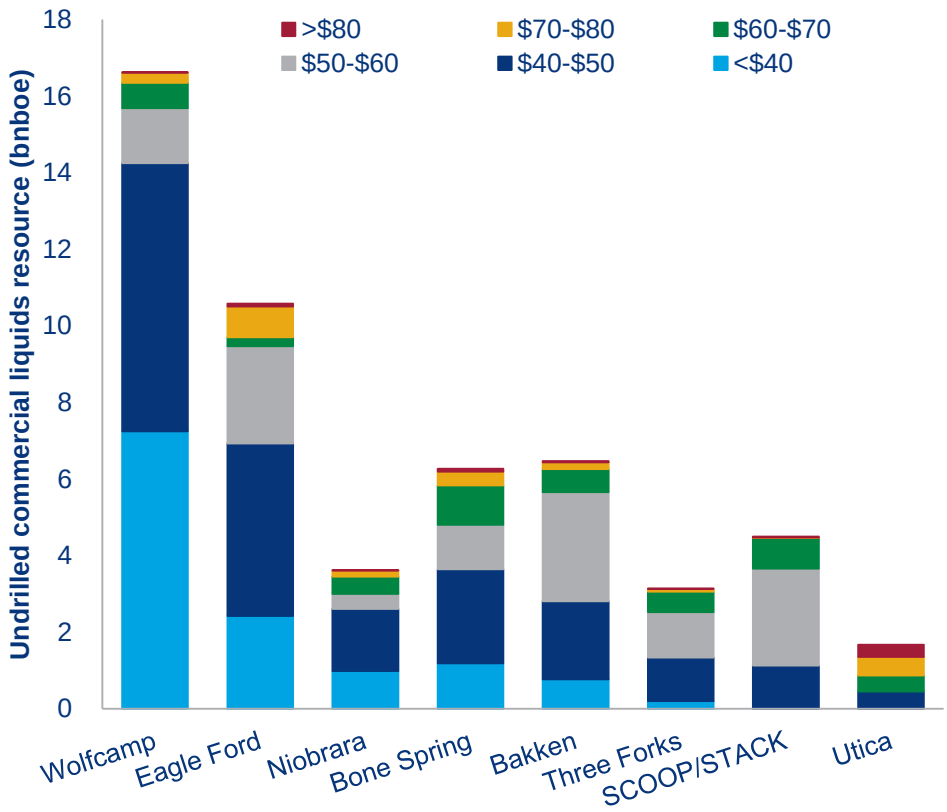
US L48 can provide plenty of low cost resource

Key play liquids asset benchmarking

Source: Wood Mackenzie

Key play remaining liquids resource



*Only considers companies covered by Wood Mackenzie

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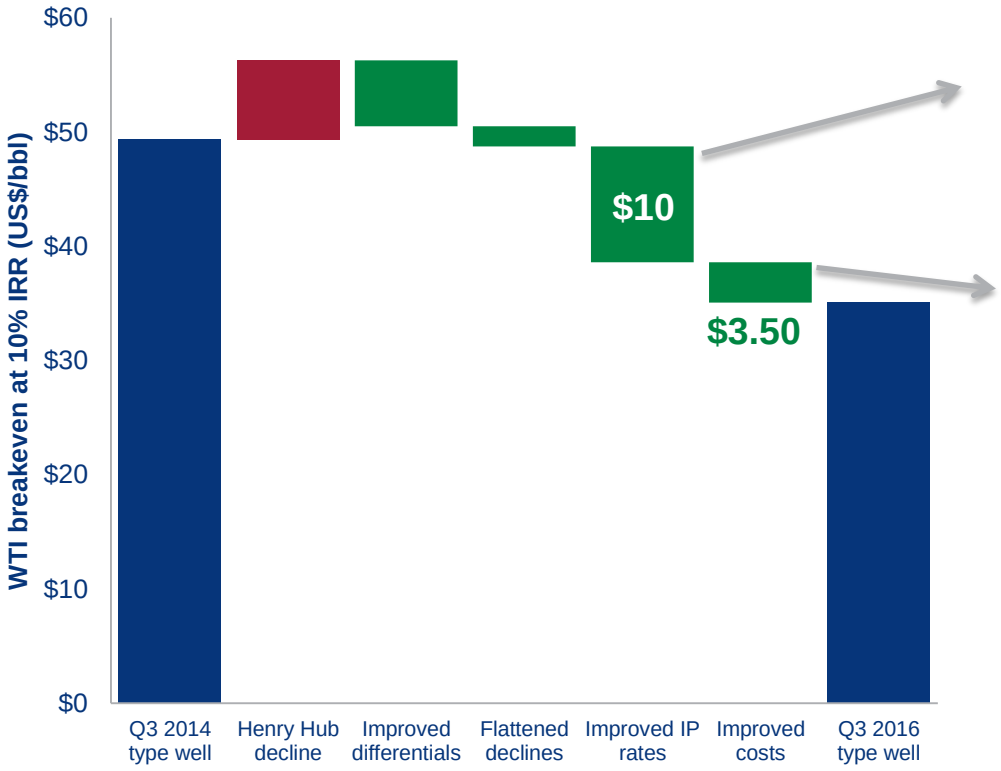
US L48 breakevens; a story of productivity gains and cost reduction

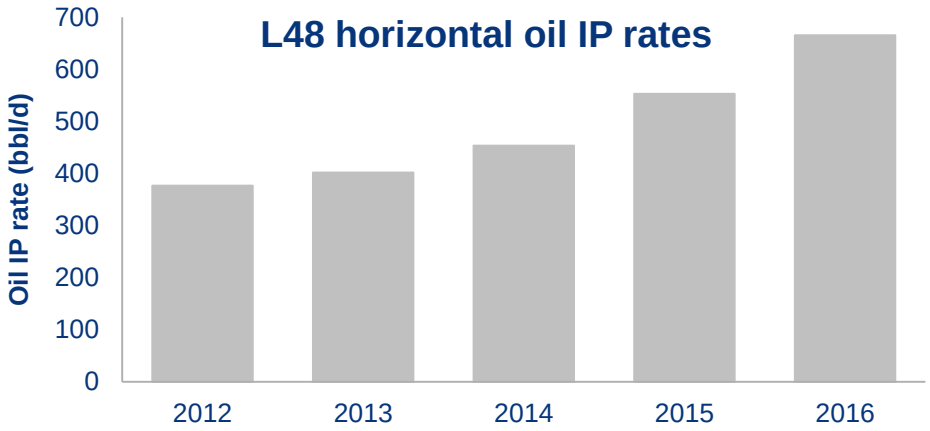
Lower 48 breakevens

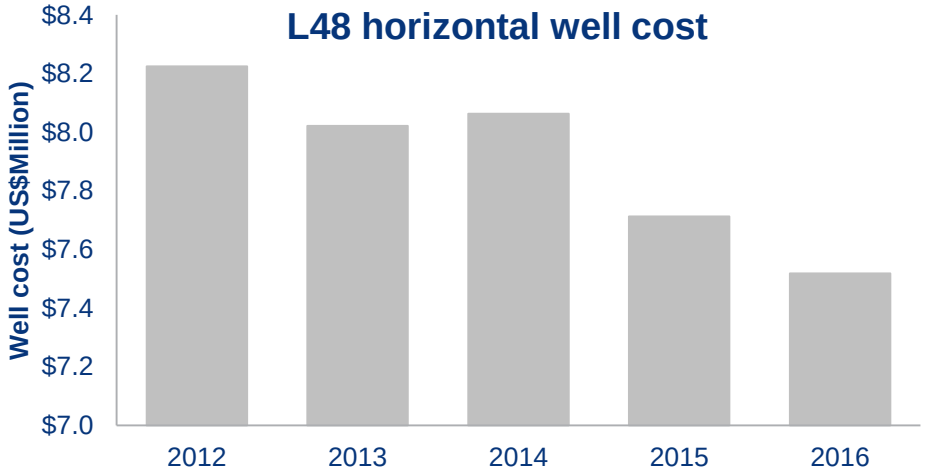
Liquid breakevens have fallen by 25% across the Lower 48 despite lower associated gas price support since 2014. Initial production increases of ~30% and cost reductions of ~15% have kept Lower 48 operators drilling sub-$50/bbl.



Source: Wood Mackenzie, example based off Karnes Trough sub-play

Productivity and costs improving





Source: Wood Mackenzie North American Well Analysis Tool

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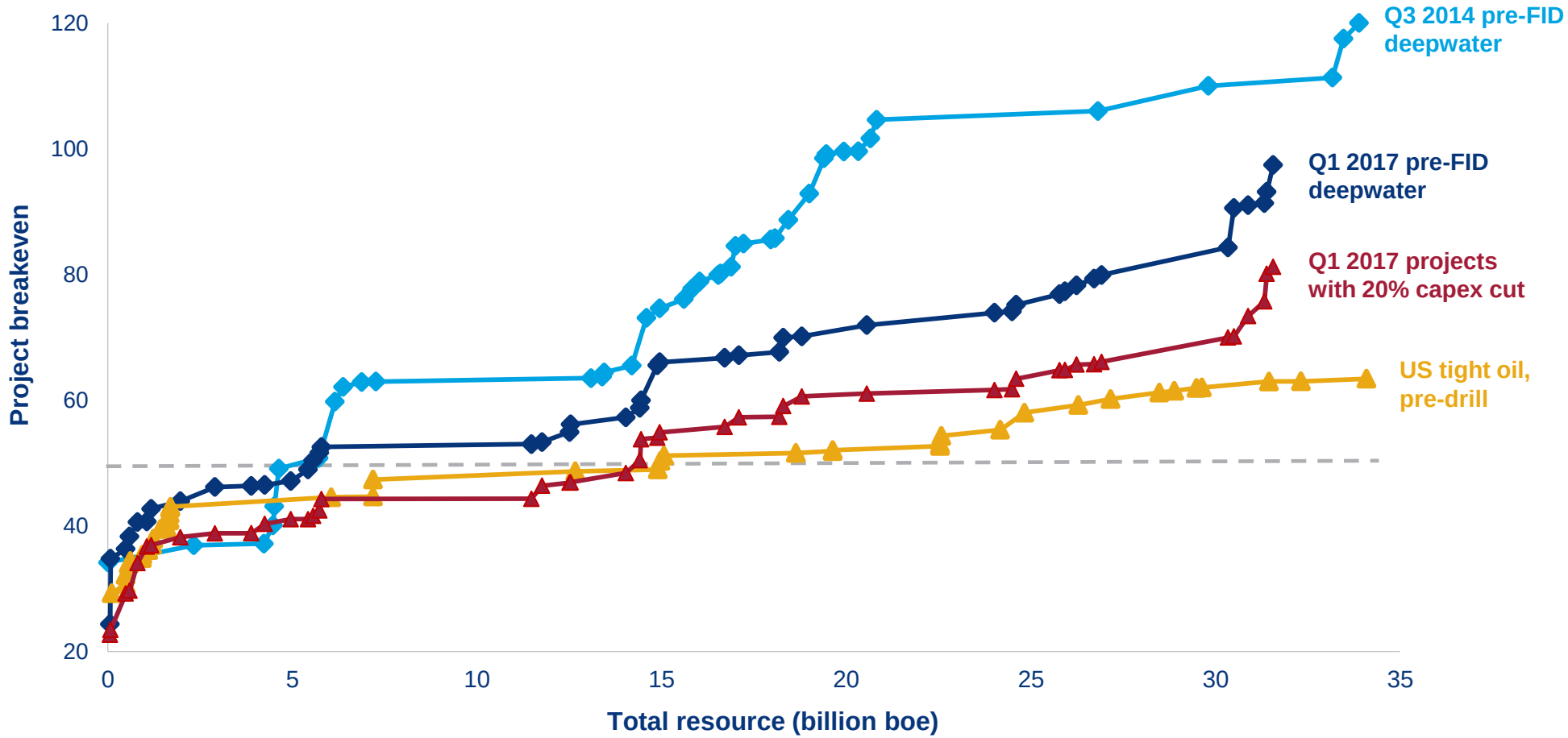
But 'high-grading' is increasing the competitiveness of deepwater

Greenfield deepwater project cost-curve



Source: Wood Mackenzie.
Both tight oil and deepwater breakevens are run on a NPV15 basis, which we believe is an industry standard screening criteria.

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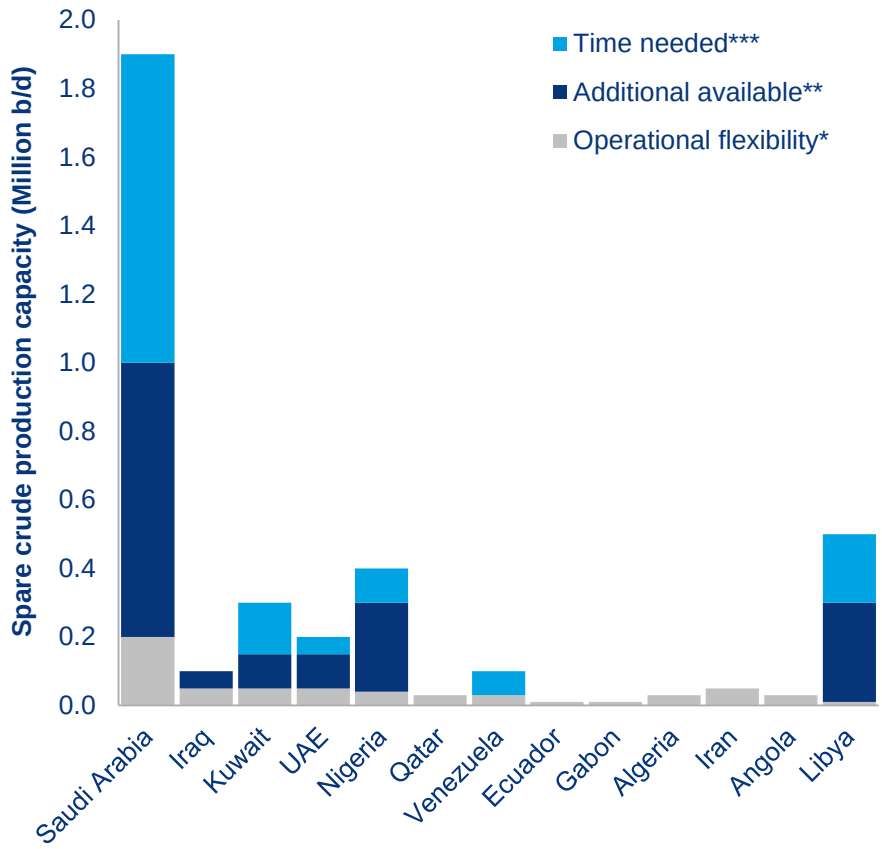
Will Saudi Arabia limit price to prevent higher cost 'mega projects' from taking FID?

OPEC spare capacity



- Saudi Arabia, UAE and Kuwait could bring ~1 million b/d online within 1 month
- They can bring on a further 1.1 million b/d with some expenditure (longer lead time)

Note: Hatching denotes 'capacity' that would only be available under fully benign operating conditions

* E.g. delaying routine maintenance or drawing harder from amenable reservoirs (not sustainable beyond a few months)

** Producing within a month assuming benign above-ground operating conditions

*** Logistical barriers and/ or some investment required

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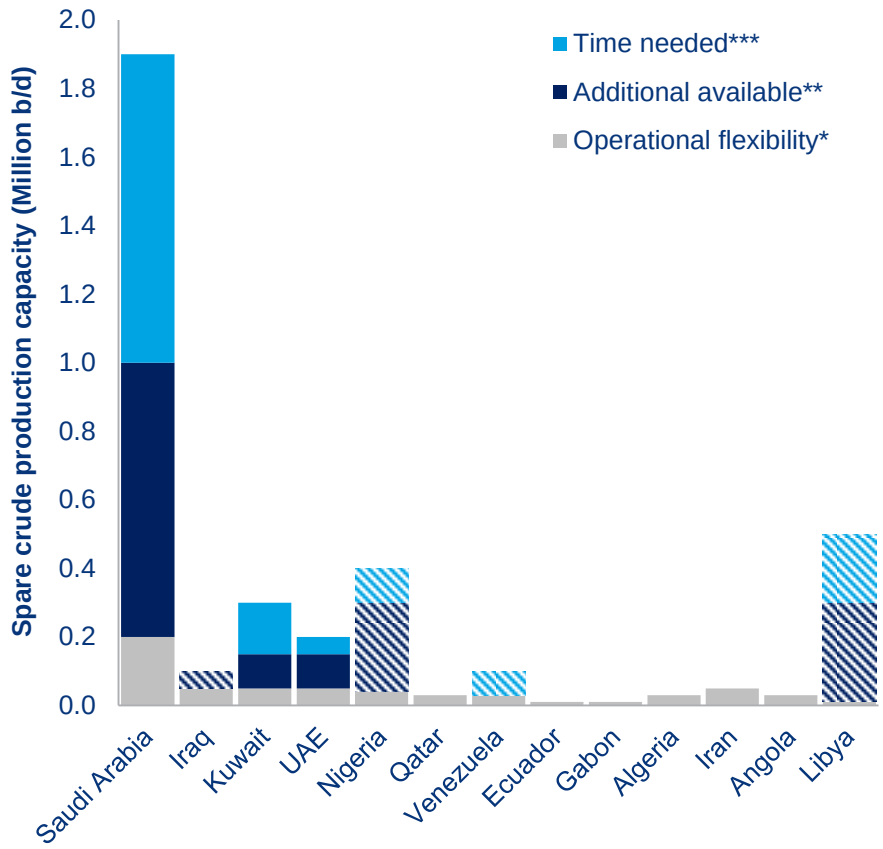

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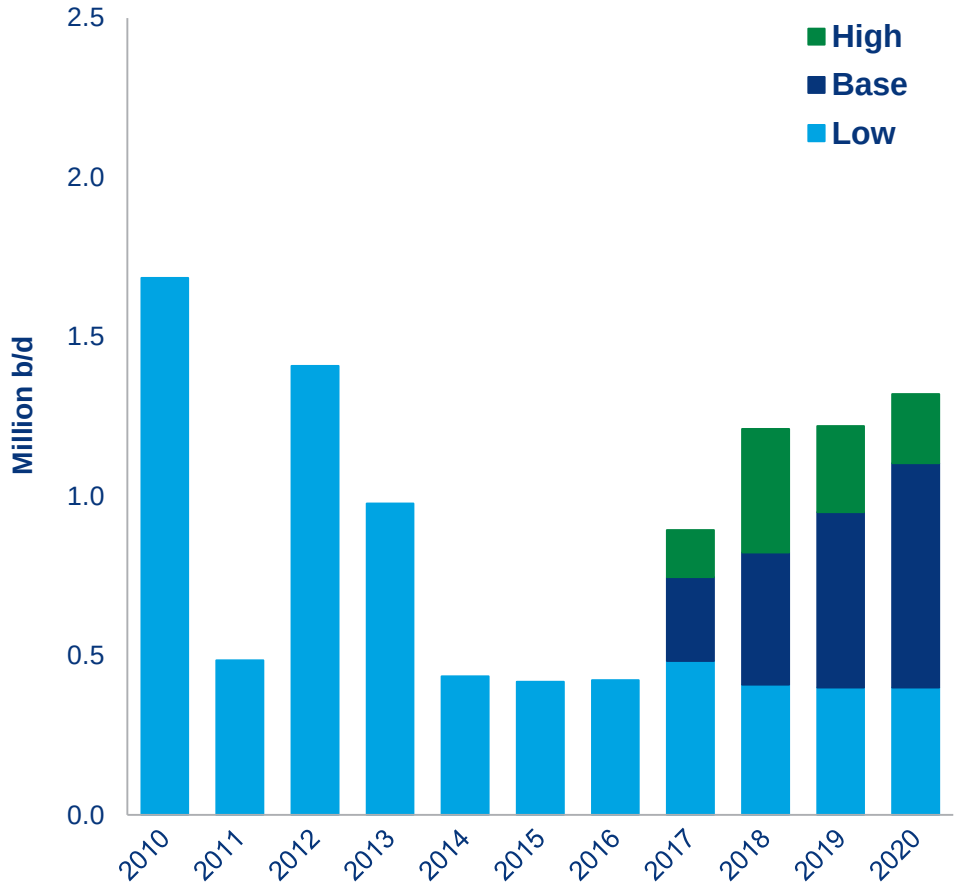
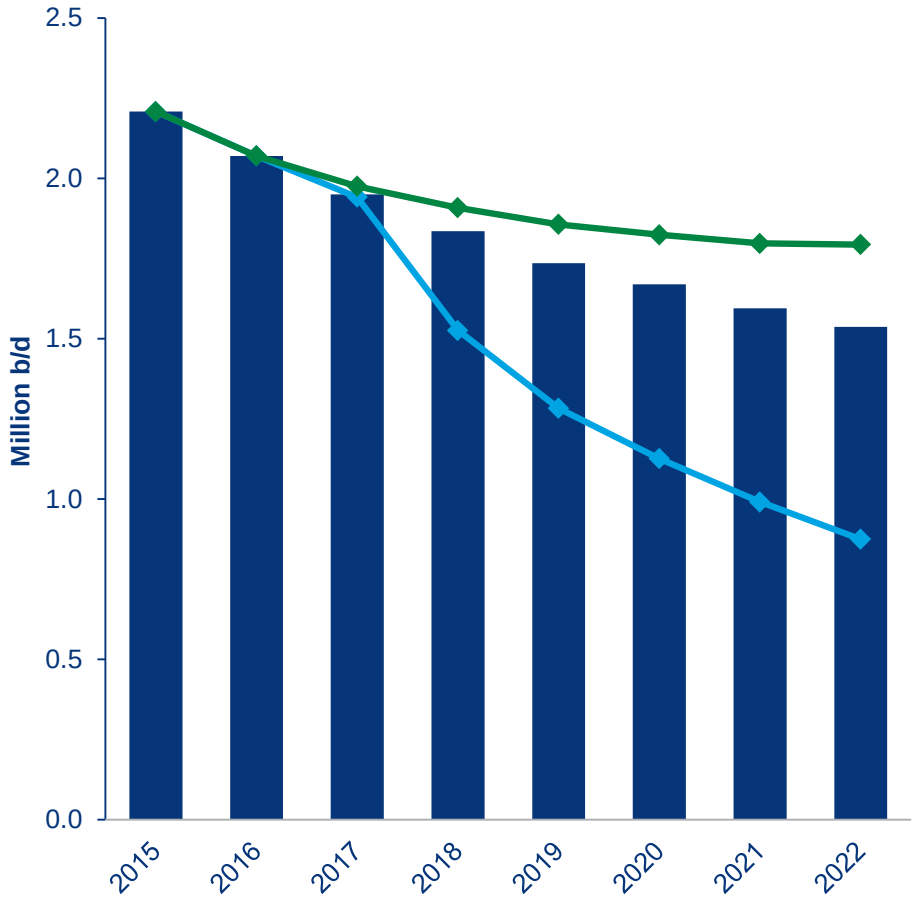
Libya is *the* wildcard for supply over the next few years

Unification in Libya would allow the NOC to get close to its targets.
Default in Venezuela later this year would wipe 310,000 b/d off 2018 production

Libya production scenarios



Venezuela production scenarios



Source: Wood Mackenzie

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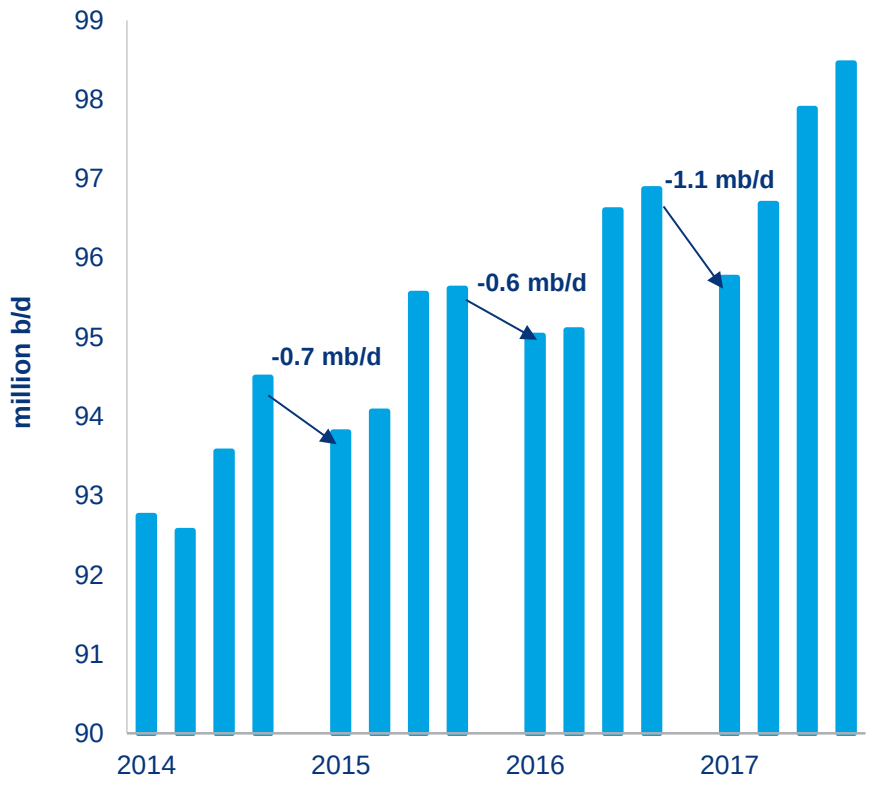
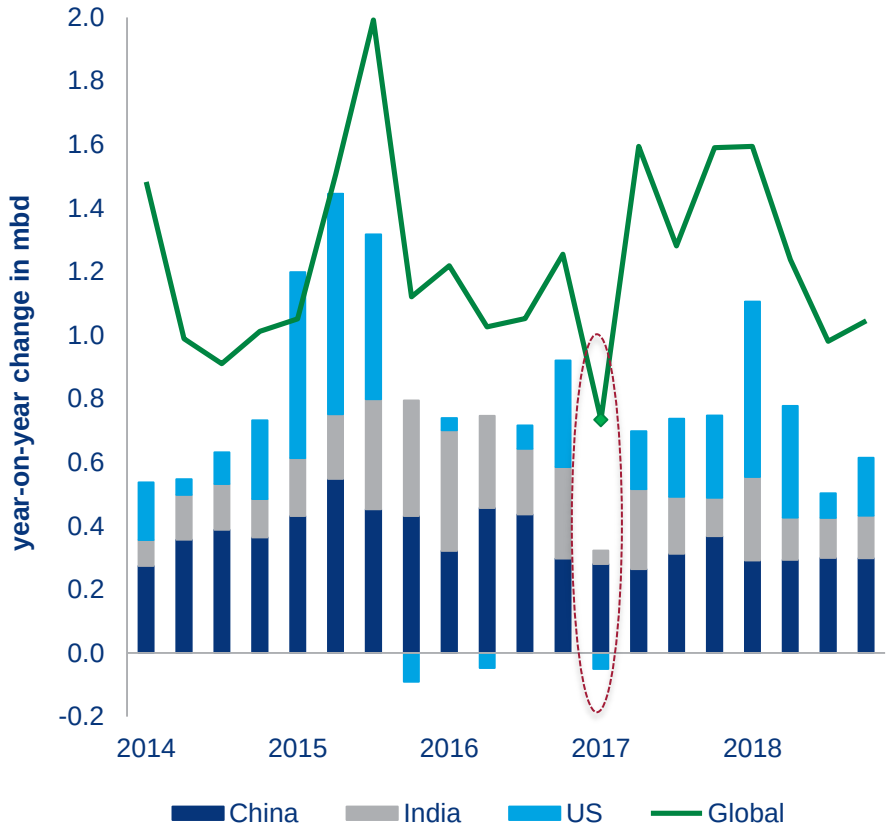
Oil demand has been exceptionally weak so far this year

The '3 pillars of growth' – the US, China, and India – stalled in the first quarter

Global oil demand





Source: IEA MODS, EIA, Wood Mackenzie forecast

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Global conventional exploration: resetting the business

Julie Wilson

Upstream Forum

May 11, 2017

Exploration reset: less is more

The exploration industry is becoming leaner, smaller, more efficient and more profitable.

- Explorers can and will fix their broken economics
  - » Profitability will recover – even in a US$50-60 oil price world
  - » Tight budgets will lead to enhanced prospect quality
  - » Lower development costs are key to improving resource conversion of discoveries

- Exploration will play a smaller role in reserve replacement
  - » Improved efficiency will come from less investment and fewer, lower-risk wells
  - » A refocused, leaner industry will discover smaller volumes
  - » Most companies will rely more on other renewal options – unconventionals, discovered resource opportunities, enhanced recovery and M&A

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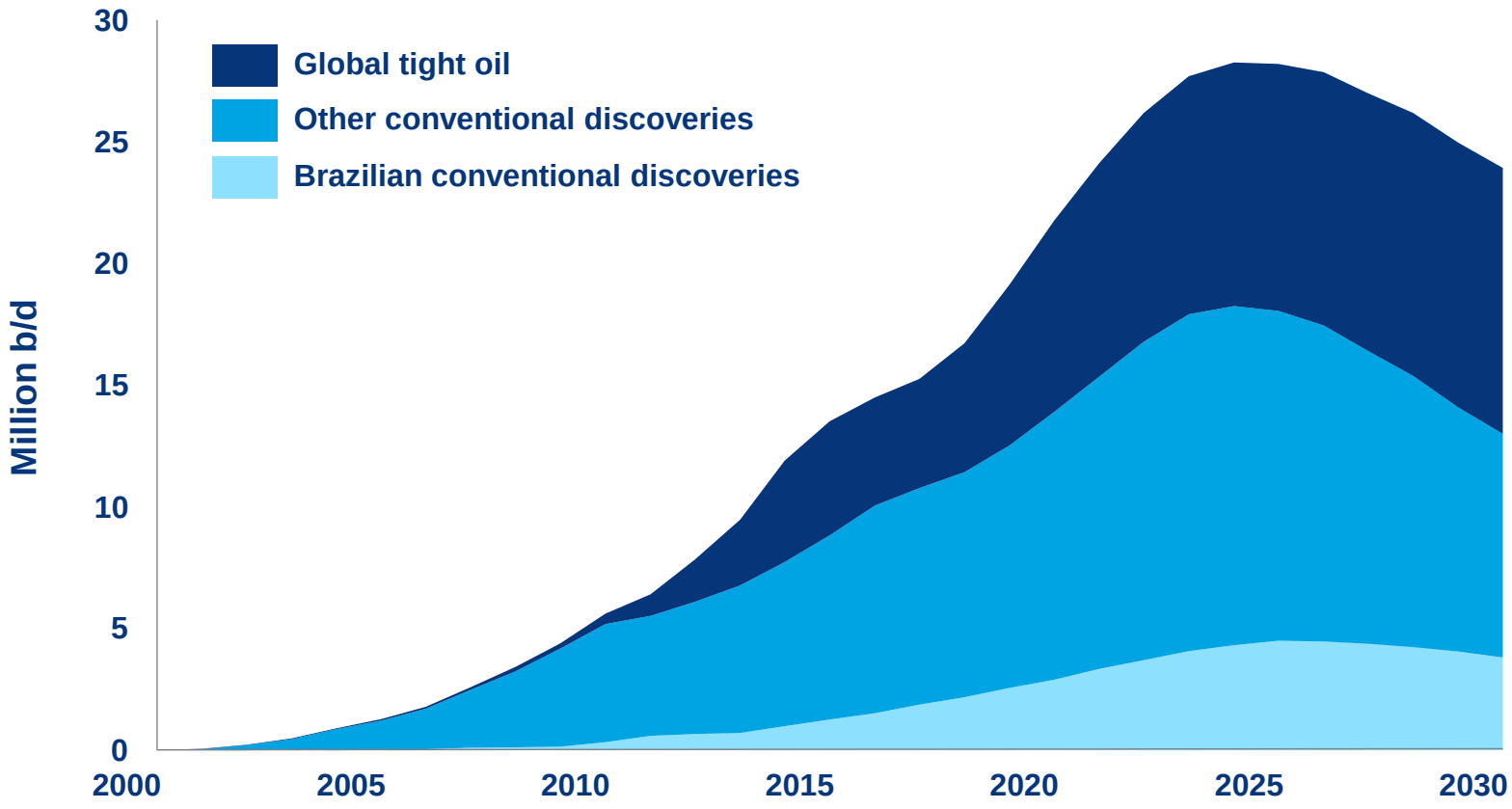
Conventional exploration's problem is not the volumes

New field exploration beats tight oil to be the industry's top organic growth engine.
By 2025, 20% of global oil supply will come from post-2000 conventional discoveries.

Liquids production growth from exploration finds and tight oil since 2000



Source: Wood Mackenzie

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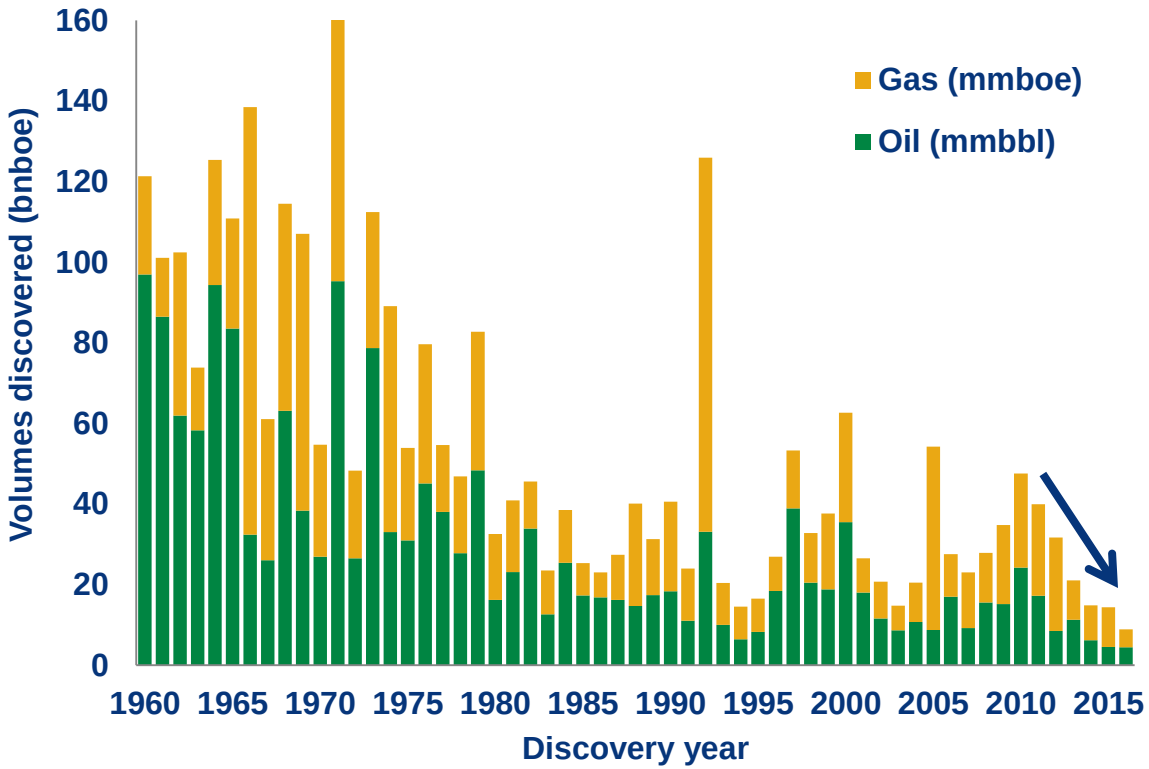
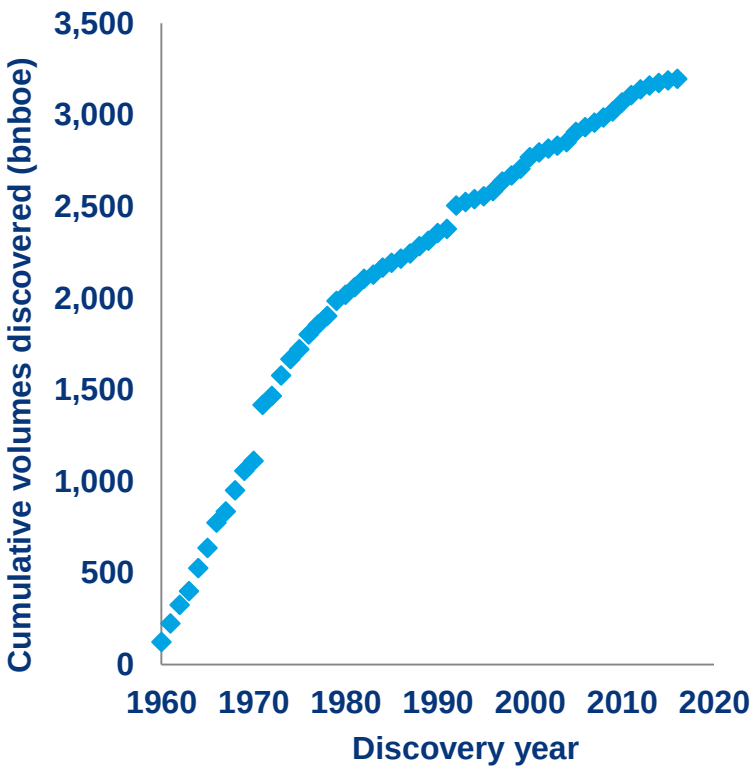
The recent dip in discovered resources looks troubling

Could this signal terminal decline of conventional exploration? Unlikely – that would imply the simultaneous maturing of geologically-diverse, exploration plays globally.

Conventional exploration volumes



Global creaming curve by year



Source: Wood Mackenzie. Conventional volumes only by year of discovery well completion

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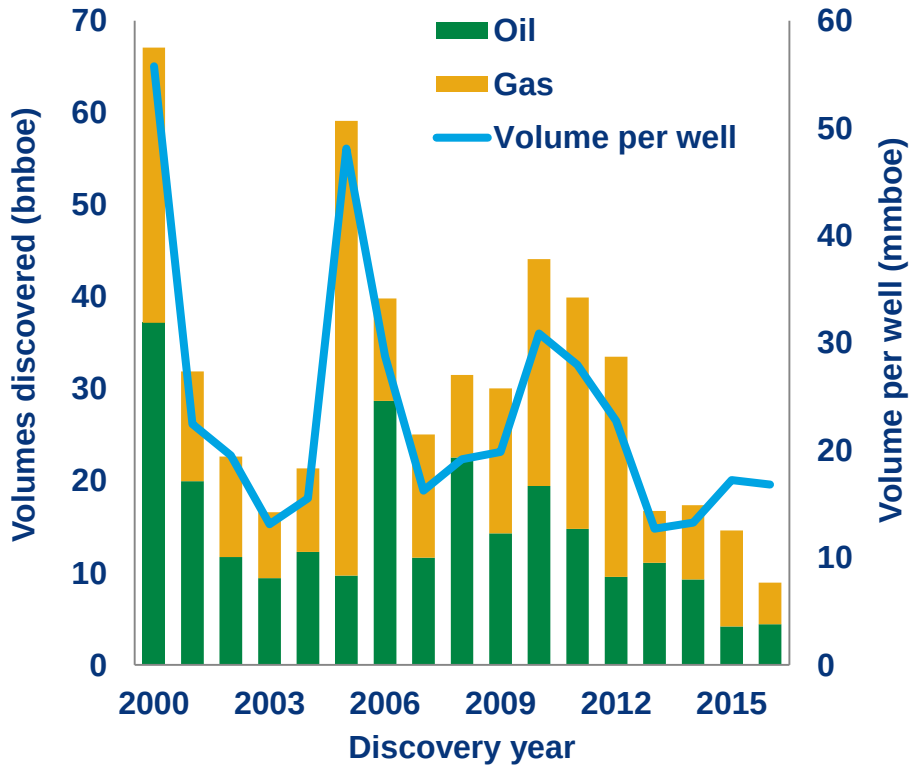
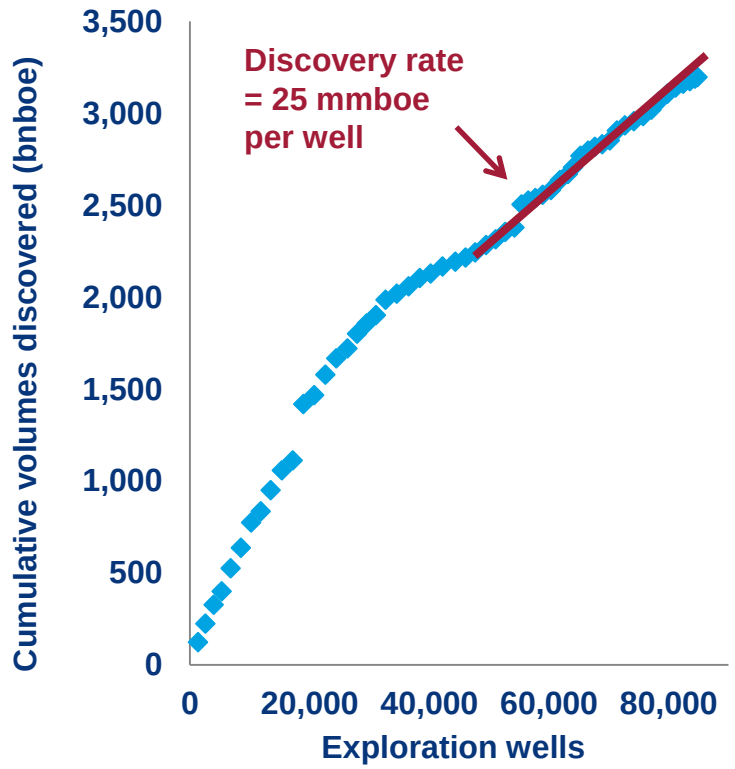
This resource trend looks healthier on a volume-per-well basis

Falling volumes are due to fewer wells. The last 40,000 exploration wells discovered an average 25 mmboe per well with a straight-line creaming curve trajectory.

Resource discovered per exploration well



Global creaming curve by wells



Source: Wood Mackenzie. Conventional volumes only by year of discovery well completion

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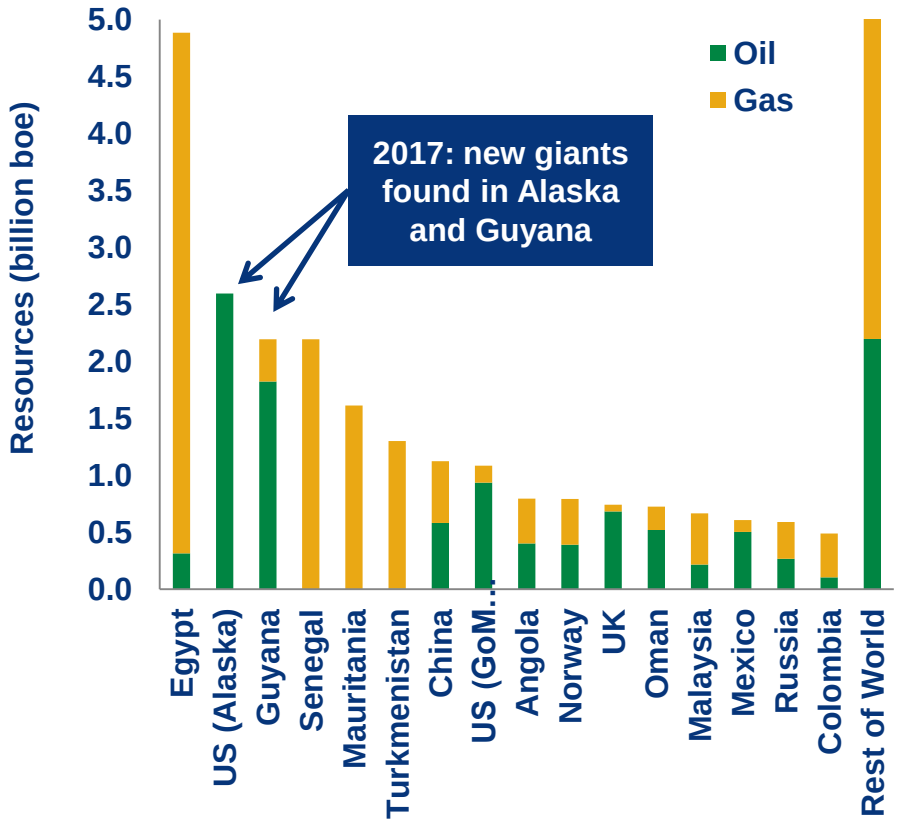
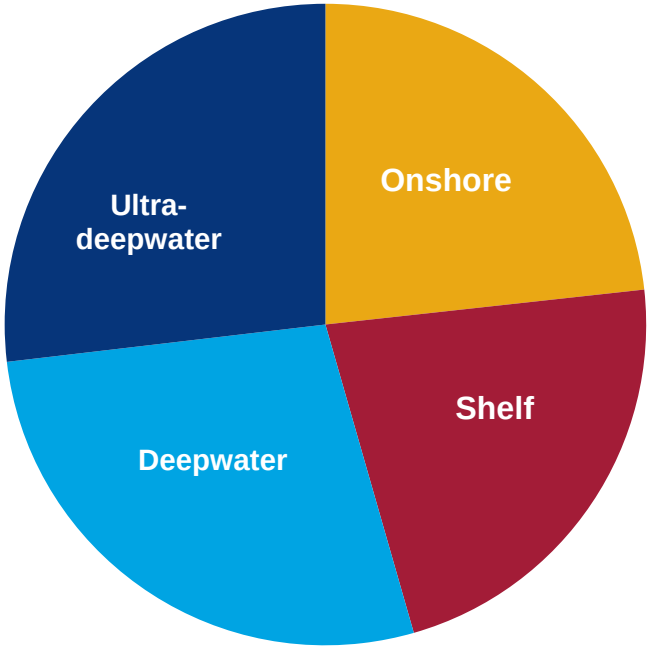
Recent exploration volumes mainly in deepwater

Big volumes of past two years largely in new plays and basins

New discoveries from 2015 by country



New discoveries from 2015 by sector



Total 27 billion boe
11.5 billion bbl oil
90 tcf gas

Source: Wood Mackenzie. Includes conventional new field discoveries completed January 2015- mid-April 2017.

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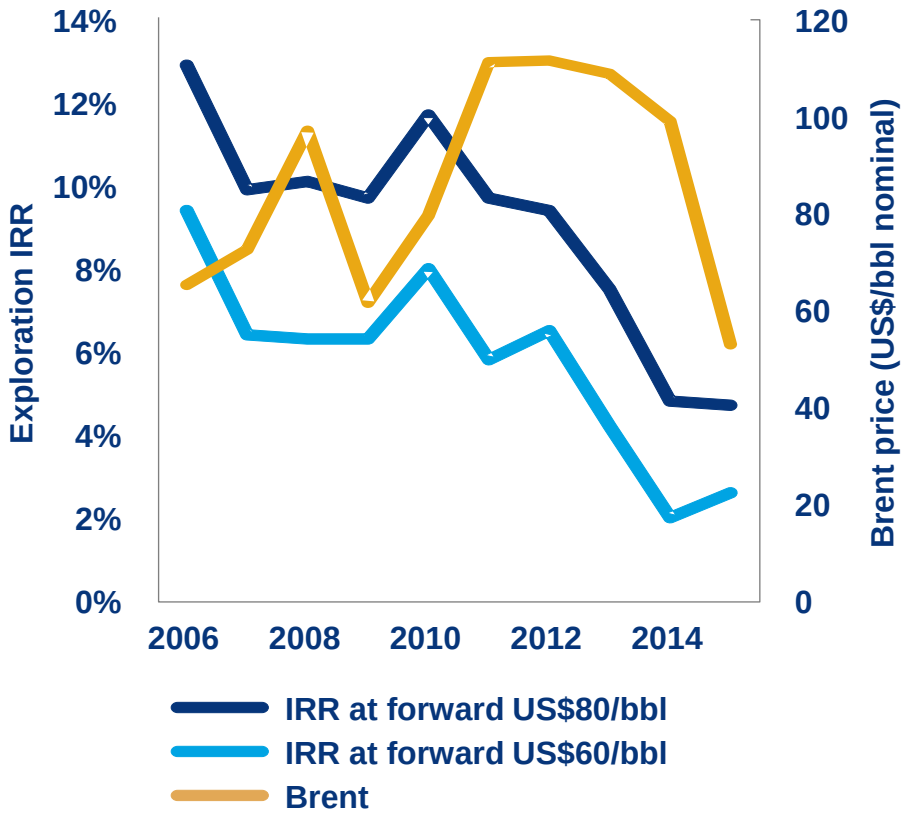
Yet exploration industry economics were broken

Despite the healthy volumes, exploration returns sank to unacceptable lows, even while oil prices were high.

Exploration industry returns



- Average exploration industry IRR (at US$80/bbl) fell below 10% three years *before* the 2014 oil price crash
- Rising technical complexity – including water depth, remote location, reservoir depth – has compounded industry inflation and led to higher finding and development costs
- Growing share of gas has increased commercial complexity
- High costs have left no clear route to commercialisation for more than half of the resource volumes discovered over the past decade

Source: Wood Mackenzie Exploration Service

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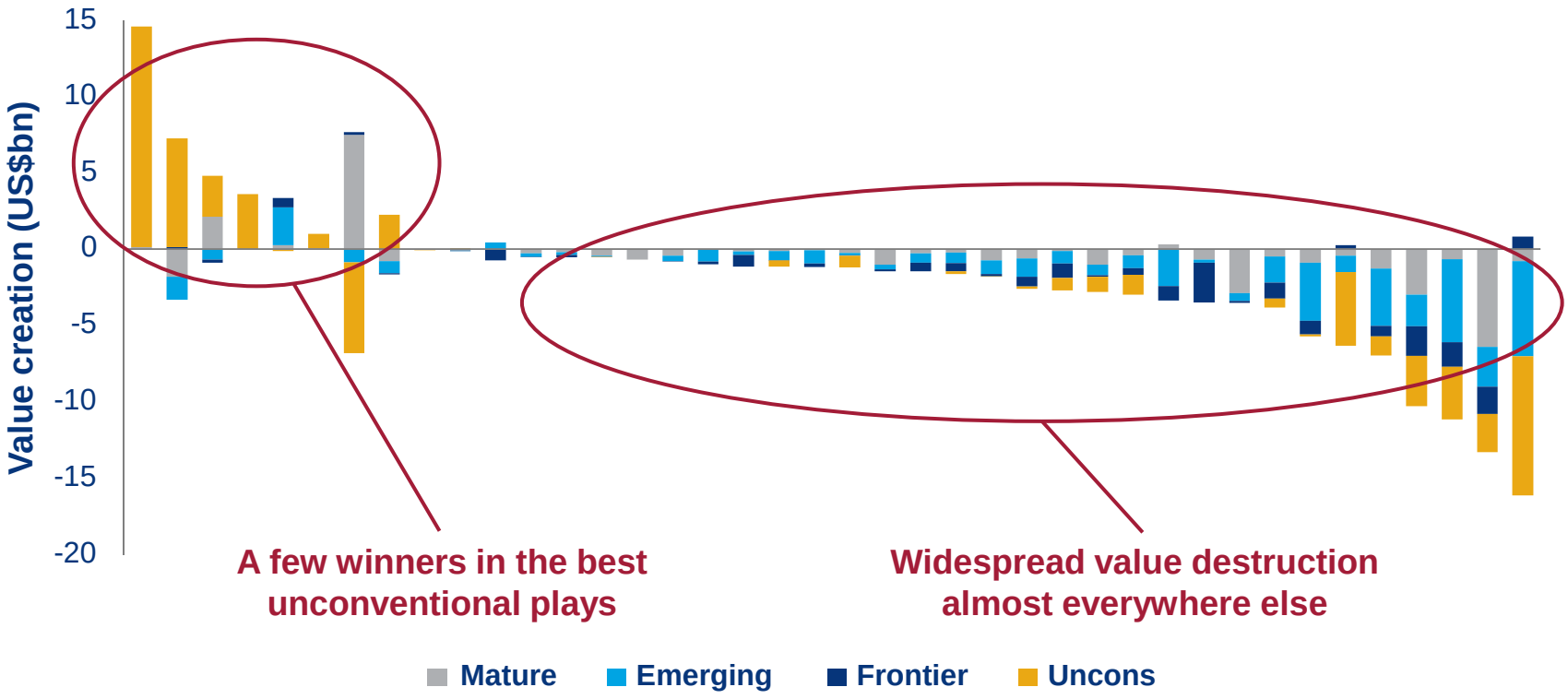
Five-year value creation ranking by company

Hardly anyone creating value in conventional exploration – efficiency needs to improve

Exploration value creation by theme and basin maturity 2011-2015



Source: Wood Mackenzie. Value creation at Base price, with Brent at US$70/bbl flat in real terms from 2019.

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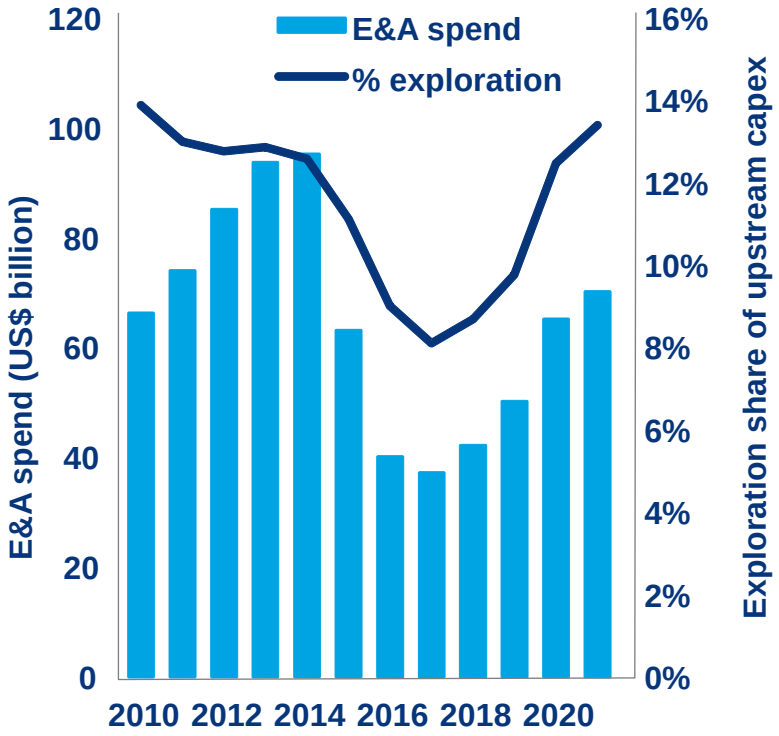
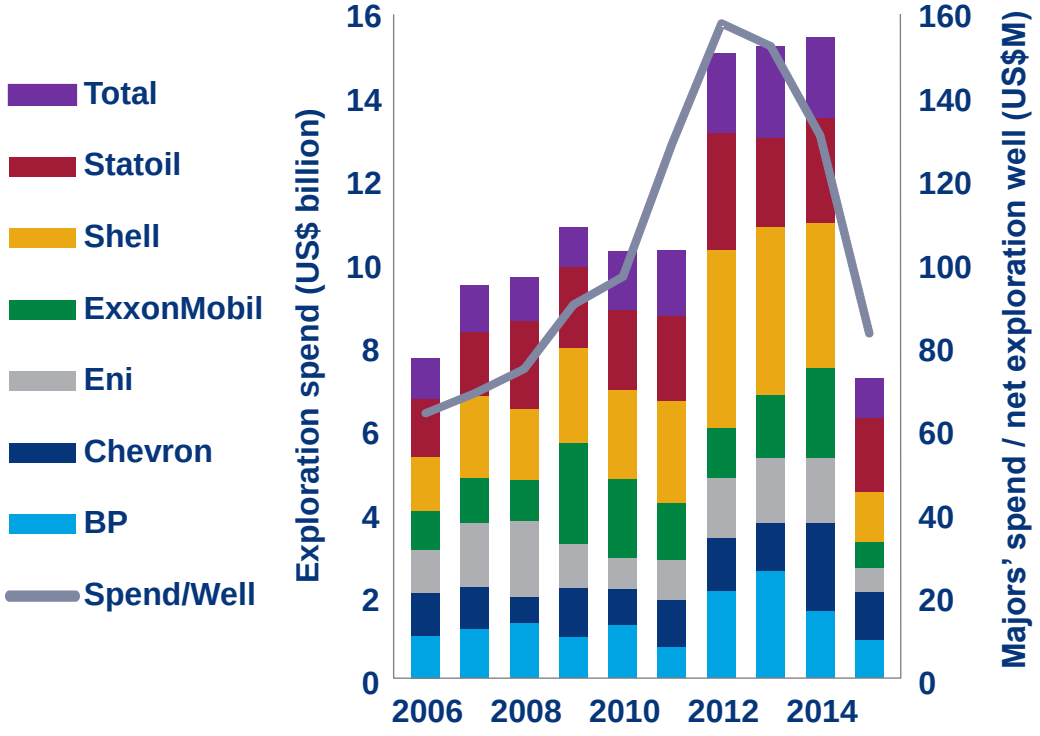
Fixing exploration returns – reduced spend

The industry has slashed spend to less than half its 2014 peak. This forces a focus on quality, as companies can now only afford to drill their best prospects.

Conventional exploration spend



Majors' conventional exploration spend



Source: Wood Mackenzie. Includes appraisal.

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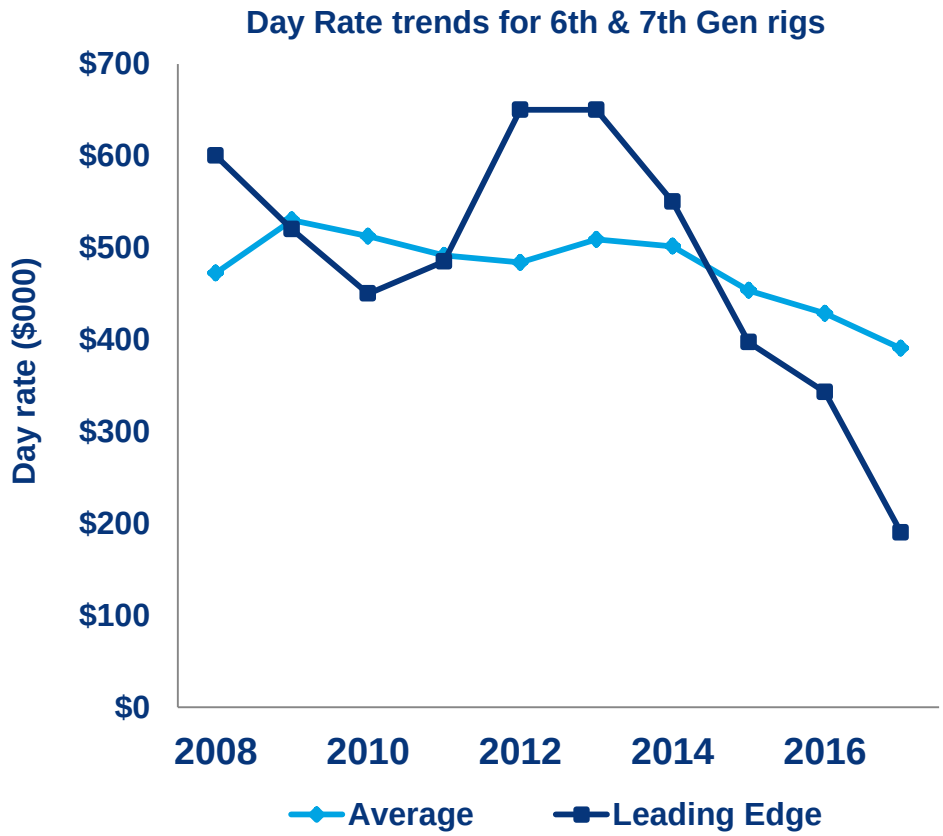
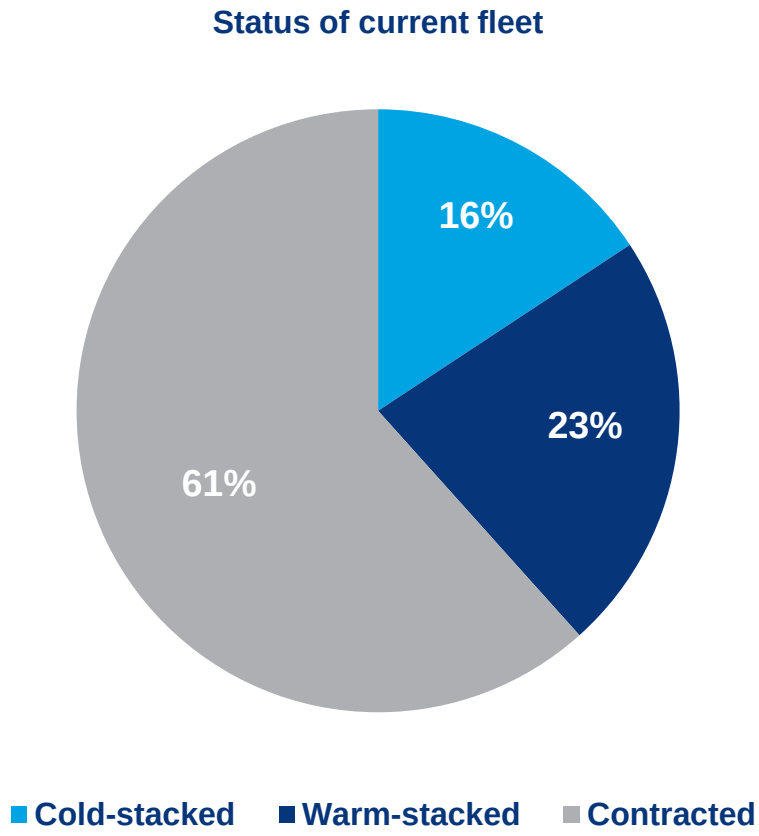
Leading edge day rates for high-spec rigs point to continued deflation as contracts roll off

~85% of UDW fleet are 6th-7th gen units; ~60% of the fleet could be stacked by end-2017

Market conditions for Gen 6 and 7 rigs





Source: Wood Mackenzie Supply chain analysis

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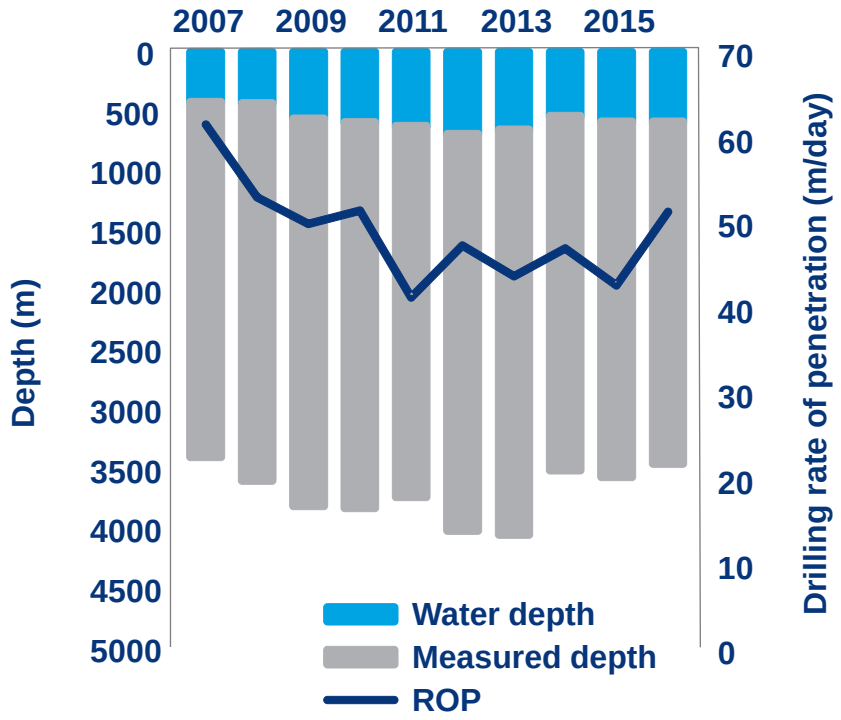
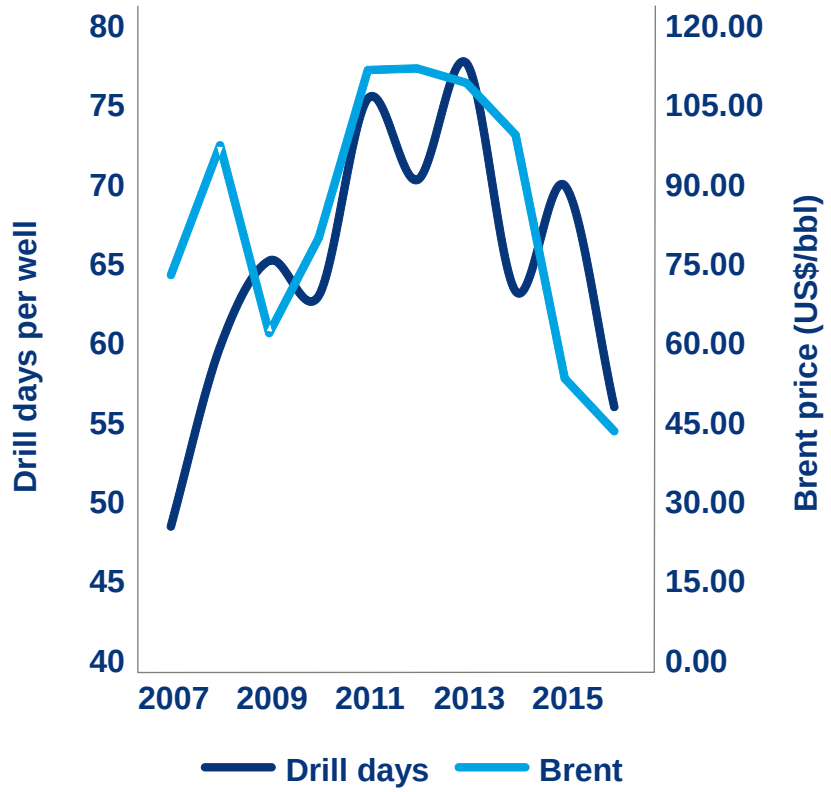
Drilling simpler wells

Easier targets and less complexity

Exploration well water depth and TD trends



Drill days per offshore exploration well



Source: Wood Mackenzie

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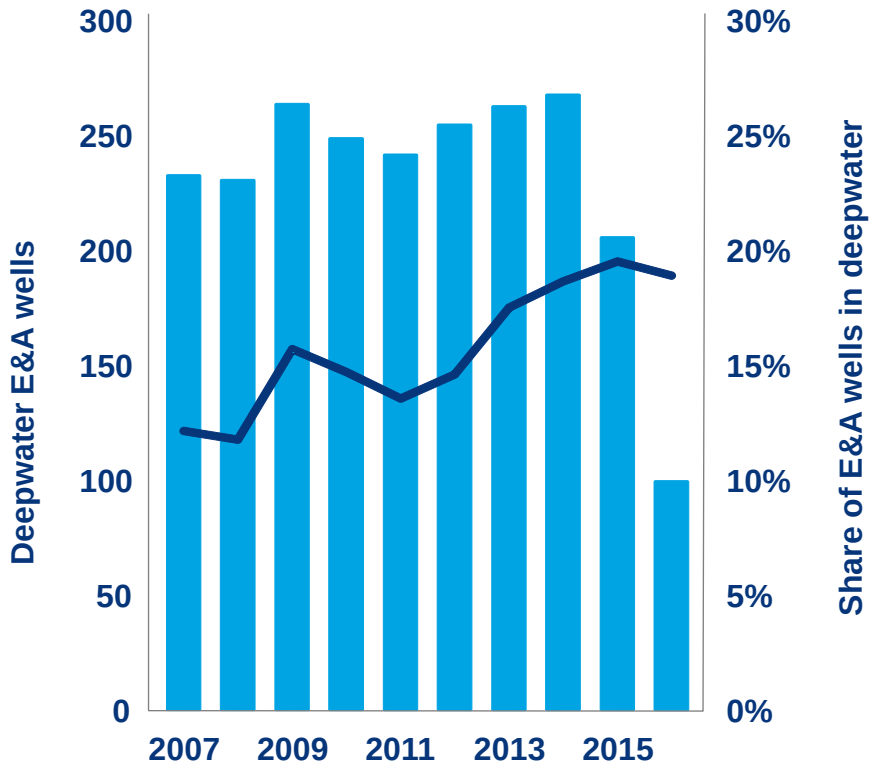
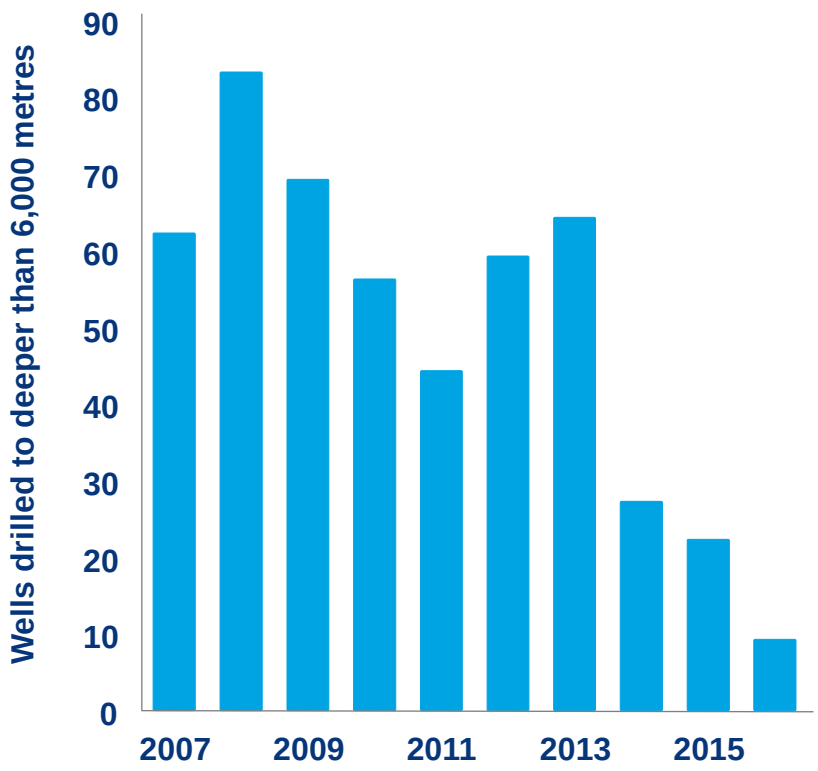
Deepwater investment holding up better than HPHT

The best deepwater oil plays, like Guyana and Senegal, break even below US$40

Deepwater E&A wells



HPHT E&A wells



Source: Wood Mackenzie

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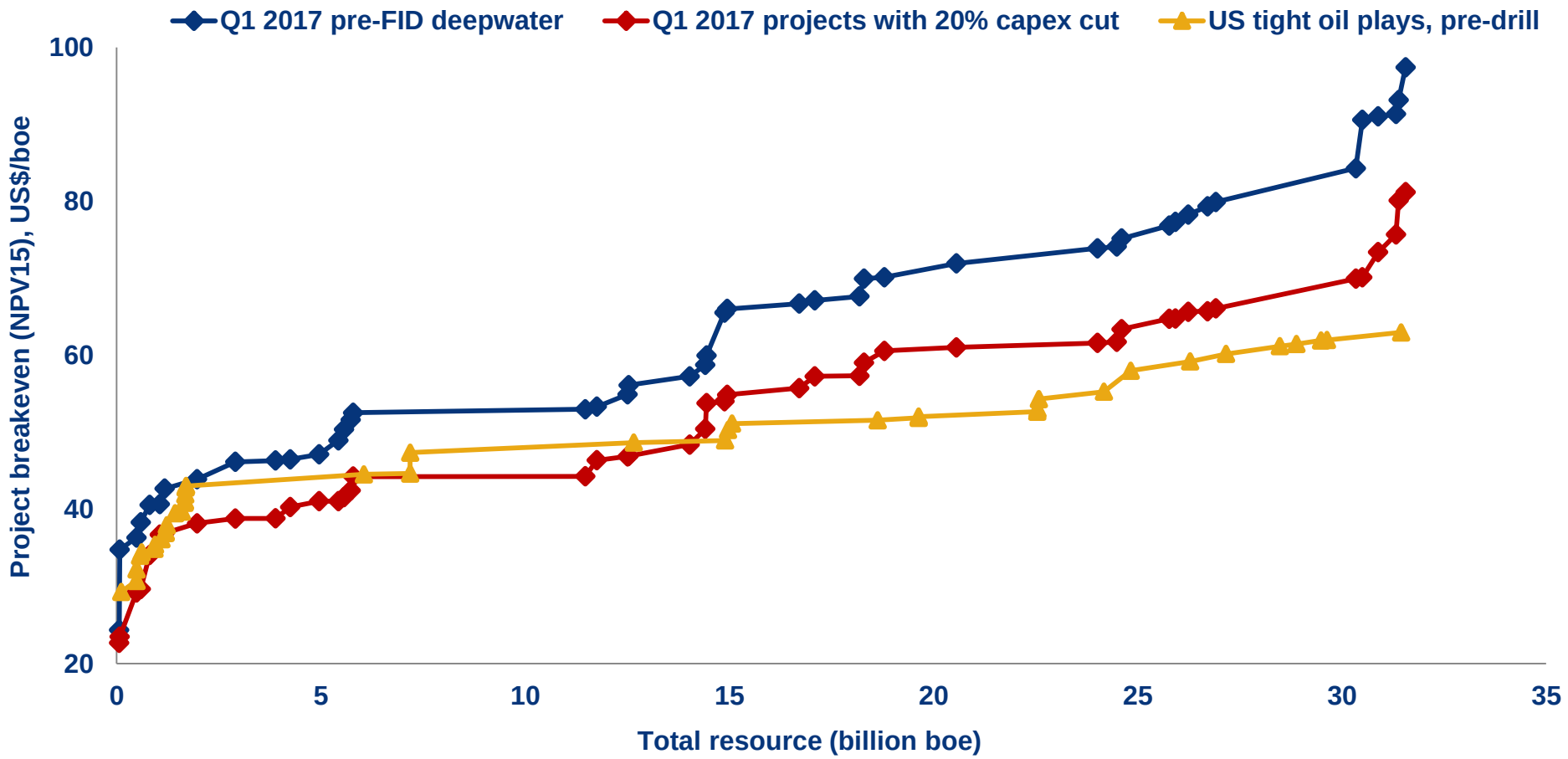
Deepwater costs compete with tight oil

Greenfield deepwater project cost-curve



Source: Wood Mackenzie

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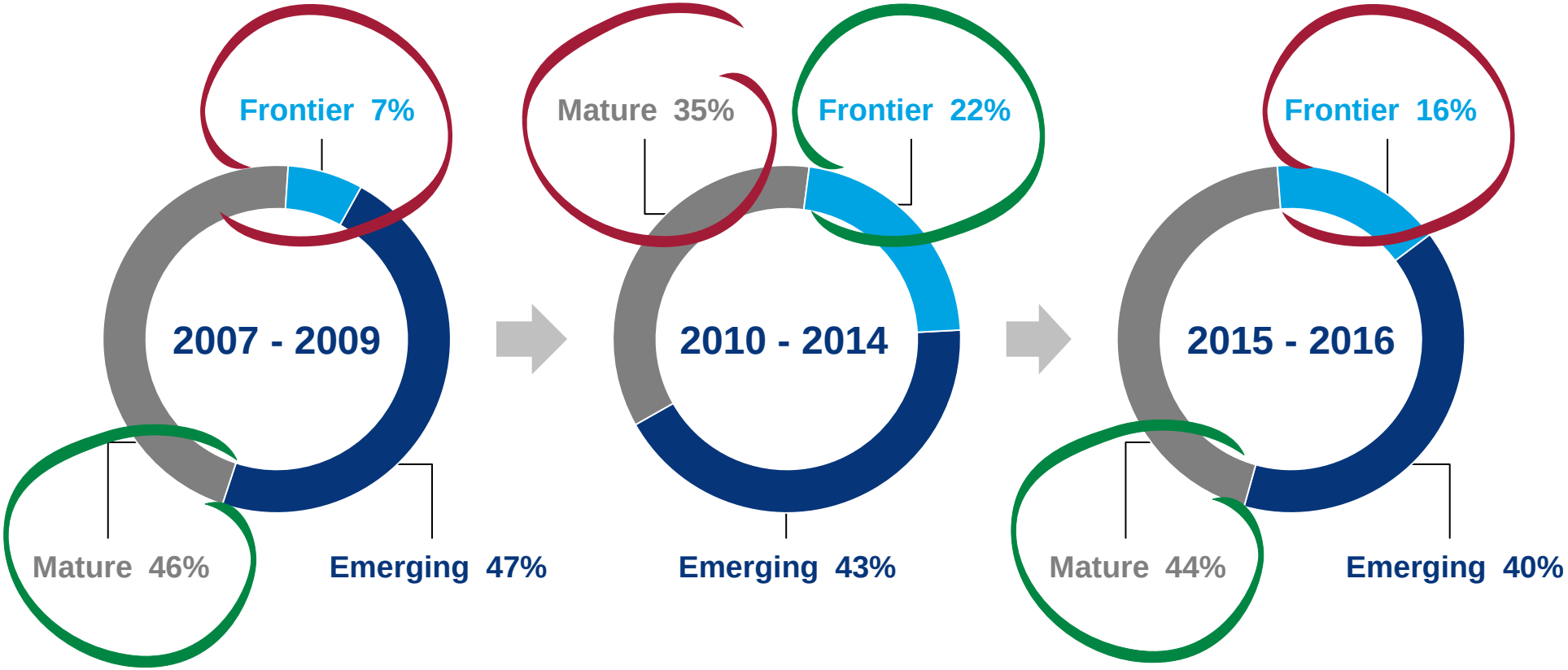
Re-focusing of portfolios shifts deepwater explorers away from frontiers to mature basins

Infrastructure, well-understood geology and established logistics/services

Proportion of deepwater exploration wells drilled by basin maturity



Source: Wood Mackenzie Exploration Service

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Exploration economics – the fiscal factor

Governments need to get the terms right to attract explorers

Source: Wood Mackenzie 'A Balancing act: global fiscal trends and benchmarking' (November 2016)

Wood Mackenzie
A Verisk Analytics Business

Fiscal evolution

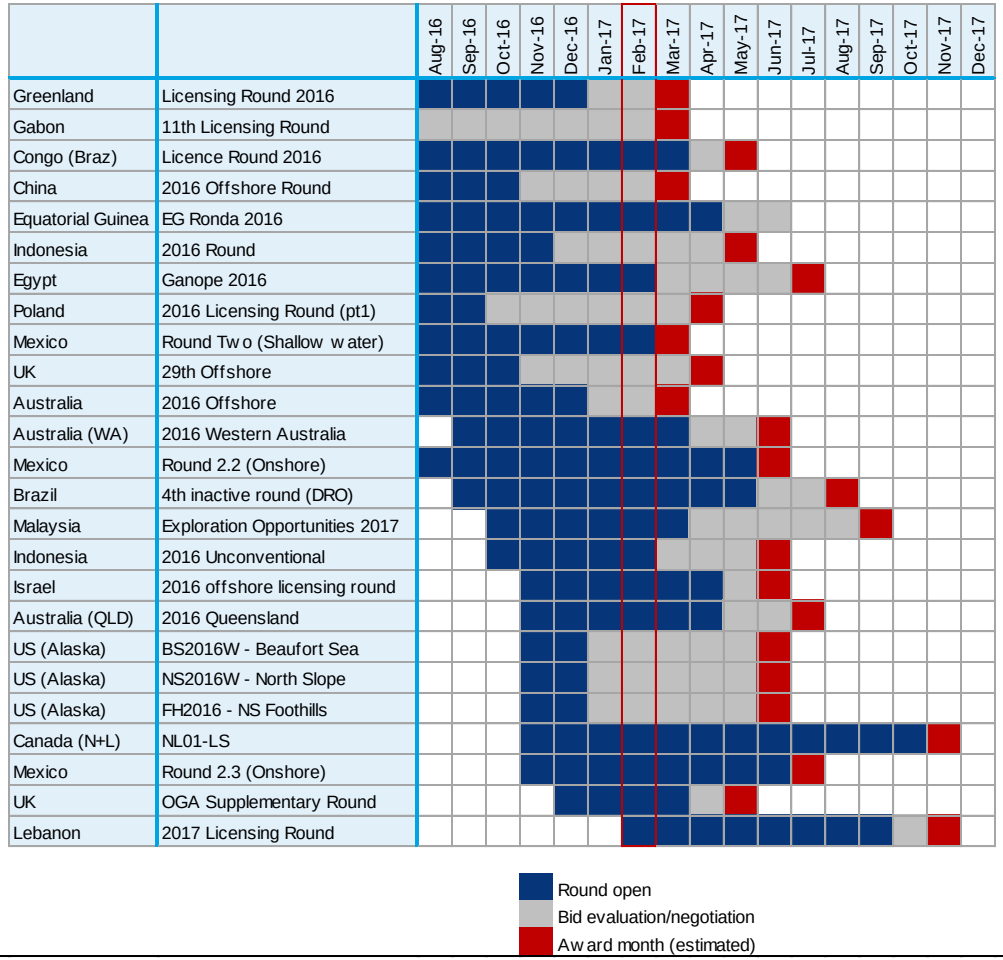
Increasing use of fiscal terms to determine licence awards

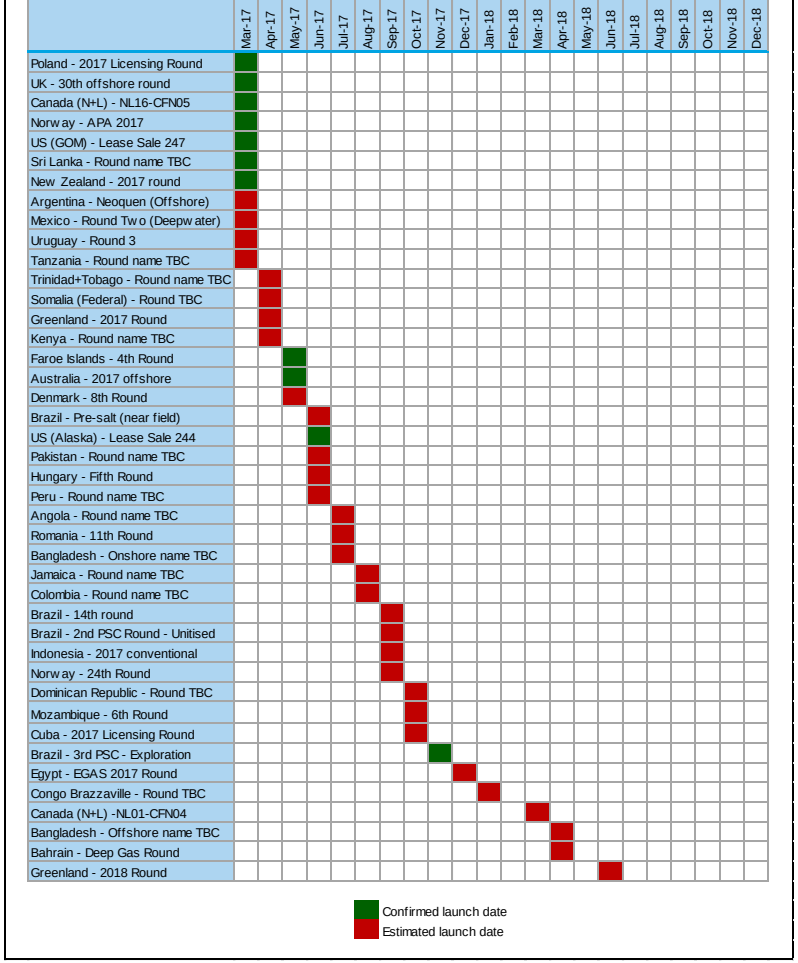
Source: Wood Mackenzie 'A Balancing act: global fiscal trends and benchmarking' (November 2016)

Wood Mackenzie
A Verisk Analytics Business

Fixing exploration returns – low-cost renewal of quality acreage

Over 60 licensing rounds active or expected to launch in next 18 months





Source: Wood Mackenzie 'Fiscal and Licensing month in brief' (March 2017)

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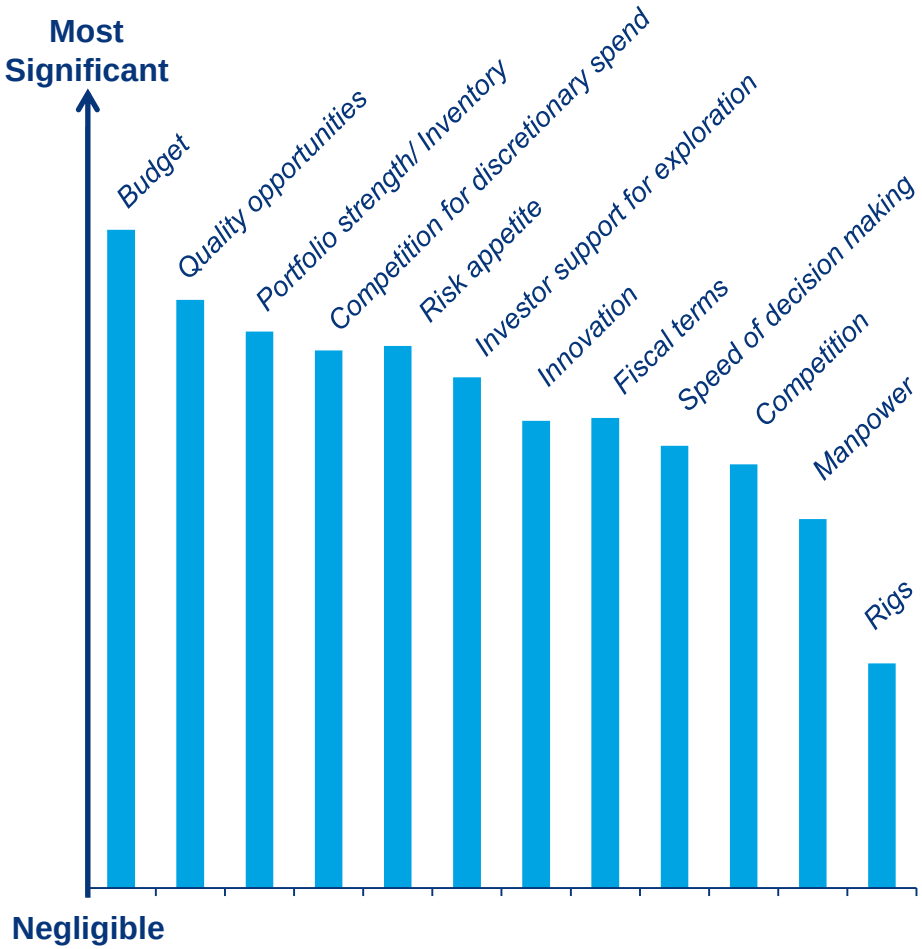
Budget and quality of opportunities & inventory are the top concerns for explorers

What are the most significant challenges for your company in Exploration today?

2017 Challenges



Evolution of selected challenges

Challenge	Change of Importance
Quality opportunities	↑
Portfolio strength/ Inventory	
Risk appetite	↓
Fiscal terms	
Competition for discretionary spend	

- Budget remains the most significant challenge
- Competition for discretionary spend and fiscal terms are diminishing challenges
- Limited investor support continues to be a concern
- Risk appetite has dropped three places since 2016 as companies have adjusted to different business models
- Quality opportunities are back in focus after extreme portfolio cuts seen in the past two years, especially for NOCs

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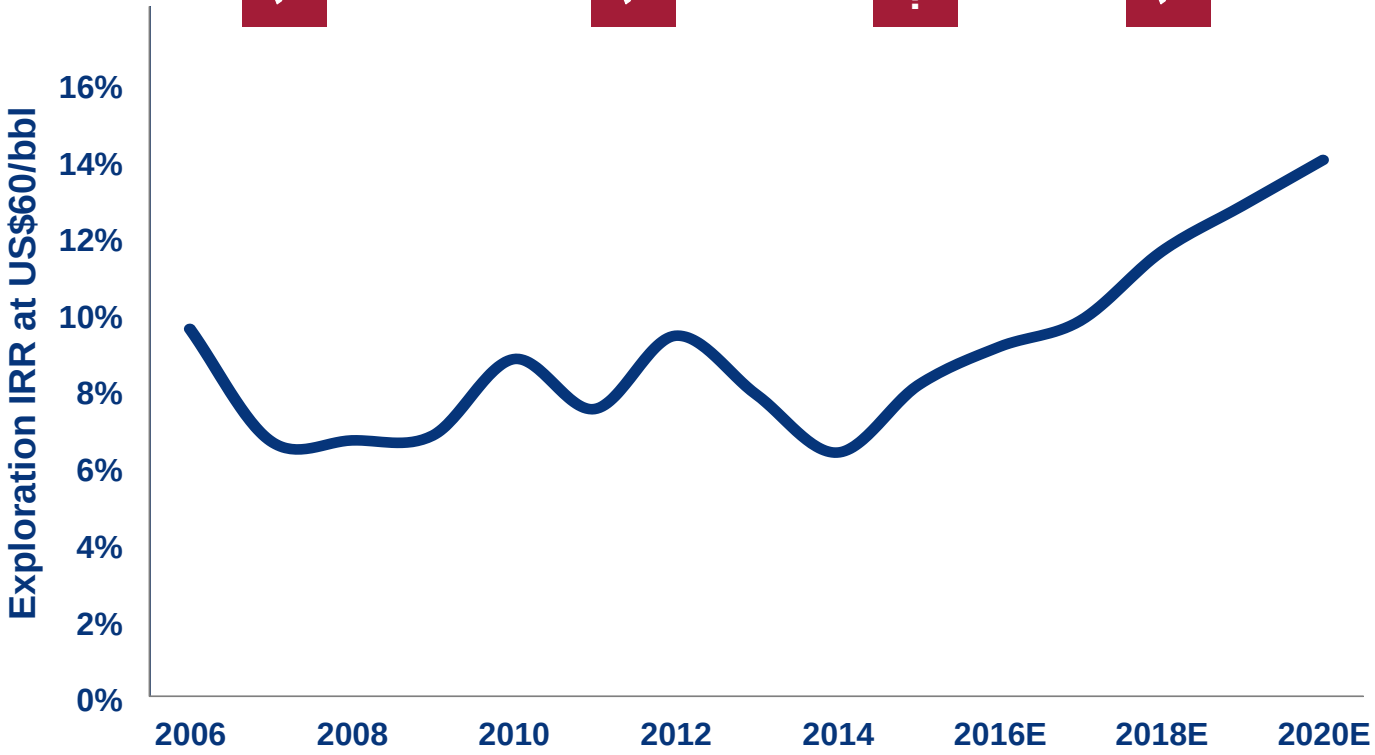
With progress on all fronts, exploration economics will recover

Reduce exploration costs by >50%	+	Reduce development costs by >25%	+	Refocus portfolios to avoid complexity	+	Avoid tough fiscal terms	+	Reload acreage at low cost	=	Exploration returns up even at US$50/bbl
✓		✓		✓		?		✓		?



Source: Wood Mackenzie Exploration Service.

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Who can grow? How US Independents will balance production ambitions with cash-flow priorities

Andy McConn

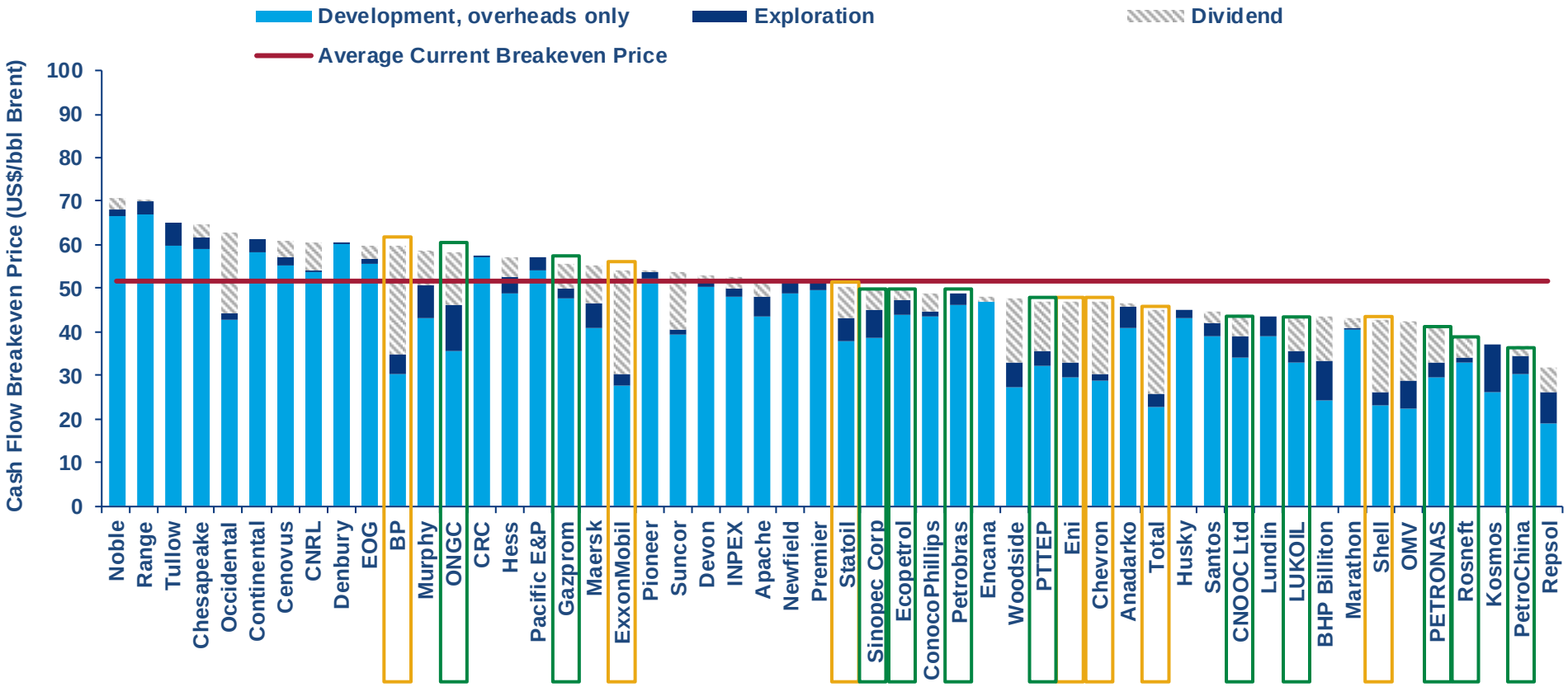
Upstream Forum

May 11, 2017

The sector is functioning healthily at $50/bbl

But growth-oriented Independents need a recovery to avoid outspending cash flow

Oil price required for cash-flow neutrality between 2017 and 2019



Source: Wood Mackenzie Corporate Benchmarking Tool Q1 2017. Base-case estimate of Brent price required to remain cash flow neutral (accumulate no additional debt) between 2017 and 2019. Includes full corporate costs and distributions and downstream cash flow for BP, Cenovus Energy, Chevron, Eni, ExxonMobil, Husky Energy, OMV, Petrobras, Repsol, Shell, Suncor Energy and Total. For all other companies we apportion announced dividend and buyback programmes to the upstream business on a pro-rata basis.

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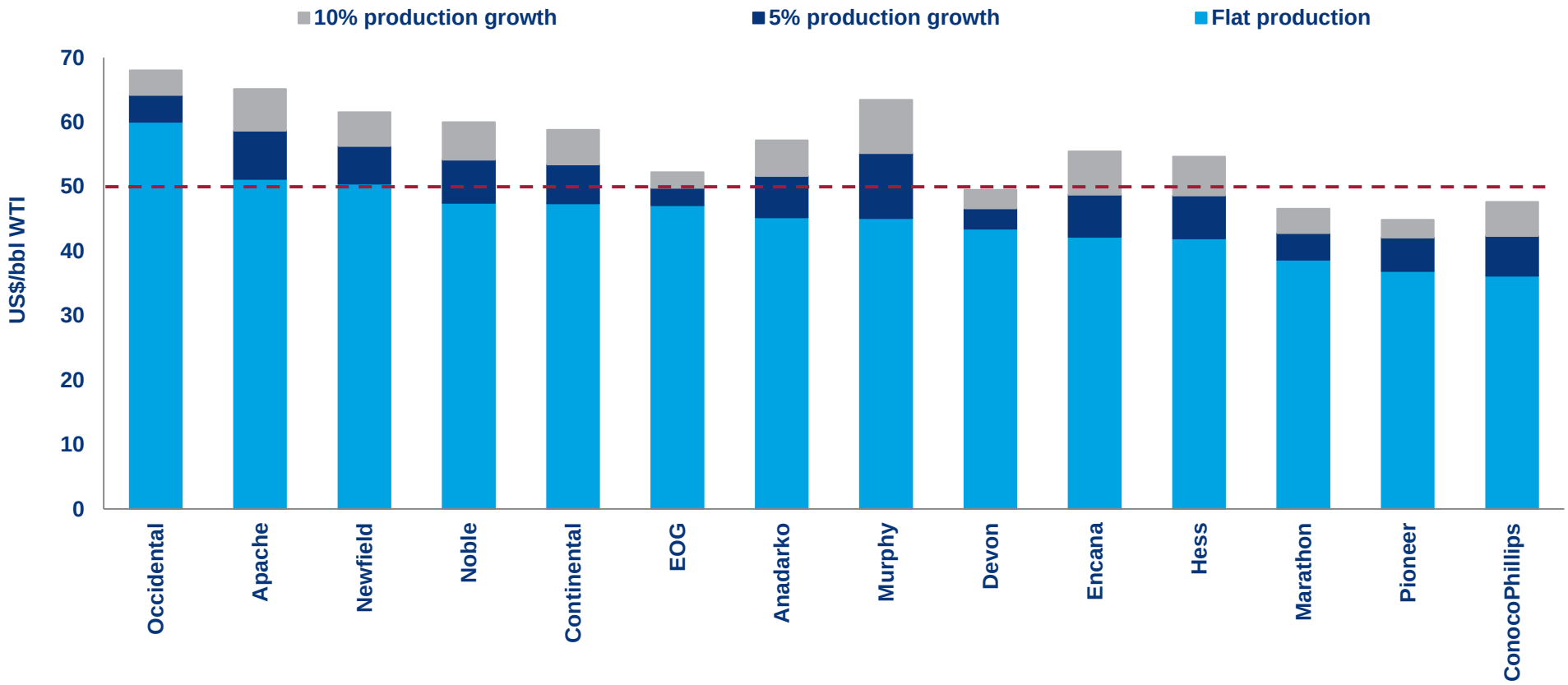
Tight-oil players are highly sensitive to oil-price movements

Organic double-digit growth is difficult at $50/bbl, but easy at $60/bbl

Oil price required for cash-flow neutrality in 2017 at each production scenario (US$/bbl WTI)



Source: Wood Mackenzie. Production scenarios are based on a 15:1 mcf:boe ratio, reflect the change in full-year corporate-level entitlement production from 2016 to 2017, and are adjusted to exclude the impact from M&A. All cash-flow items (e.g., all capex, dividends, G&A, interest expense, and hedging) are included in the calculation. Gas-price assumptions are dynamically linked to the oil price.

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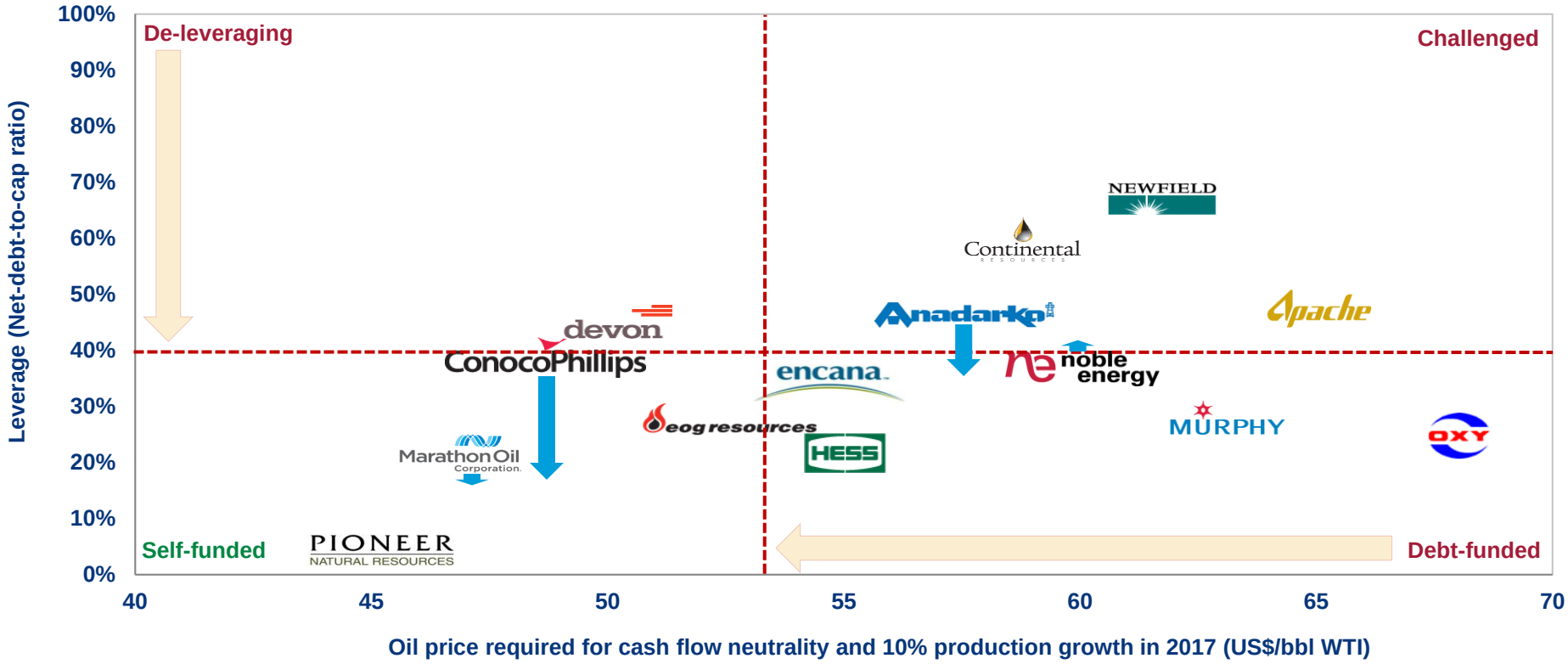
Leverage concerns constrain near-term growth

Asset sales will play a large role in de-leveraging initiatives

Oil prices required to grow production by 10% in 2017 versus net-debt-to-capitalisation ratios



Source: Wood Mackenzie. Leverage ratios use information from Q4 2016 financial statements.

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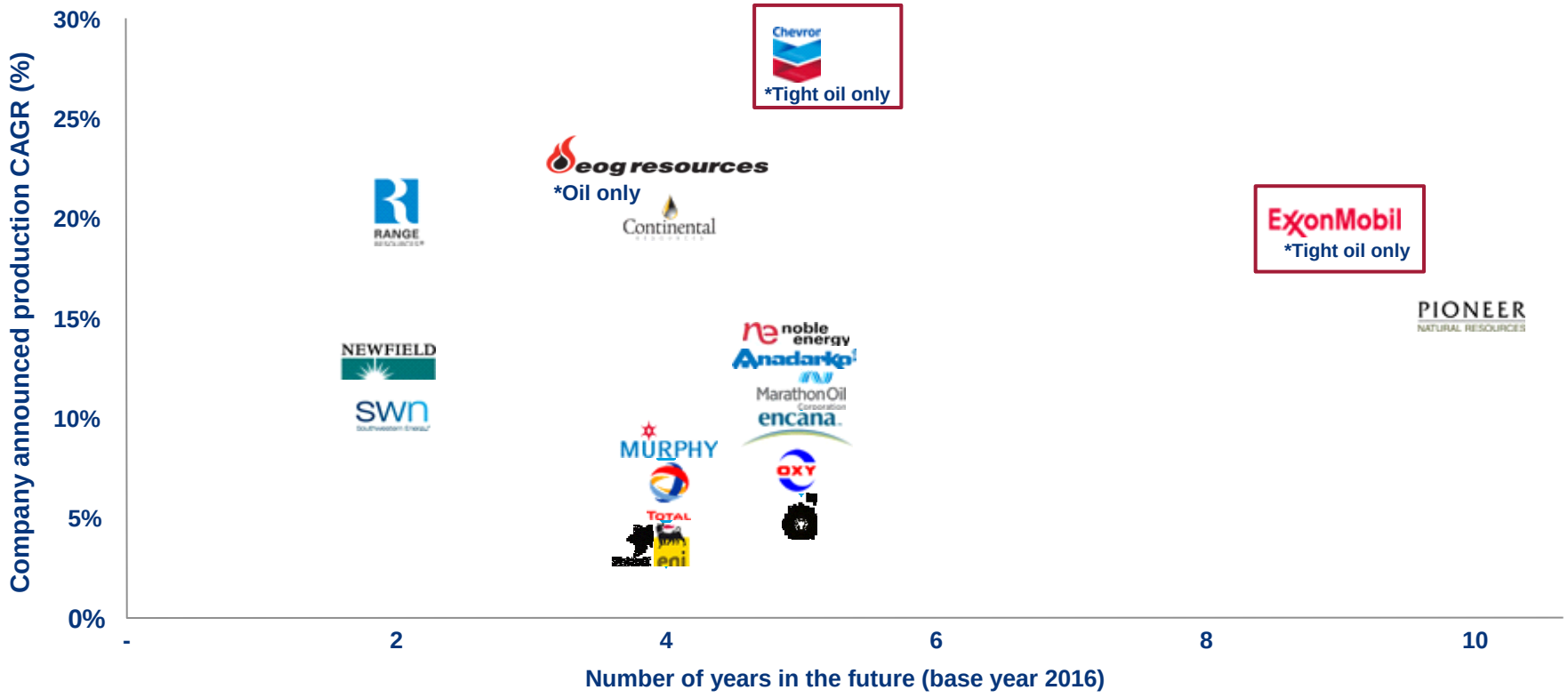
Growth targets focus on the long term

The Majors' targets signal a willingness to compete with smaller, nimbler peers

Company-announced production-growth targets (CAGR)



Source: Wood Mackenzie. Includes all multi-year production targets announced during the Q4 2016 results season within our Corporate Service coverage.

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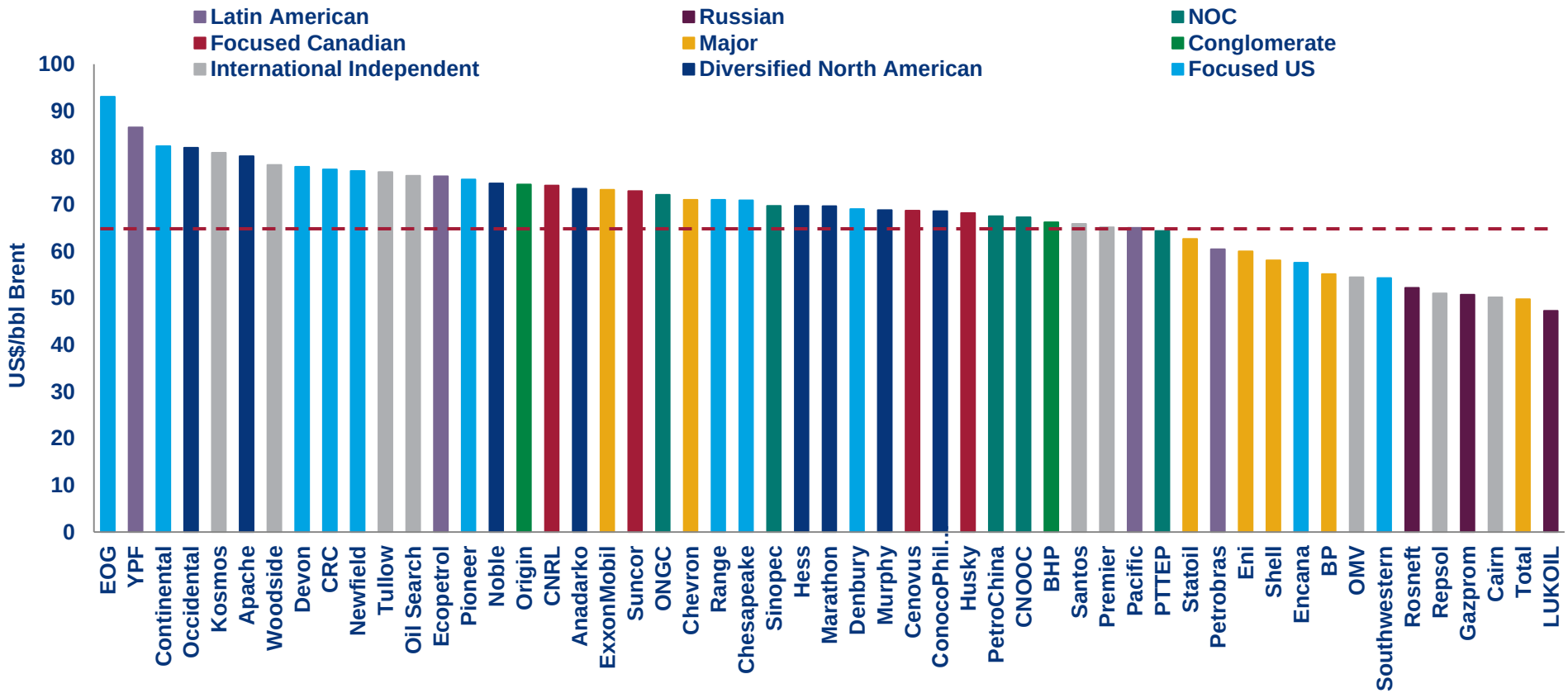
Market valuations imply expectations for an oil-price recovery

North American Independents' share prices reflect the largest premiums

Long-term oil price required in our models to equal market valuations



Source: Wood Mackenzie, Thomson Reuters. The implied oil price is the long-term real Brent oil price required to make Wood Mackenzie's NPV of the company's commercial portfolio equal to the Upstream Enterprise Value ((average of market cap in February 2017 + latest net debt) x WM portion of total value in upstream) at a 10% discount rate.

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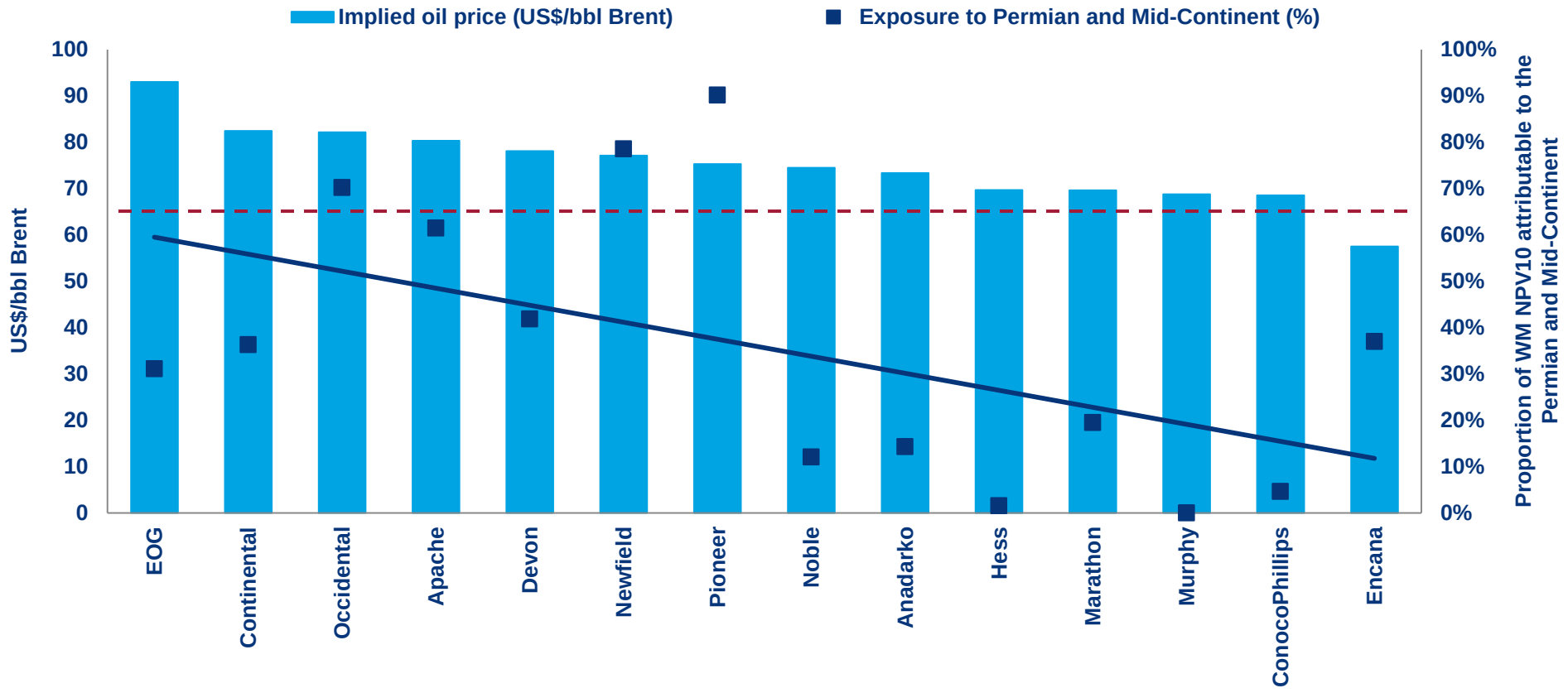
Permian and Mid-Continent assets command market premiums

Cost inflation poses a key risk

Long-term oil price required in our models to equal market valuations (US$/bbl Brent)



Source: Wood Mackenzie

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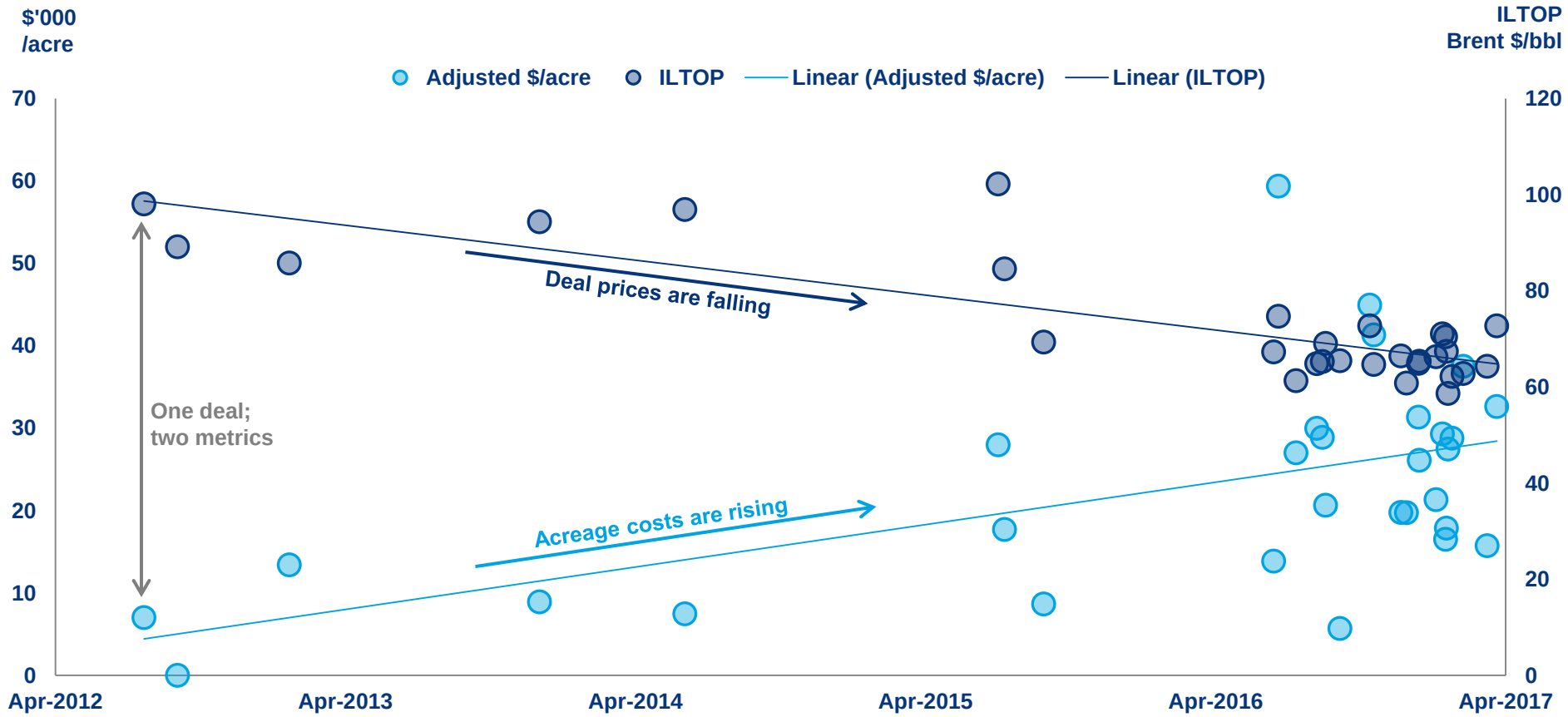
Permian acreage costs are rising, but deal breakevens are falling

Deal prices are reasonable, but near-perfect execution is required to create value

Adjusted $/acre vs. ILTOP for selected deals



*Source: Wood Mackenzie. * The implied long-term oil price is the real Brent oil price required to make Wood Mackenzie's NPV of the assets included in the transaction equal deal consideration, based on our asset cash flow models and a 10% discount rate.*

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Lower 48 service sector: how much does a recovery cost?

Jackson Sandeen

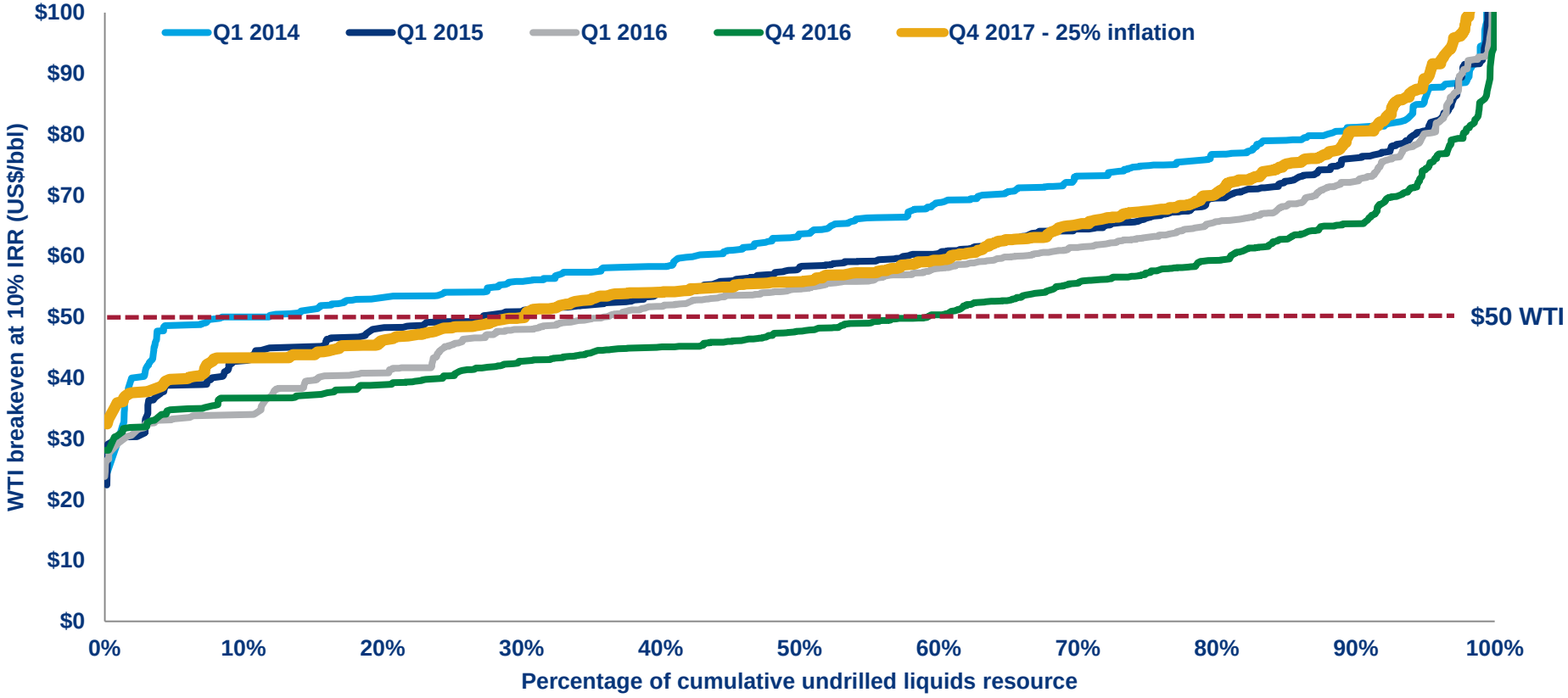
Upstream Forum

May 11, 2017

Down, down, down, and UP?

Is the industry prepared for higher costs? Breakevens across our coverage fell by roughly $15 per bbl from early 2014 to year-end 2016. Costs are coming back and future investments might not be as good as they seem.

Changes in Lower 48 liquids breakevens since 2014



Source: Wood Mackenzie

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What industry is saying on costs: US L48 inflationary pressure

"We're assuming as I said earlier just from hearing industry discourse about 10% to 15% (cost inflation) this year which would affect us by 5% which we're going to offset by efficiencies."

Tim Dove, Pioneer CEO

"It does appear the inflation has picked up somewhat from a few months ago, but we think we can largely offset that."

Dave Hager, Devon CEO

"And of course, we are somewhat reluctant to talk about hard numbers, because quite frankly, we're still out there negotiating with a lot of our service providers, and we don't see a lot of benefit in that."

Lee Tillman, Marathon Oil CEO

"The cost inflation, yes, it may happen. We know some of the service sector has being working literally on survival cash margins and that there needs to be some flowback of that. But we're in the reasonably good position of choice."

Simon Henry, Shell CFO

"North America pricing is going to recover in a more robust fashion. In the product lines that we will remain, which is Well Construction, related product lines, MPD, Completions, etc., the pricing trajectory is quite nice and we will continue to enjoy that."

Krishna Shivram, Weatherford Interim CEO

"We have modelled in a 5% to 10% increase in costs by year-end 2017...a blended estimate that includes service cost increases that are partially offset by continued efficiency gains that we expect, and lower drilling costs, as term rig contracts expire during the year."

Jack Stark, Continental COO

"E&P spending surveys currently indicate that 2017 North America E&P investments will increase by around 30% led by the Permian Basin, which should lead to both higher activity and a long-overdue recovery in service industry pricing."

Paul Kibsgaard, Schlumberger CEO

"We've seen request up in – of increases up into the mid-30% range, that doesn't mean they're getting those price increases. It's the beginning of the negotiation, and in some cases, we've had to replace suppliers, because we couldn't agree to terms."

Doug Suttles, Encana CEO

"We are finalizing contracts to secure fleets in West Texas with terms that include indexing prices to WTI and extending contracts with favourable rates."

Tim Sullivan, Apache EVP Operations

"I think as the equipment tightens, commodity prices increase and everybody wants availability of equipment when they want it, where they want it and how they want it, I don't see that there is going to be the ability for the customer to hold prices down. It's going to be a supply and demand market. It always is."

Dave Lesar, Halliburton CEO

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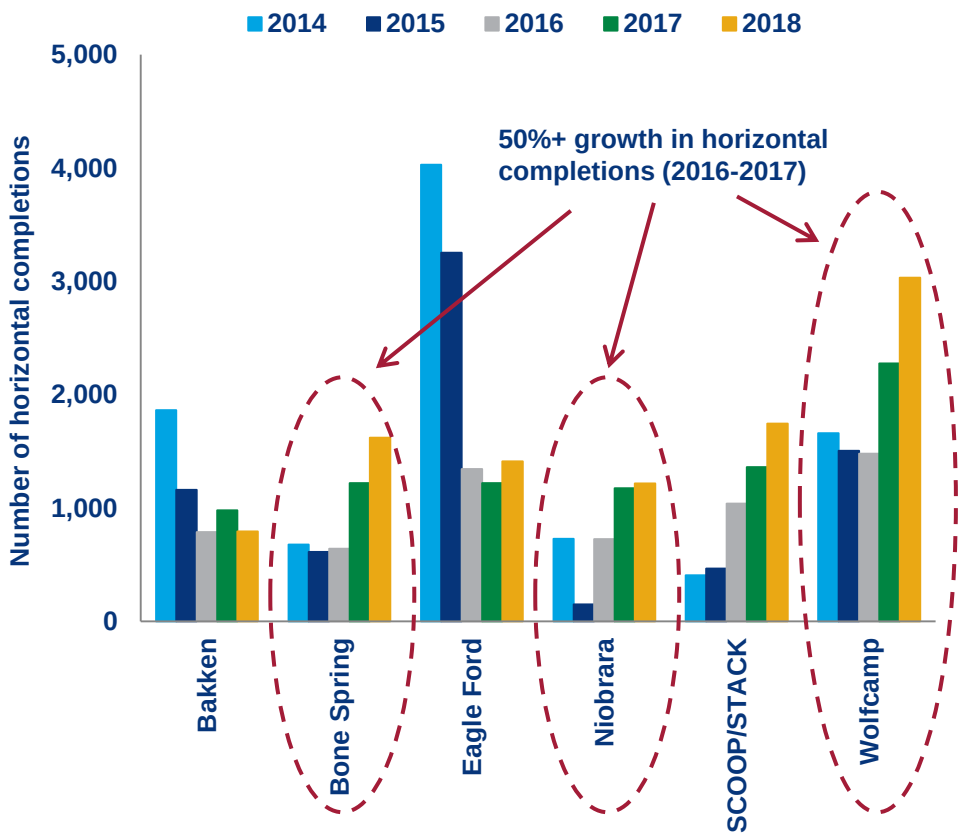
Pressure pumping pricing is ripe for inflation as the L48 rebounds

Wood Mackenzie assumes pressure pumping cost inflation of 20% in our base case

Lower 48 key tight oil play completions (2014-2018)



Source: Wood Mackenzie Upstream Supply
**2017 and 2018 completions are Wood Mackenzie forecasts*

Pressure pumping is most exposed sector

- Upward pressure on costs
  - » Completions up 37% y-o-y
  - » Working utilization near full capacity
    - » Backlog in high-activity basins
  - » Sidelined equipment in poor shape
    - » Lack of R&M
    - » Cannibalization of equipment
- Downward pressure on costs
  - » IPOs flooding the market
  - » Bankrupt companies re-emerging w/ clean balance sheets

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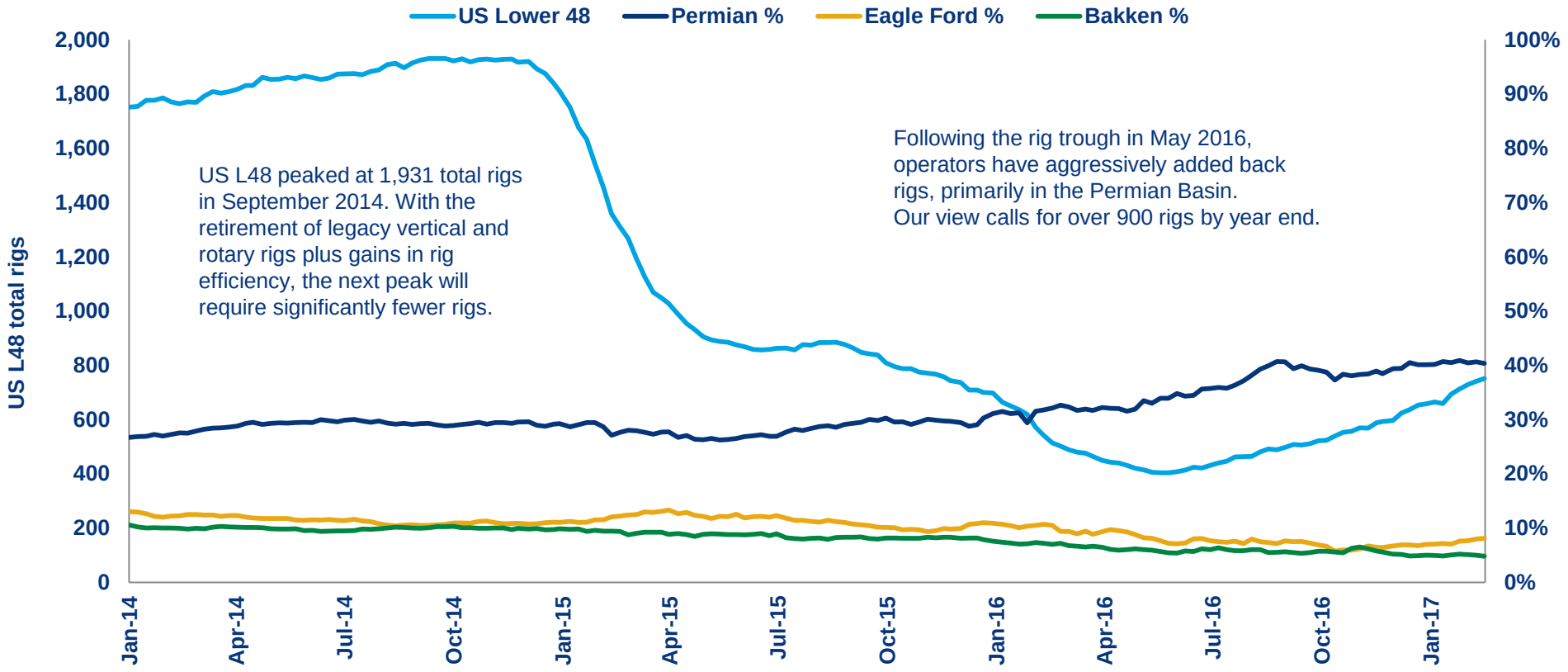
Rig utilization rates battered in 2016; tightening in high-spec market

Wood Mackenzie assumes horizontal drilling rig cost inflation of 10% in our base case

US total land rig count (2014-2017)



Source: Wood Mackenzie

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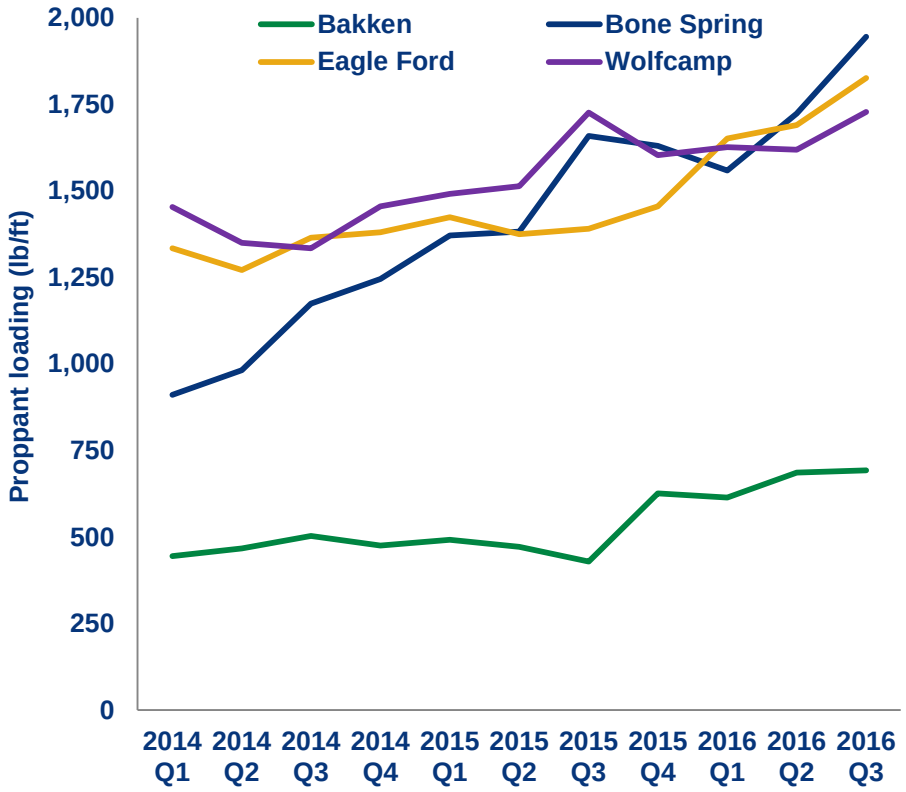
Proppant demand continues to grow despite potential downsides

Wood Mackenzie assumes proppant cost inflation of 15% in our base case

Proppant loading by key tight oil play (2014-2016)



Will proppant demand continue unconstrained?

- Upward pressure on costs
  - » Growth in horizontal completions
  - » Growth in proppant loading per well
    - » Leading edge operators and laggers
  - » Short-term supply constraints
- Downward pressure on costs
  - » Continued shift to cheaper regional sand over Northern White
  - » Potential oversupply
    - » Acquisitions, new mines, production ramp-up
  - » Diminishing returns

Source: Wood Mackenzie North America Well Analysis Tool

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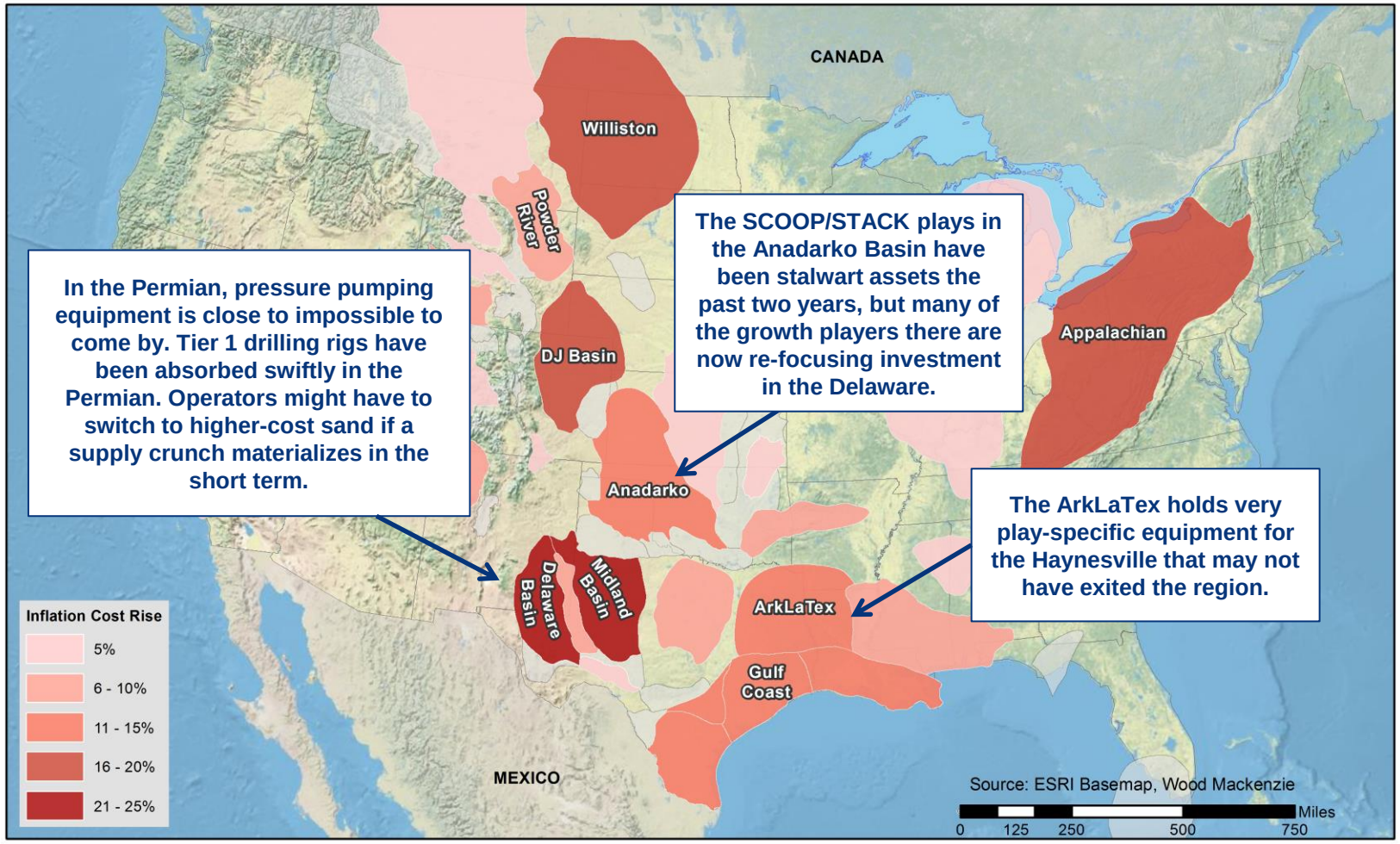
Not all inflation is created equal

Midland and Delaware sub-basins lead the charge; step-change could occur post-2017 in non-Permian basins such as Williston and DJ

2017 Lower 48 cost inflation assumptions by basin



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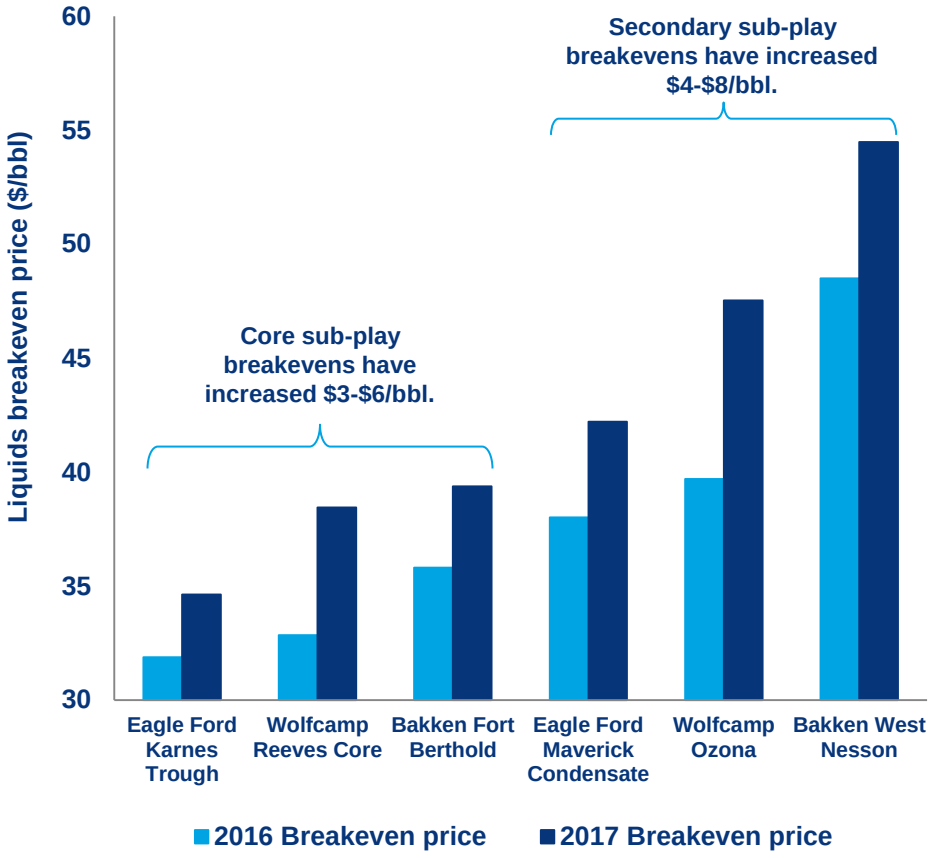
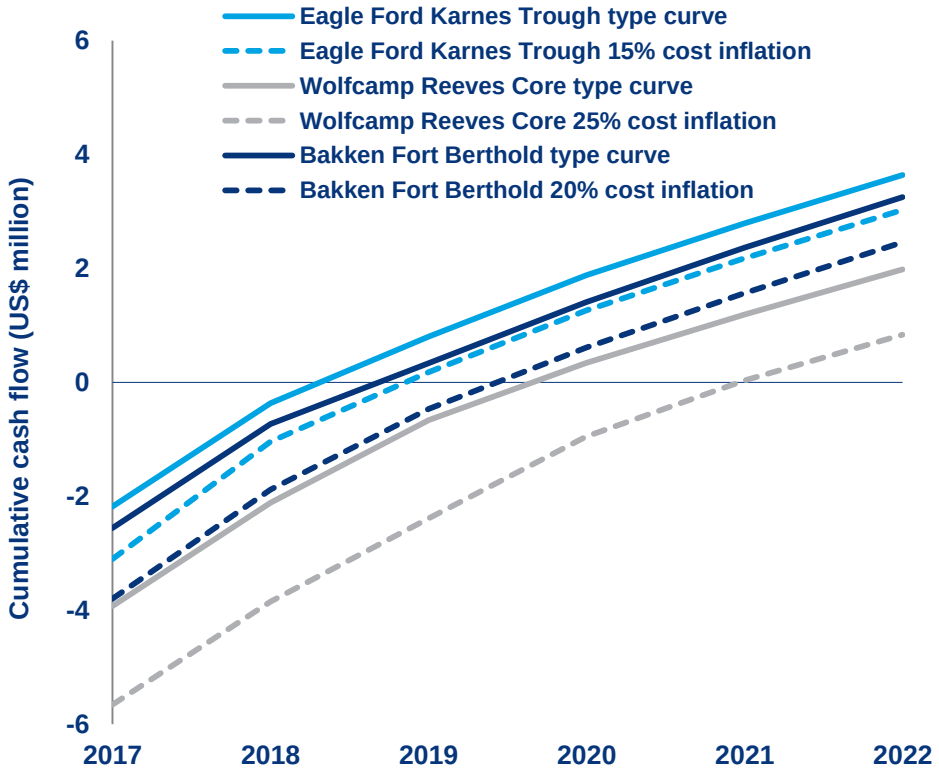
Core areas continue to yield attractive returns despite inflation

Core breakevens expected to increase $5/bbl; payback periods could be deferred 6-18 mo

Breakeven price for key tight oil plays (2016-2017)



Cumulative cash flow for key tight oil type curves



Source: Wood Mackenzie. Wood Mackenzie Global Economic Model (GEM)

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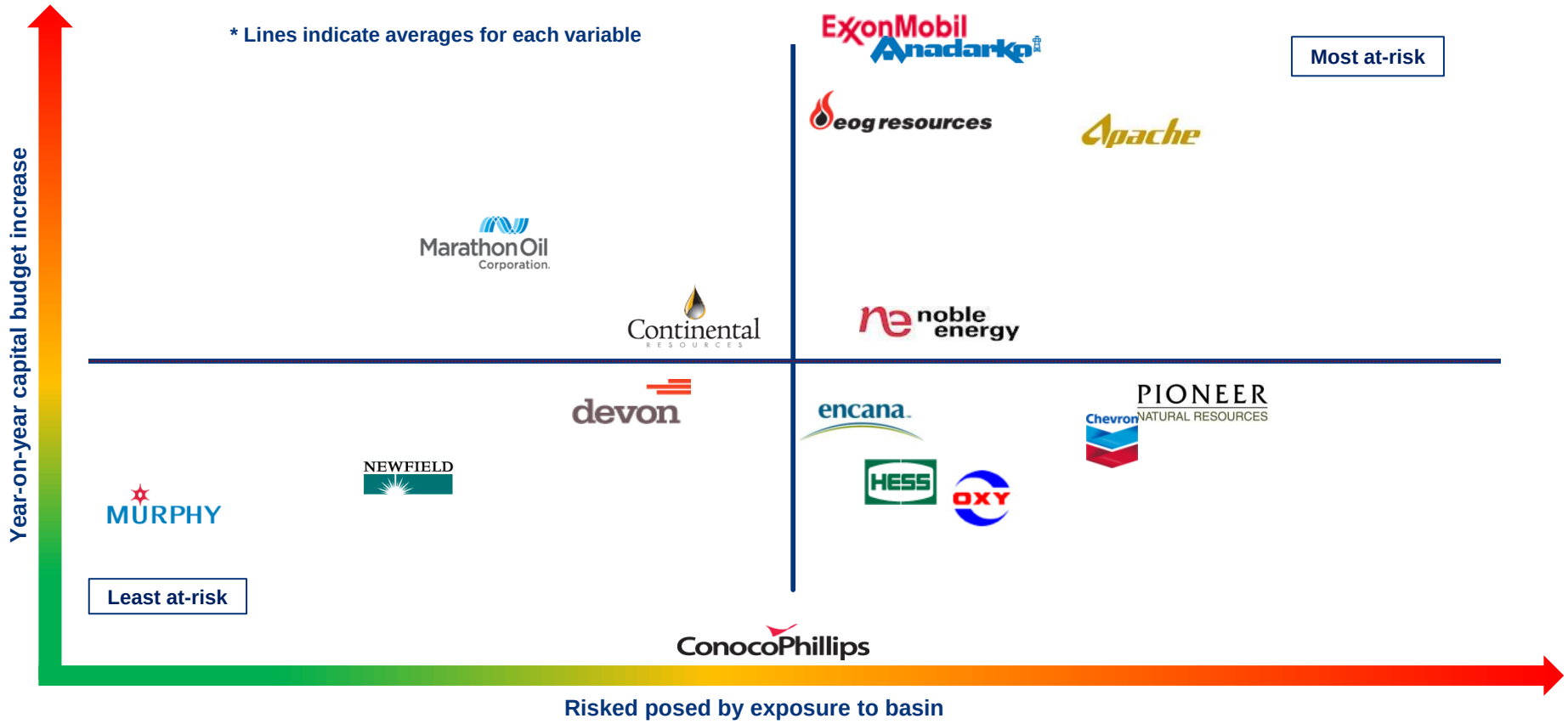
Permian operators face outsized inflation

Operators can push back on inflation via vertical integration, continued efficiencies through pad drilling and indexing OFS contracts to WTI

Corporate exposure to cost inflation across the Lower 48



Source: Wood Mackenzie Corporate Service, US focused companies

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Lower 48 service sector cost inflation

Main takeaways

- There is a key disconnect on pricing between service companies and producers.
- Wood Mackenzie forecasts onshore cost inflation of 15% in 2017.
- Inflation is weighted towards well completions. Pressure pumping is most exposed.
- Basin of activity matters. The Midland and Delaware basins stand out.
- Core acreage in the top tier plays will continue to command attractive wellhead breakevens. Marginal sub-plays could be rendered out of the money.
- Operators are mitigating costs through debundling of services, linking of contracts to WTI and vertical integration.

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Offshore supply chain: bringing costs down to increase competitiveness

Caitlin Shaw

Upstream Forum

May 11, 2017

Upcoming FIDs to 2018 (projects with 8+ subsea trees)

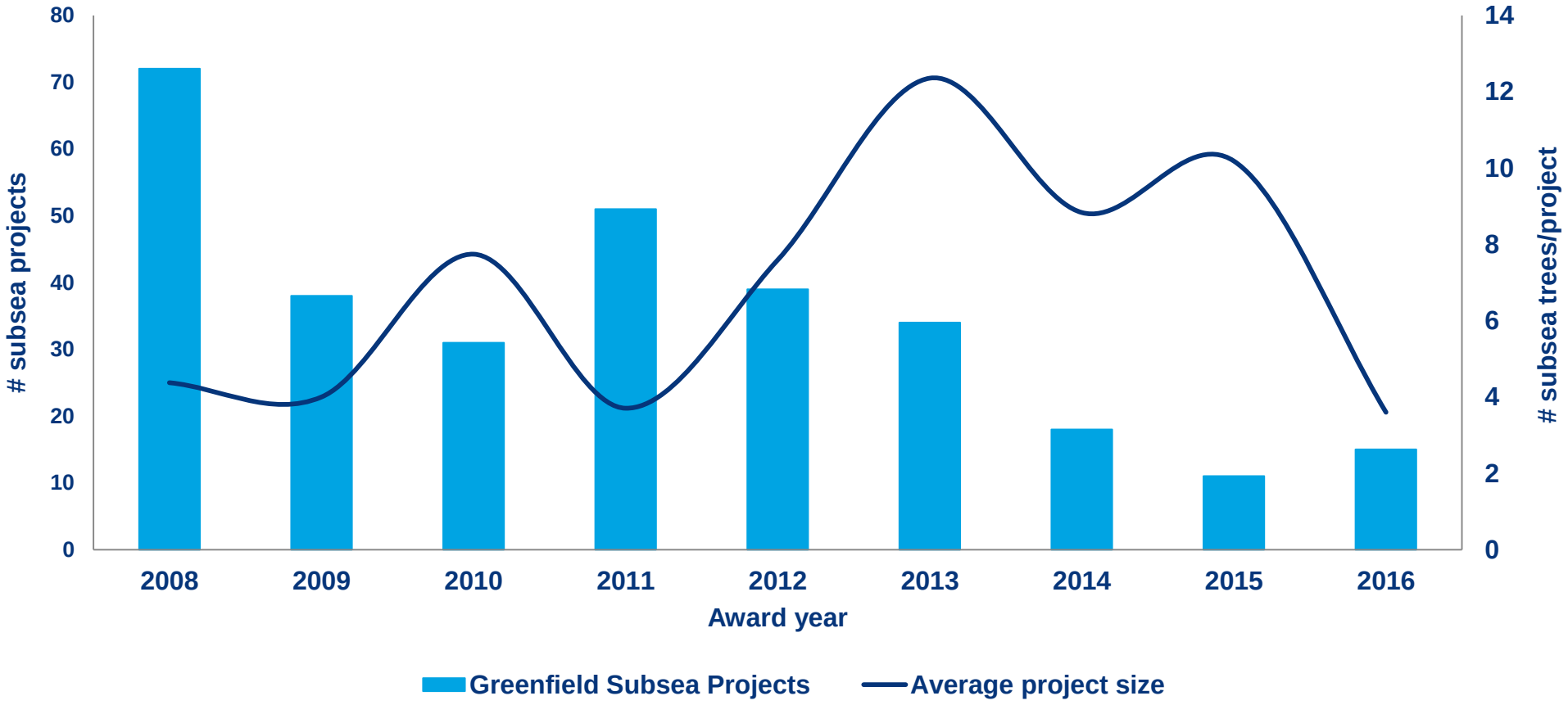
Woodmac estimates large projects (8+ subsea trees) FIDs in 2017 and 2018 to represent c.290 subsea trees. Order book is expected to surpass 2016 levels and reach 100+ range in 2017, with 2018 being the first 'rebound' year for the subsea tree market.

Source: Global Project Tracker – http://www.infield.com/market-intelligence-tools/gpt-global-project-tracker

Wood Mackenzie
A Verisk Analytics Business

Global award activity at record lows

To maximize potential it is key to understand the profile of projects, not just volume.



Source: Wood Mackenzie

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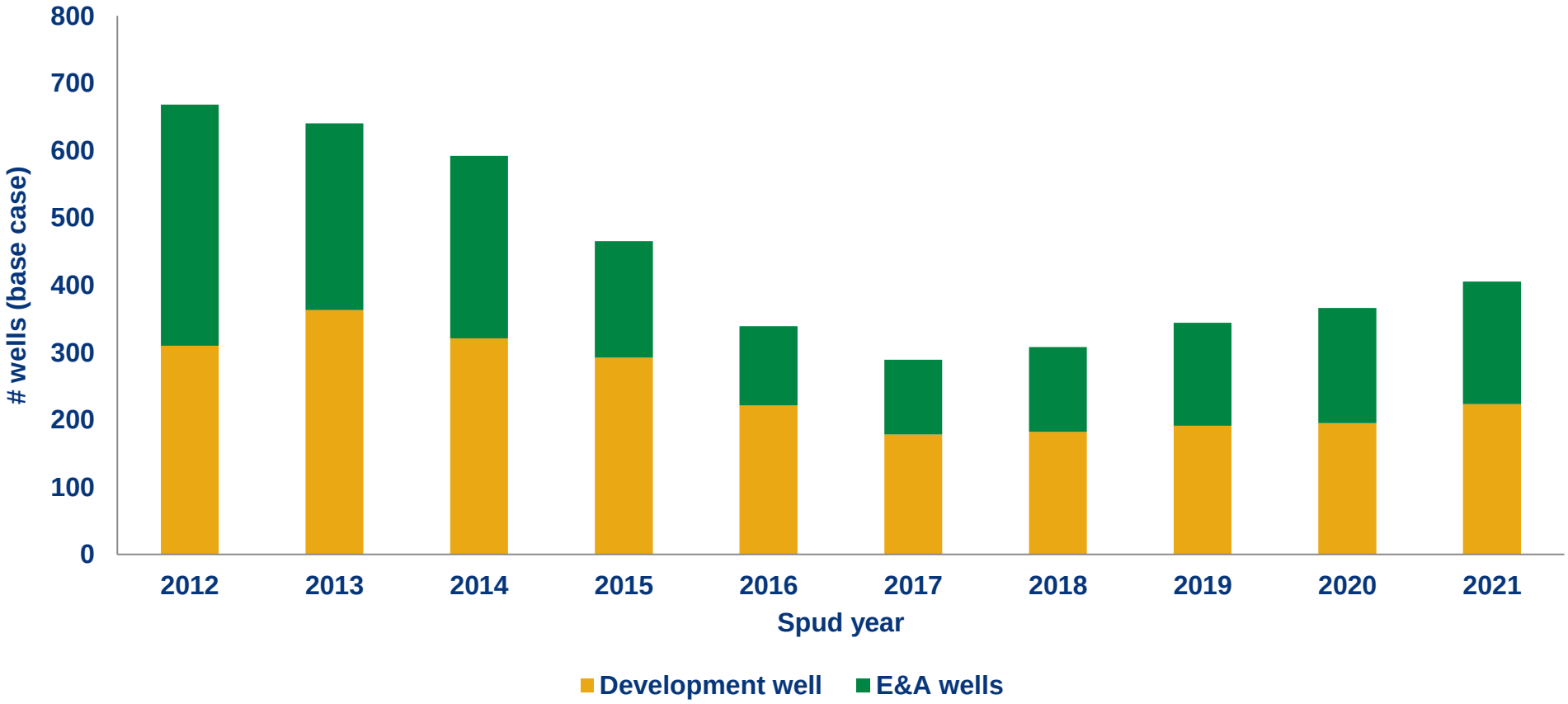
Deepwater drilling activity muted

Shifts in focus, cost concerns and the oil price crash led to severely depressed deepwater drilling demand globally and a lower for longer oil price outlook does not support pre-down turn recovery



Source: Wood Mackenzie

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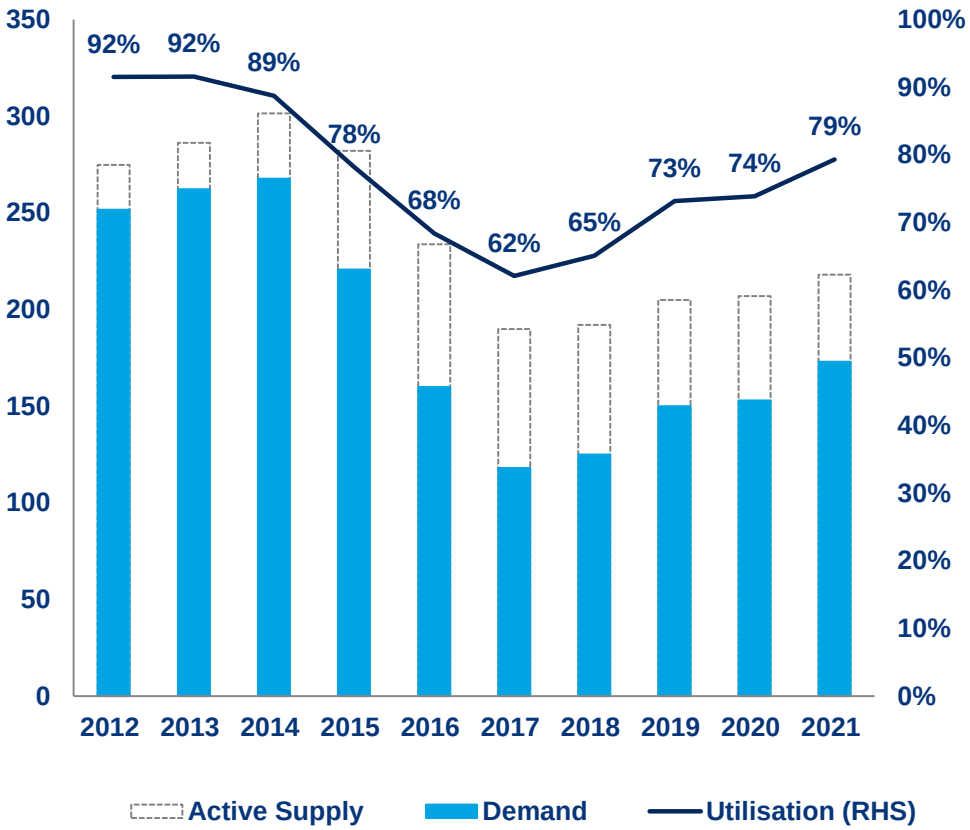
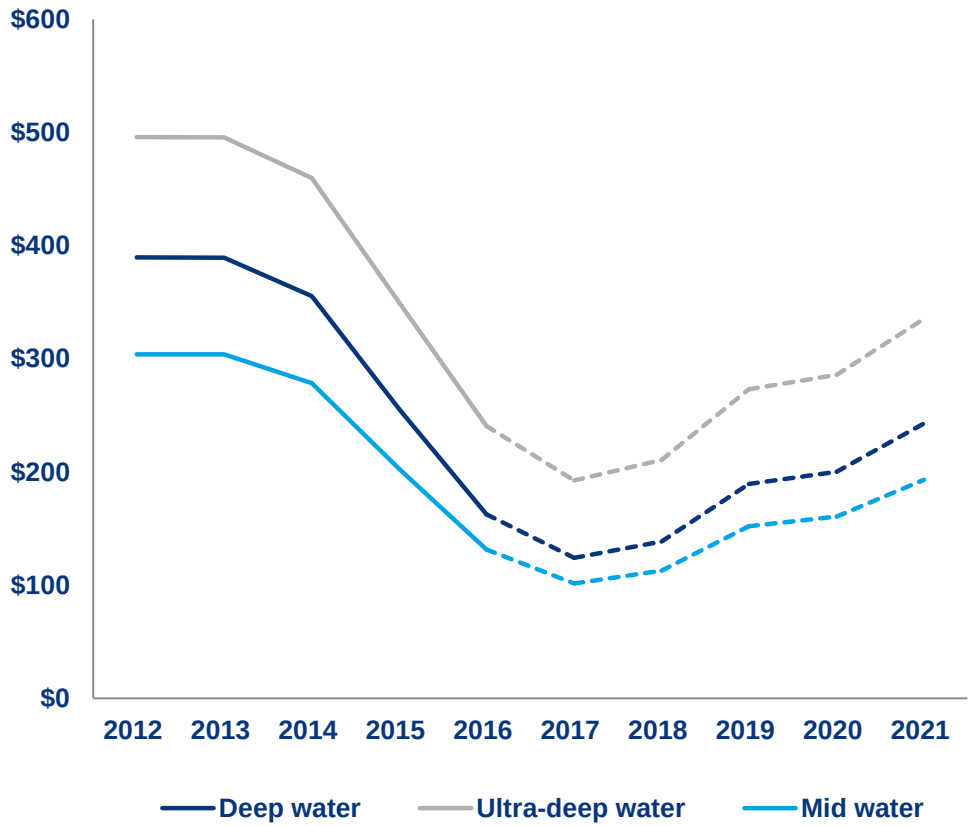
Global Floating Rig Utilisation & Day Rate Forecast

Cold-stacking and retirements have now significantly reduced active supply, though more needs to be done to support day rate growth. A slow recovery should encourage further attrition

Utilisation – Base Case (%)



Day Rate by Asset Class (US$k)



Source: Wood Mackenzie

Wood Mackenzie
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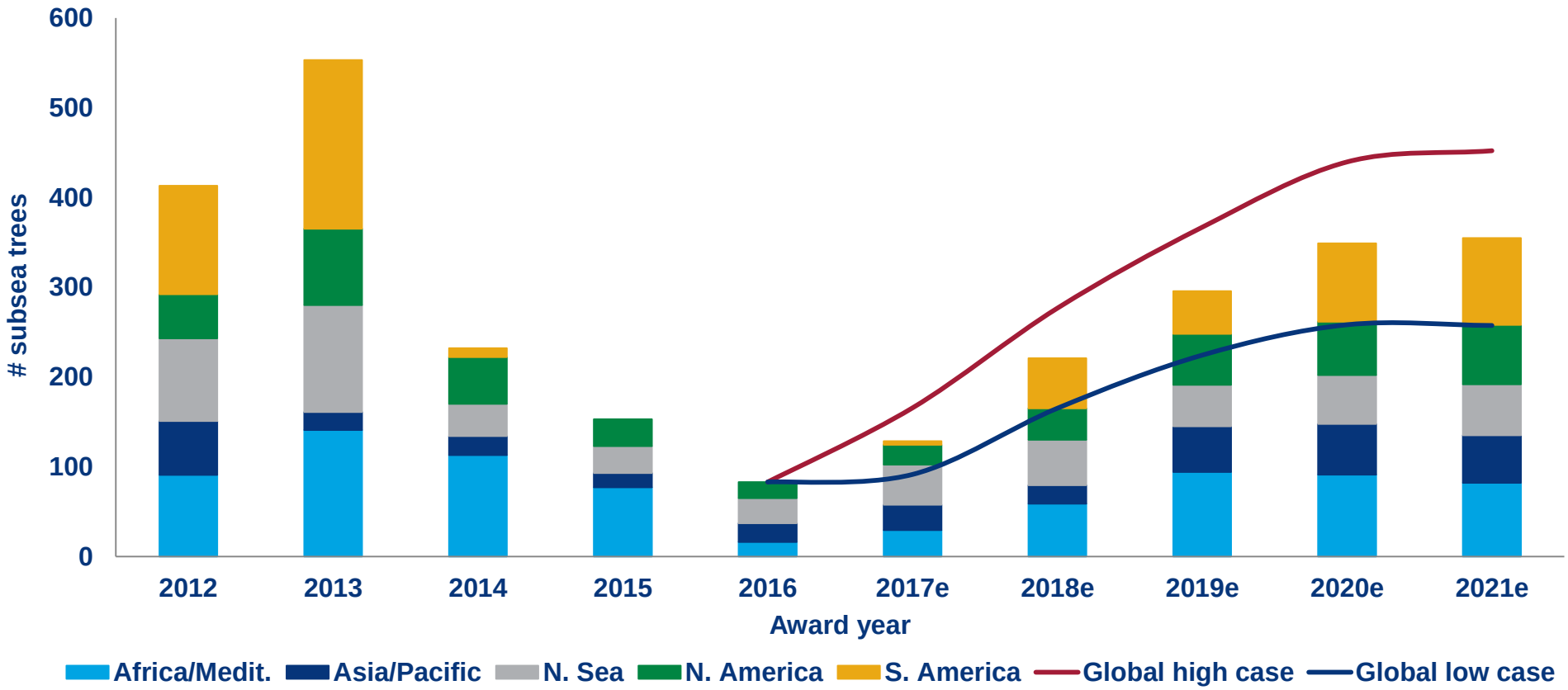
Global subsea demand

The high price of executing subsea projects caused demand to soften going into 2014 but effects were heightened once the oil price fell. Fundamental changes to deep water development where costs and cycle time are reduced will be key to the next chapter of the market.



Source: Wood Mackenzie

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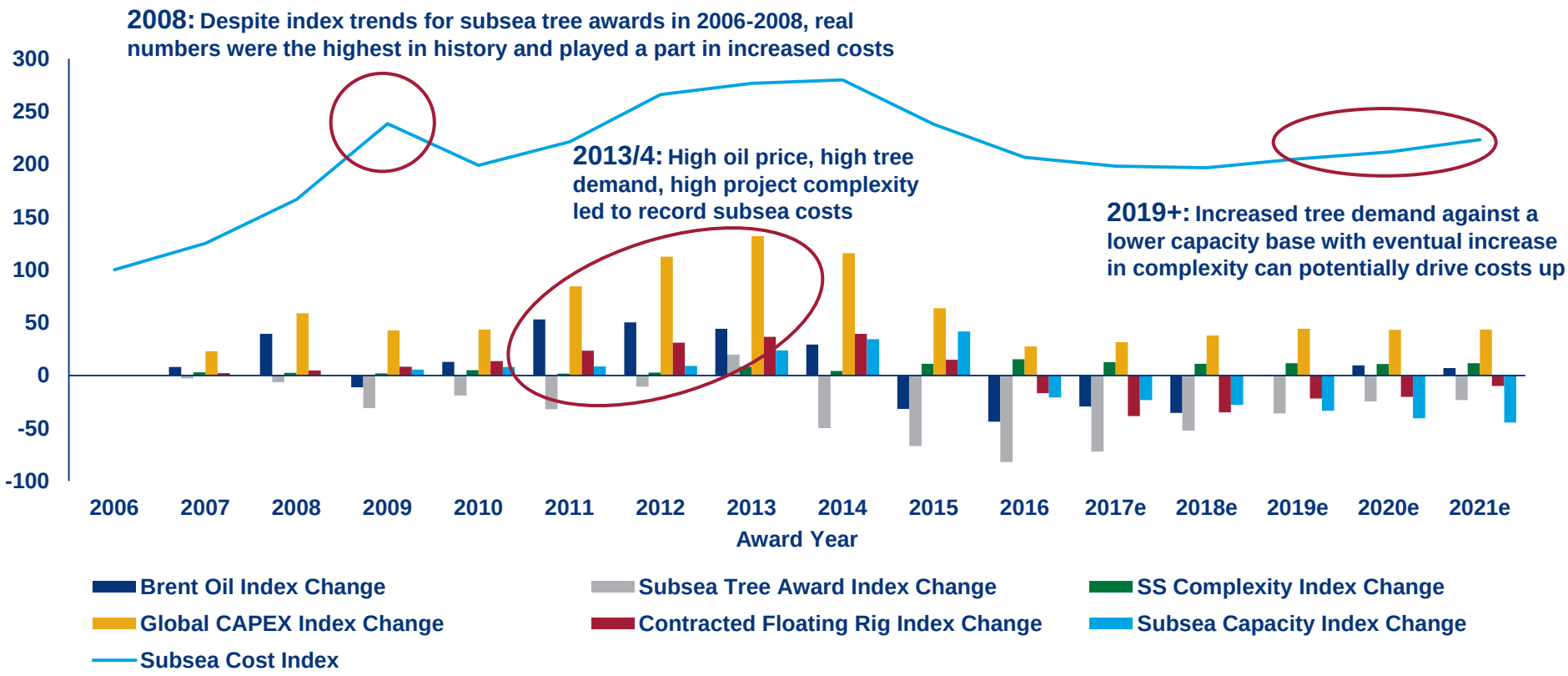
Global subsea cost index

Overall subsea costs expected to start rising towards the end of the decade due to increased demand and eventual increased complexity of projects



Source: Wood Mackenzie

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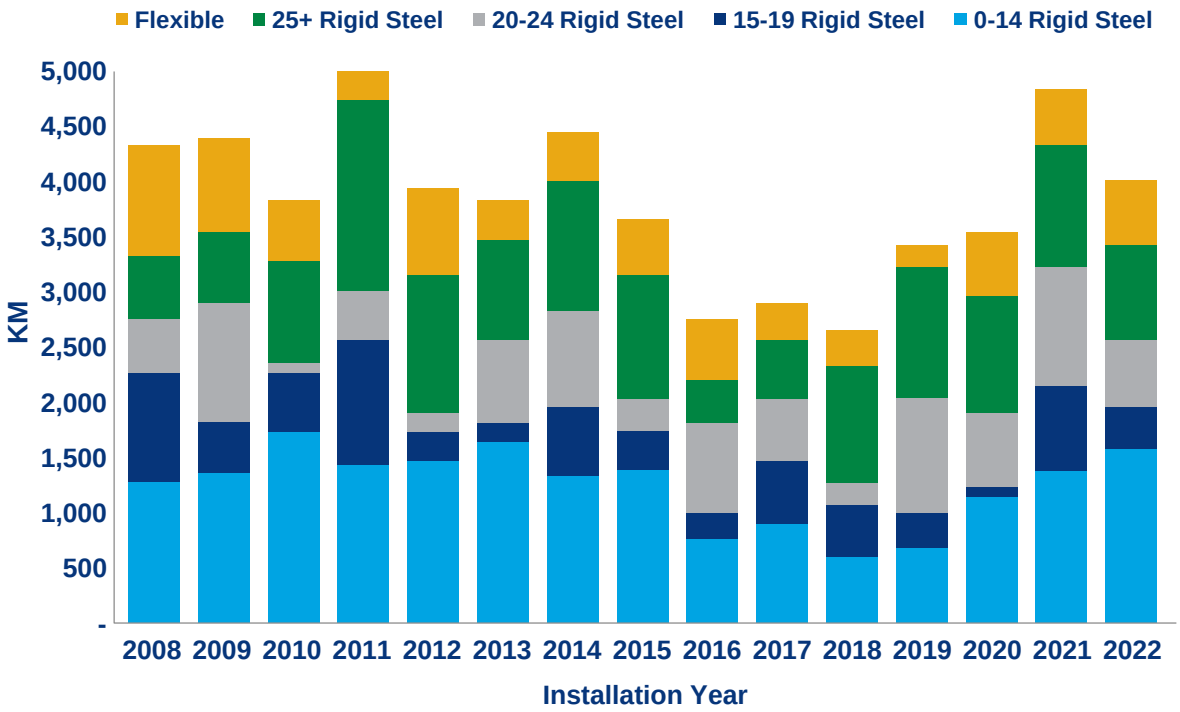
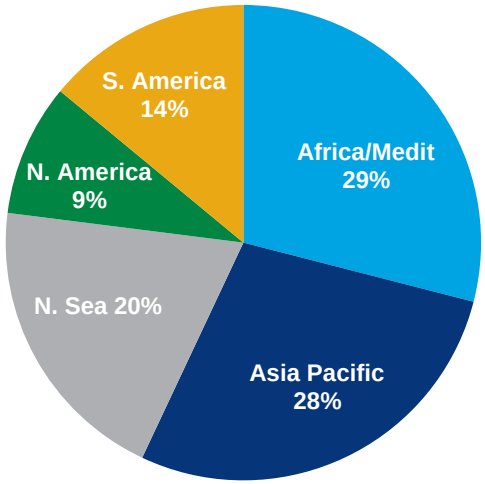
Worldwide deep water pipeline demand

2008 – 2022





Source: Wood Mackenzie

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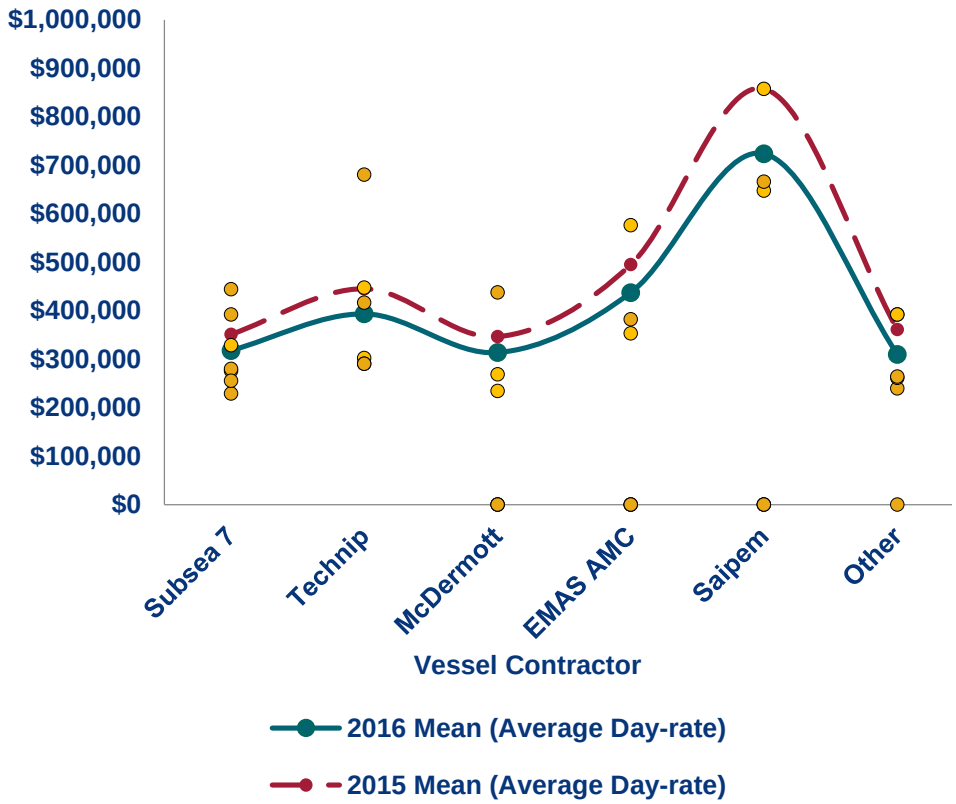
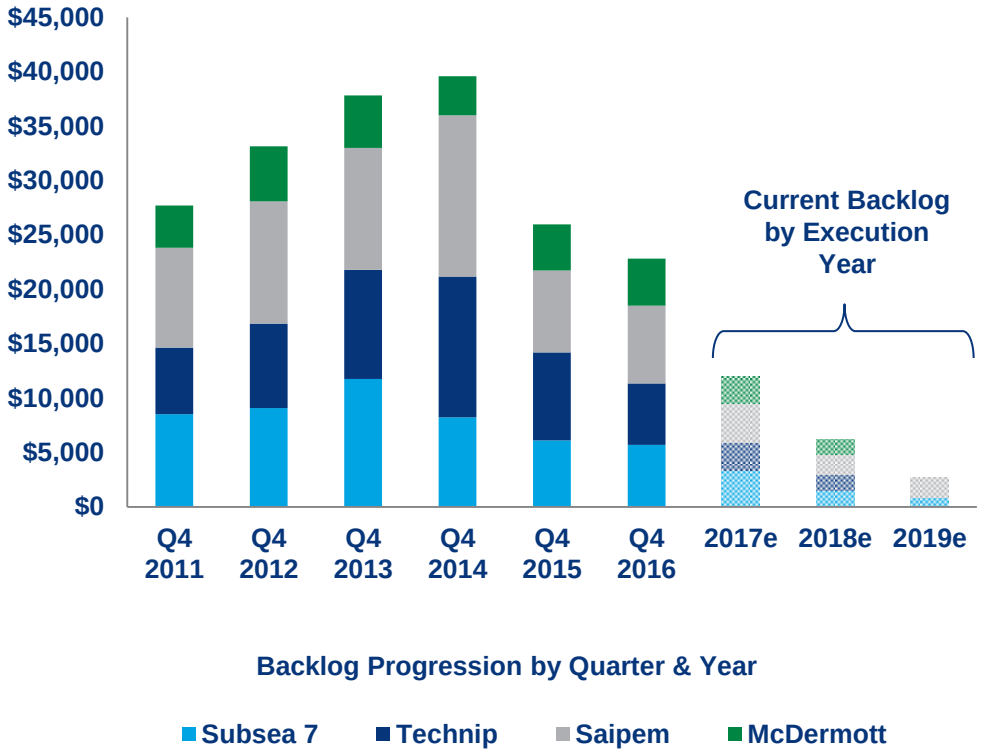
US GoM marine construction day rate trends

GoM deep water installation vessel day rates fall in 2016 and expected to decrease further in 2017

Vessel Day-rate $ (USD)



Global Backlog $ (MM)



Source: Wood Mackenzie

Wood Mackenzie
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Wood Mackenzie

A Verisk Analytics Business

Packing in the Permian: winning in a crowded basin

R.T. Dukes, Ben Shattuck,
Andrew Sheppard, Kristy Kramer

Upstream Forum

May 11, 2017

Wood Mackenzie

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Packing in the Permian: winning in a crowded basin

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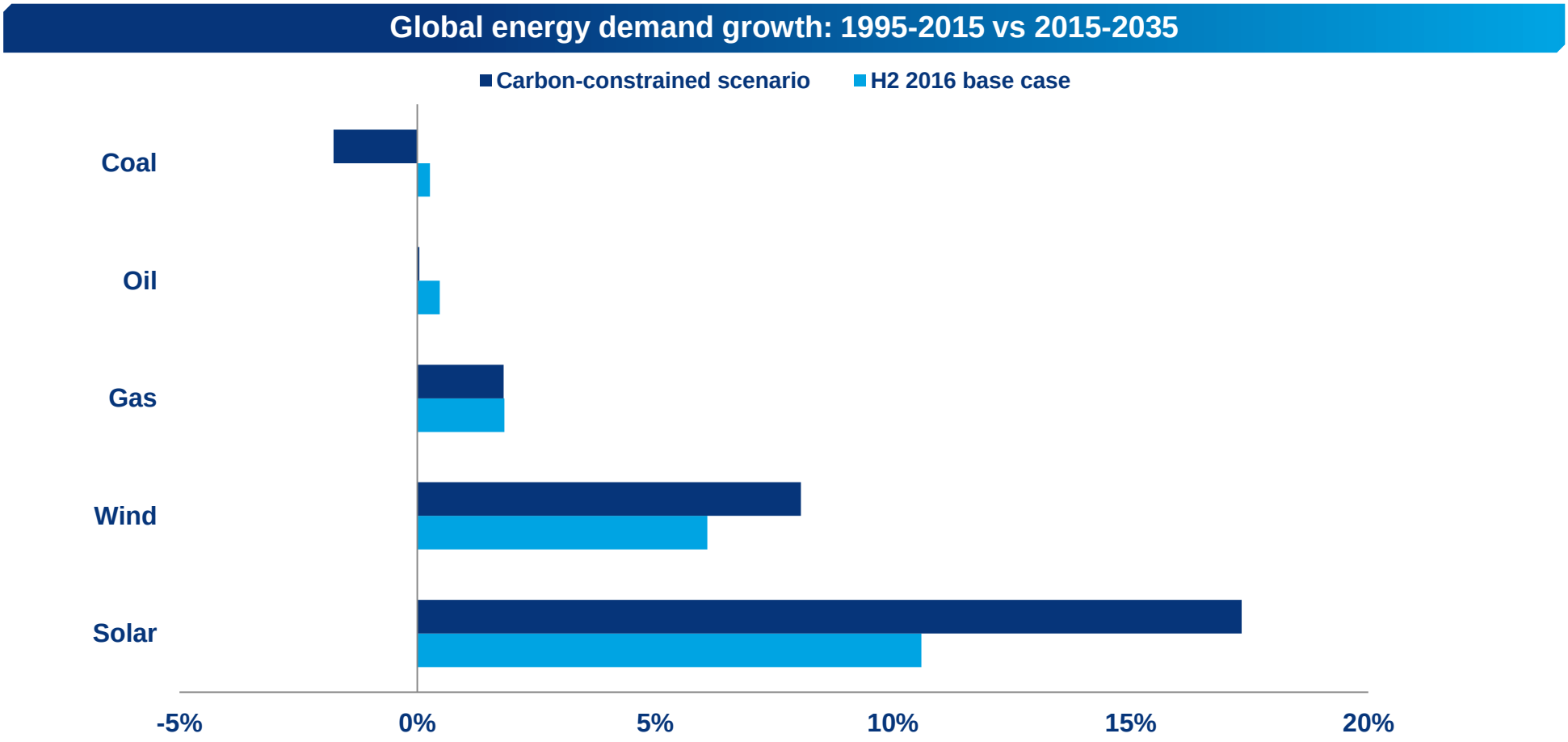
Upstream Challenges

Simon Flowers

Upstream Forum

May 11, 2017

Energy mix is shifting from fossil fuels to renewables



Source: Wood Mackenzie

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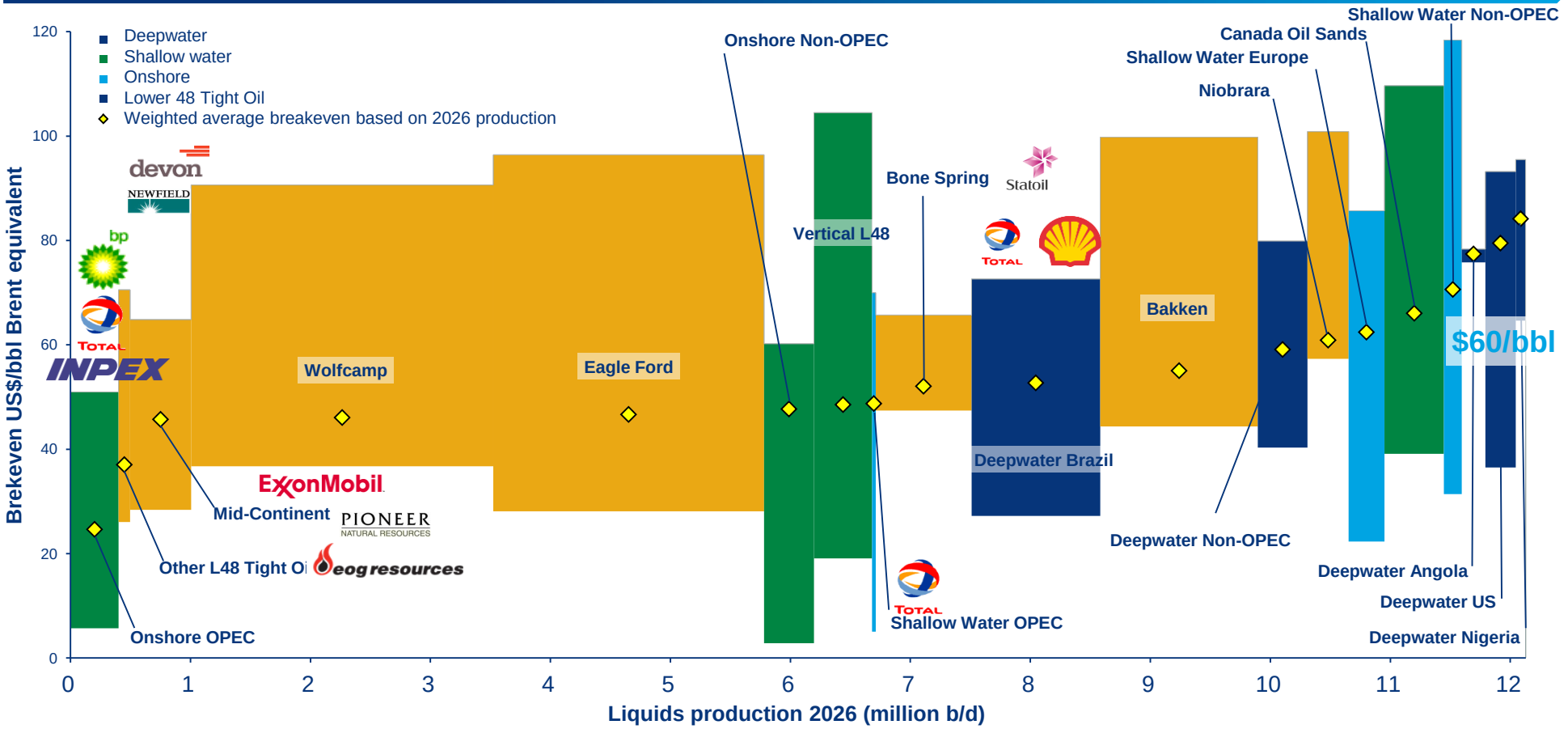
E&Ps are getting lower on the oil cost curve

Global M&A targeted at the lower cost growth plays

Pre-FID and US L48 future drilling cumulative production by breakeven in 2025



Source: Wood Mackenzie onshore breakevens at 15% discount rate, offshore at 15%

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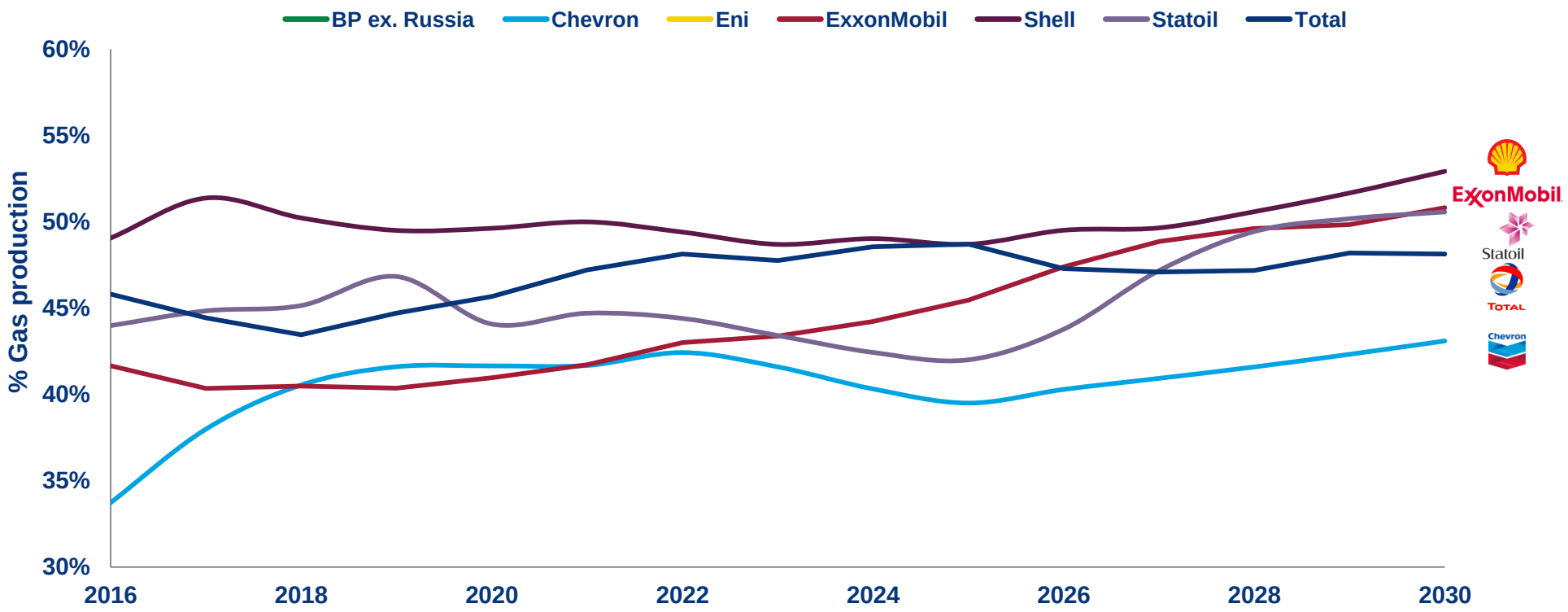
Majors: more than 50% gas production next decade

Investment in domestic gas and LNG

Gas production as a proportion of total (%)



Source: Wood Mackenzie Corporate Benchmarking Tool.

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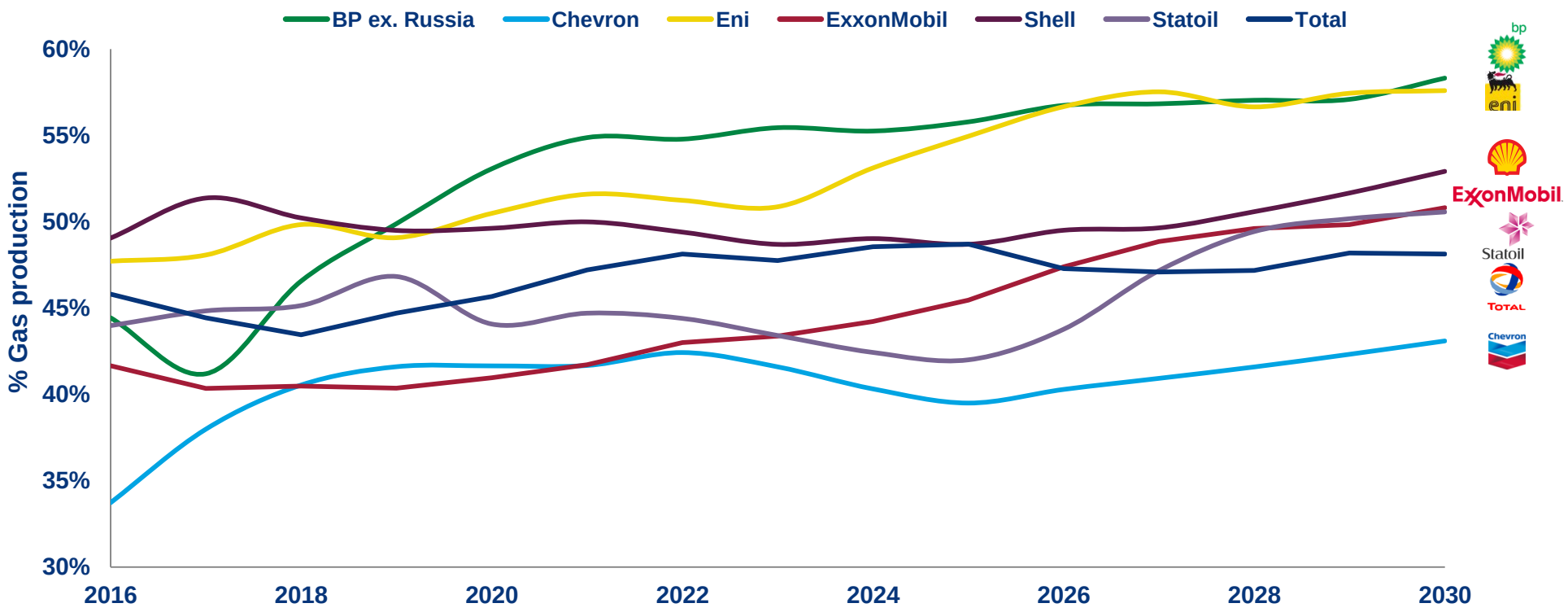
Majors: more than 50% gas production next decade

Investment in domestic gas and LNG

Gas production as a proportion of total (%)



Source: Wood Mackenzie Corporate Benchmarking Tool.

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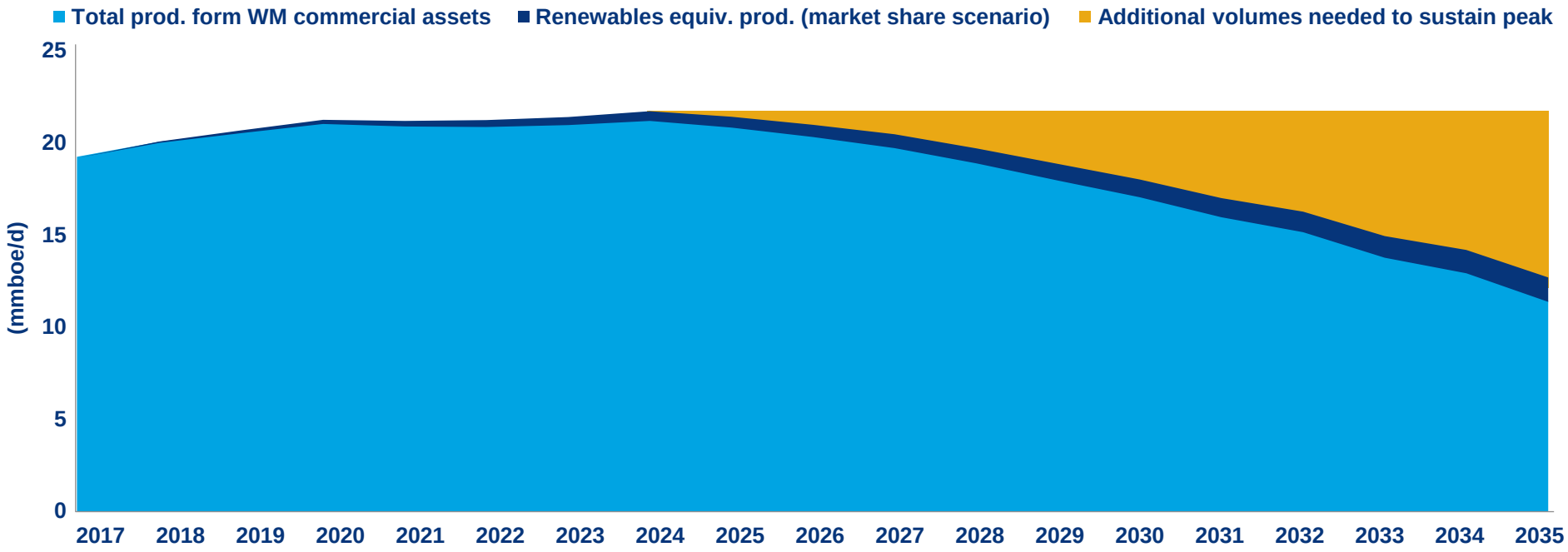
Decarbonisation: oil and gas producer to ‘energy supplier’

Renewables - the biggest shift in strategic direction in a generation

Production profile for Majors’ if renewables’ market share matches oil and gas by 2035 (energy equiv)



Source: Wood Mackenzie Corporate Benchmarking Tool.

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Mexico's upstream sector: the way forward

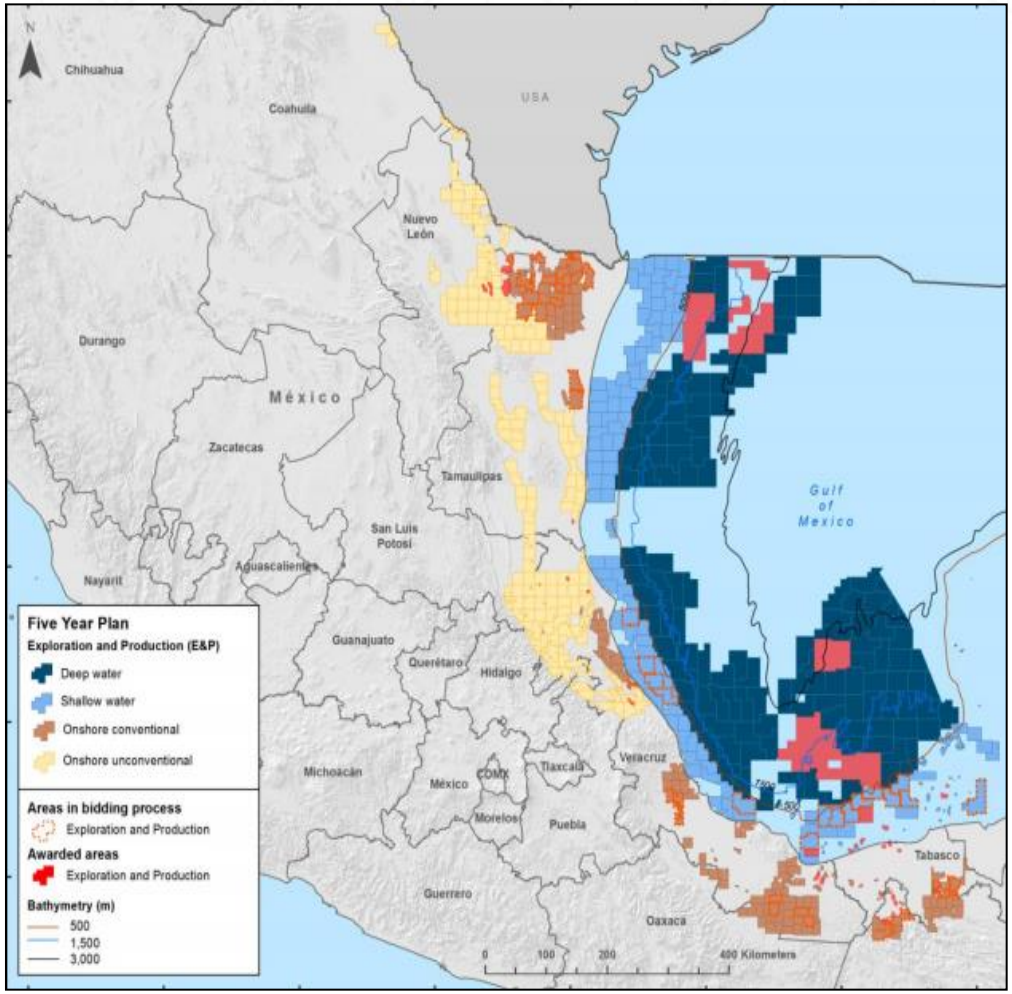
Pablo Medina

Upstream Forum

May 11, 2017

Mexico will offer ~500 upstream opportunities over 2017-2022

- Mexico unveiled an updated five-year licensing plan in March
- The plan calls for annual licensing rounds:
  - » H1 – shallow-water & onshore conventional
  - » H2 – deepwater & unconventionals
- Standardized block sizes and allows for industry nomination of any area
- Various fiscal regimes to be used



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Mexico's upstream sector already has a diverse corporate landscape

Shallow-water

TALOS ENERGY LLC
Eni
FIELDWOOD ENERGY
PAE Pan American ENERGY

Deepwater

TOTAL
Chevron
Statoil
nexen
PETRONAS CARIGALI
MURPHY OIL CORPORATION
bhpbilliton

Unconventionals

RENAISSANCE OIL CORP
LUKOIL OIL COMPANY
?

Onshore conventional

Grupo Diarco
RENAISSANCE OIL CORP
DIAVAZ
CANACOL ENERGY LTD.
GEO ESTRATOS SERVICIOS PETROLEROS
alfa
GRUPO R
BR PETROBRAS
TUBULAR TECHNOLOGY
Petrofac
HALLIBURTON
BAKER HUGHES

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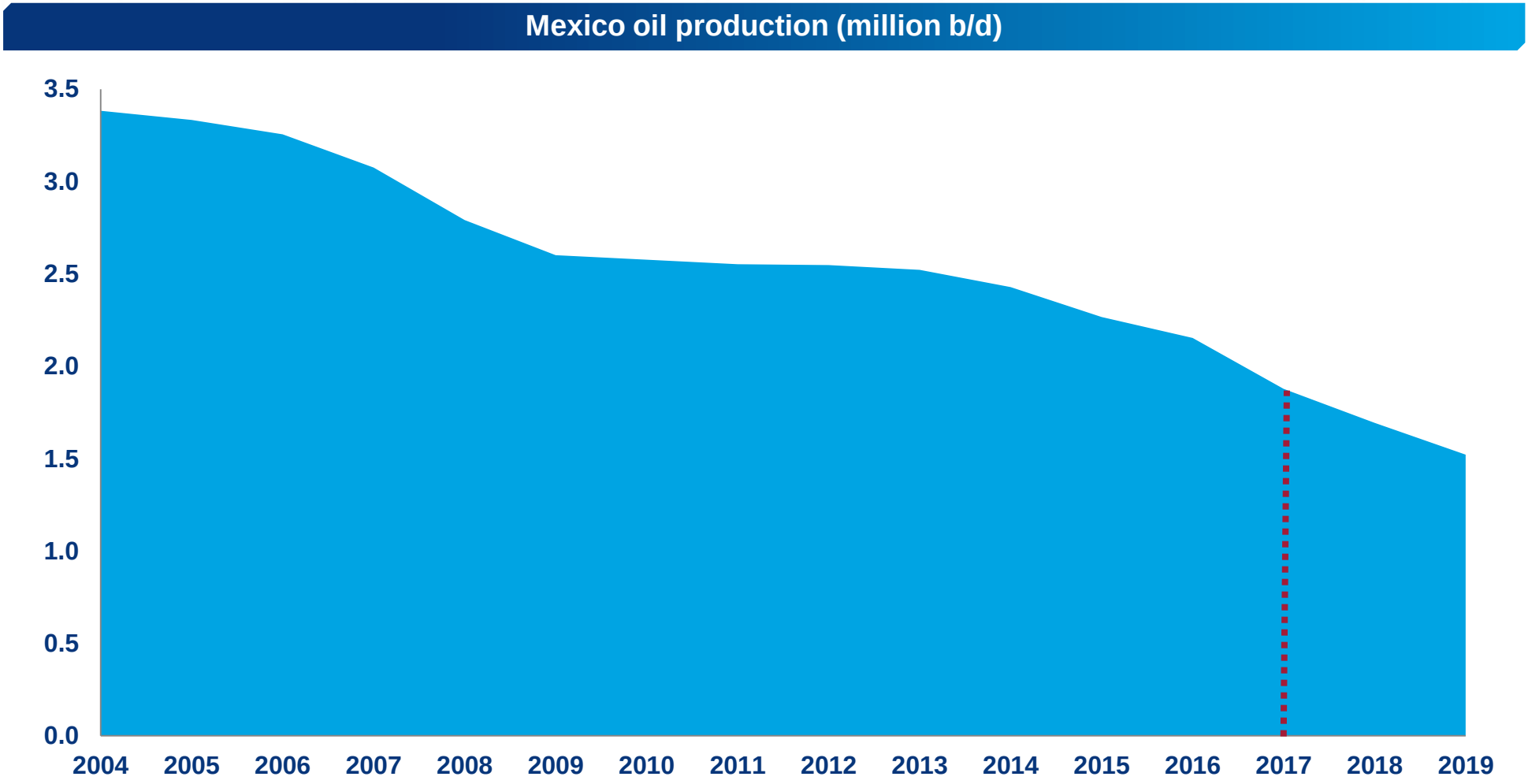
Mexico needs help to reverse the production decline



Source: Wood Mackenzie. Wood Mackenzie's production estimates (2017-2019)

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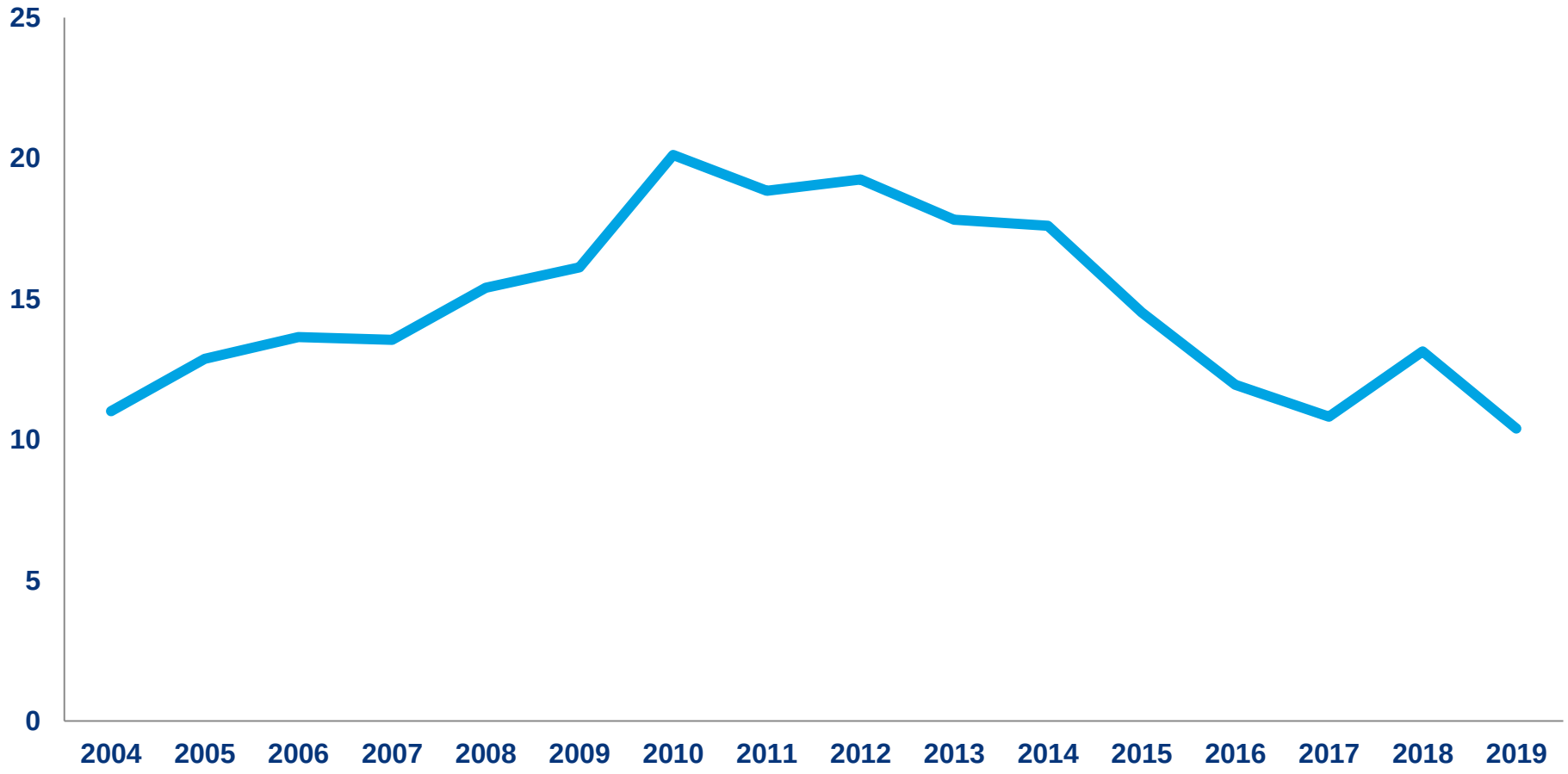
Proposed budget cuts to Pemex will accentuate the decline

Pemex upstream capex (US$ billion)



*Source: Wood Mackenzie. *Per Finance Ministry's 3-year approved budget (2017-2019)*

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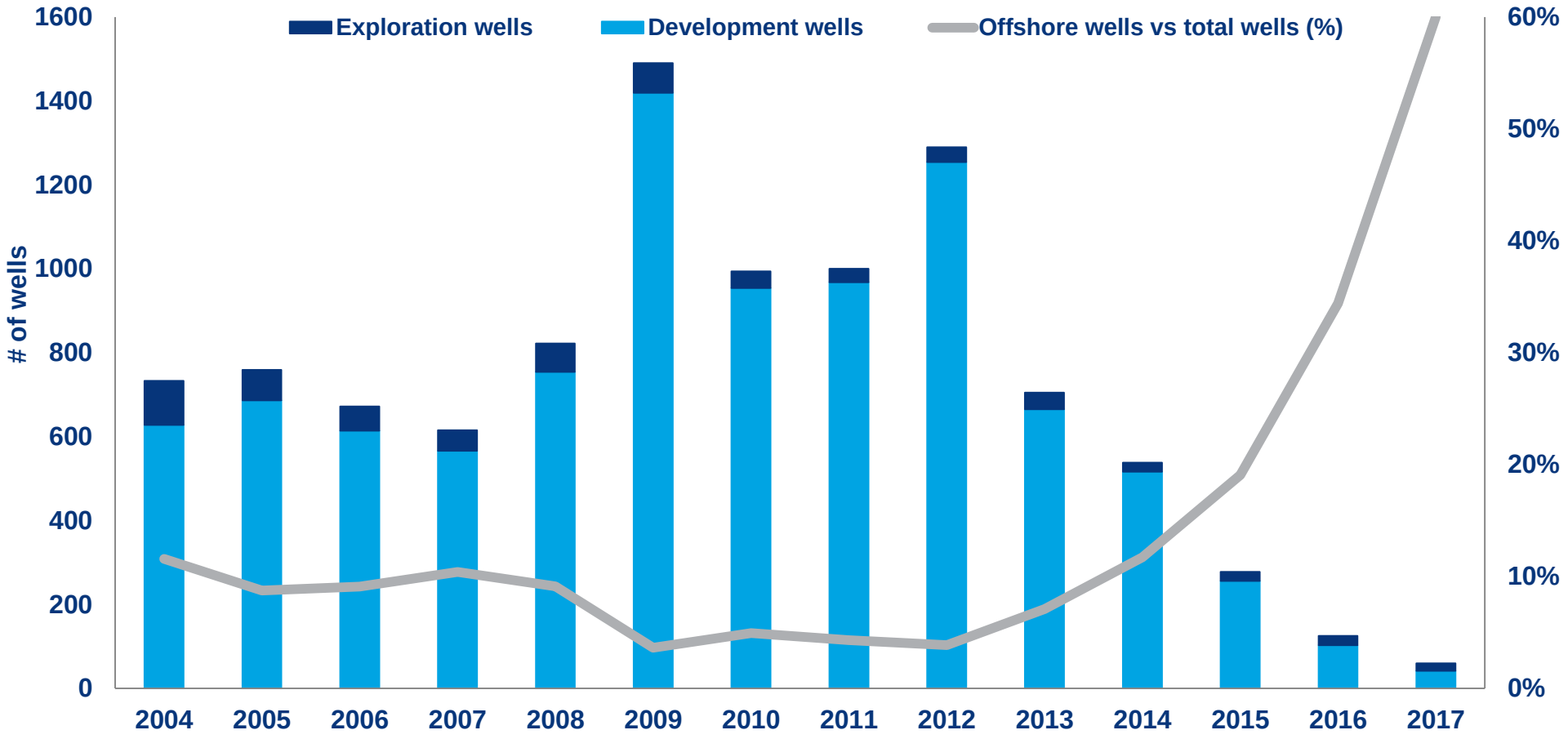
Retrenching to shallow-water assets amidst capex cuts

Drilling activity in Mexico



Source: Wood Mackenzie

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Pemex is undergoing a profound transformation

Improvements in place	Remaining challenges
Partnered with BHP in Trion	Onerous fiscal regime
Hedging its own production for the first time	Powerful union and an excess in personnel (126k workers)
Reduced pension liabilities by US$10 billion (14%)	Vulnerable to political interference ahead of 2018 presidential election

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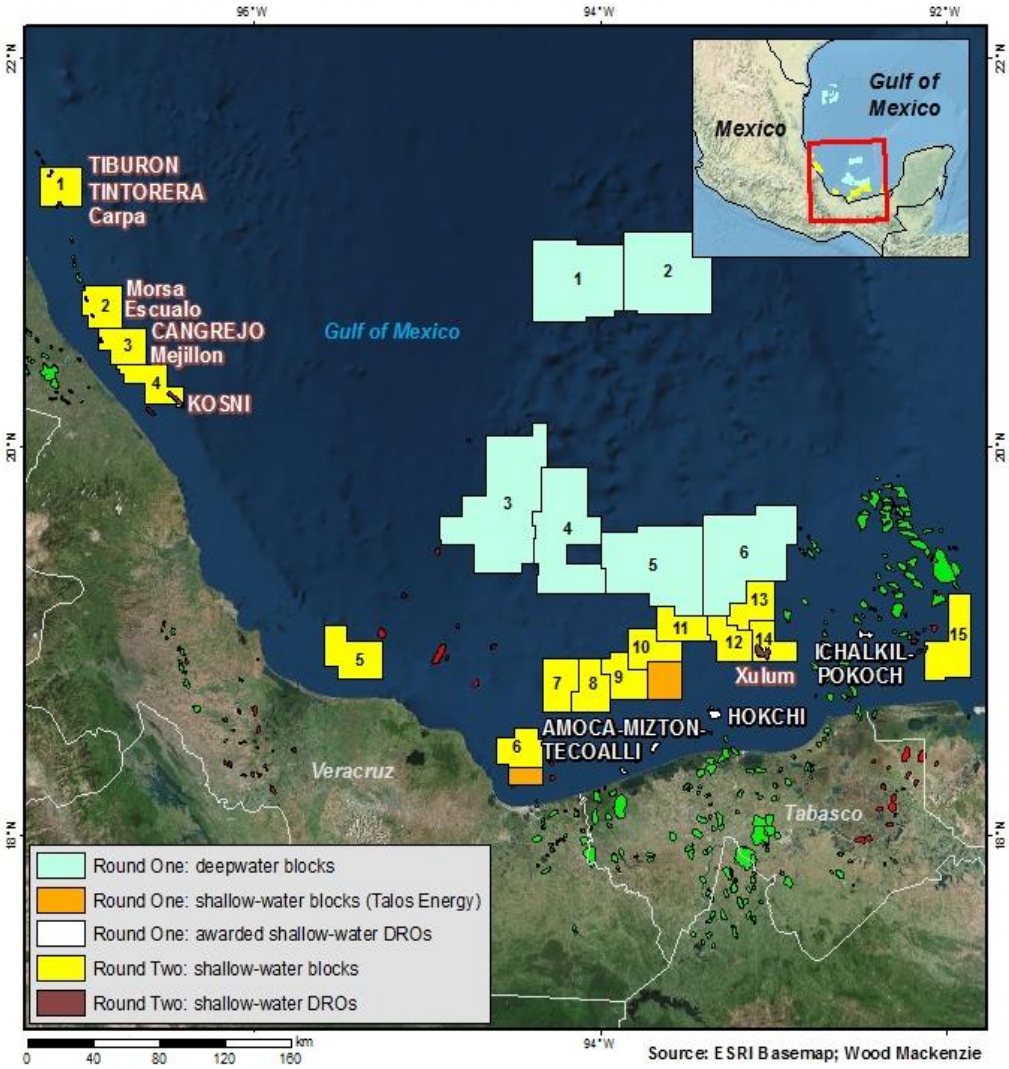
Round Two shallow-water – interesting subsalt potential

- 15 blocks on offer in Salinas-Sureste and Tampico-Misantla
- Nine small DROs included in these blocks
- Opportunity to build contiguous portfolio positions
- Subsalt potential as main attraction
- Bids to be awarded on 19 June 2017
- Ayin-Batsil is the next opportunity to partner with Pemex



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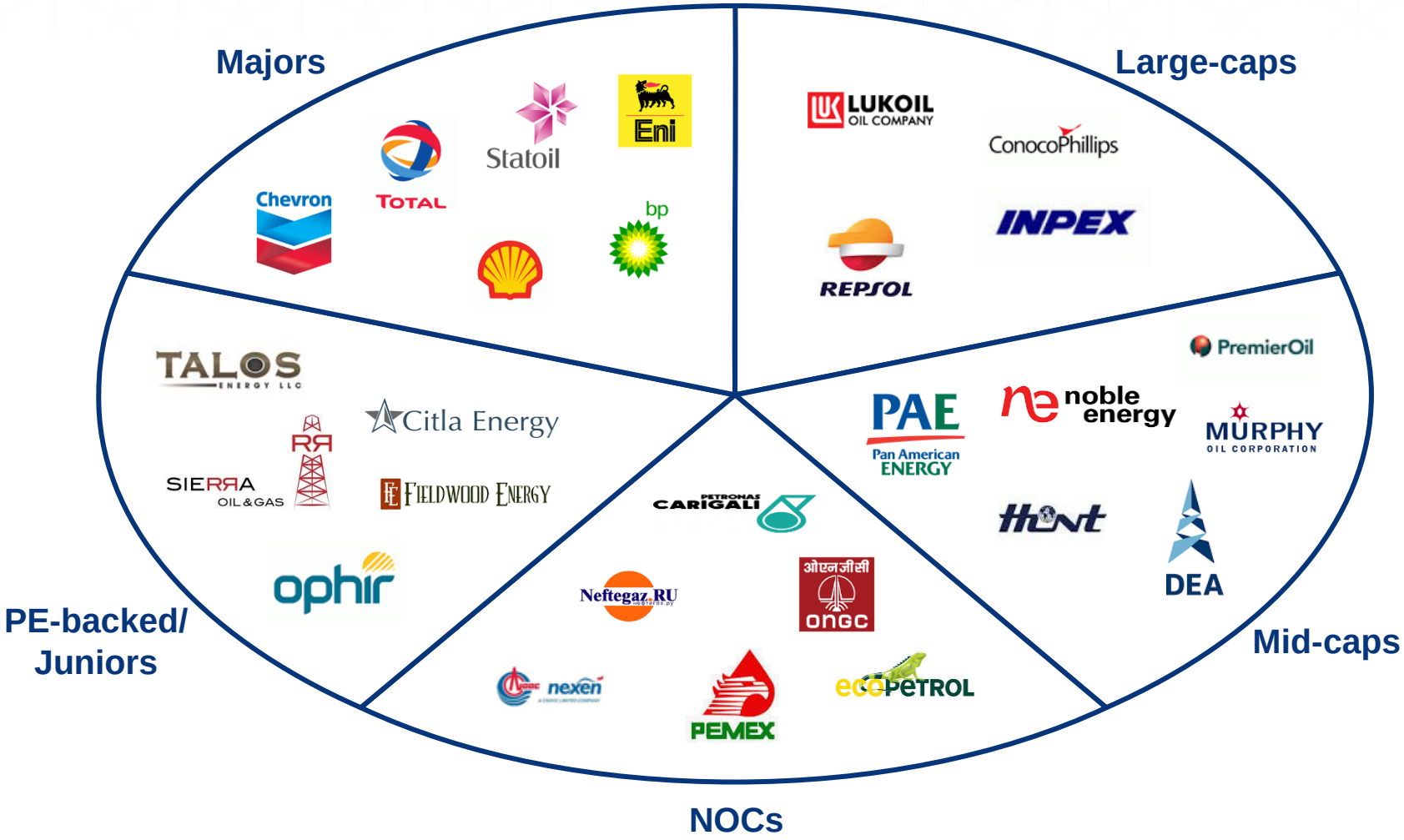
Round Two shallow-water – prequalified companies



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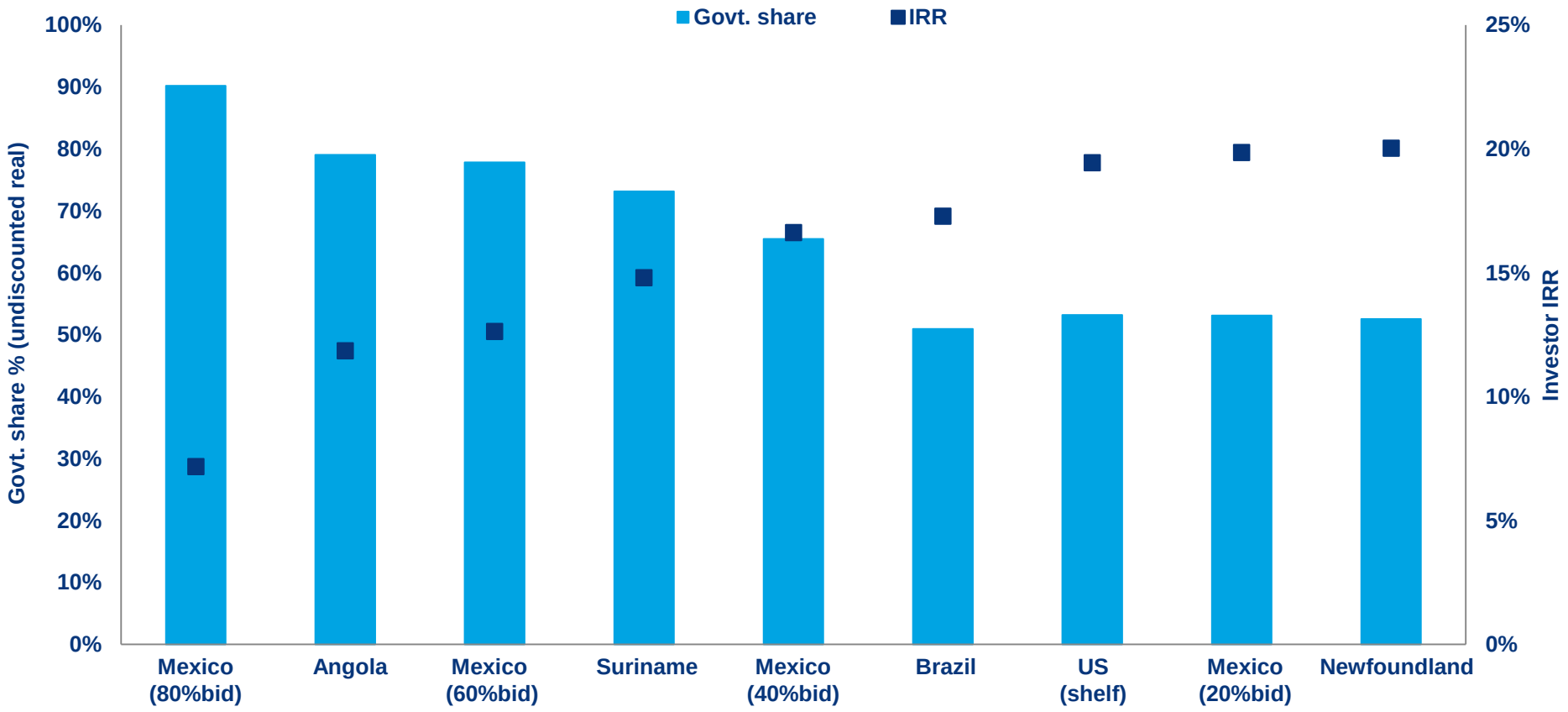
Round Two shallow-water – attractiveness depends on the minimum

Fiscal regime comparison of Round Two shallow-water terms



** Using a 150 mmboe shallow-water oil field. To account for the heavier gravity of the oil we have applied a 5.5% discount to our long-term Brent price outlook of US$65/bbl (real, 2016 terms). We have assumed a two exploration well commitment*

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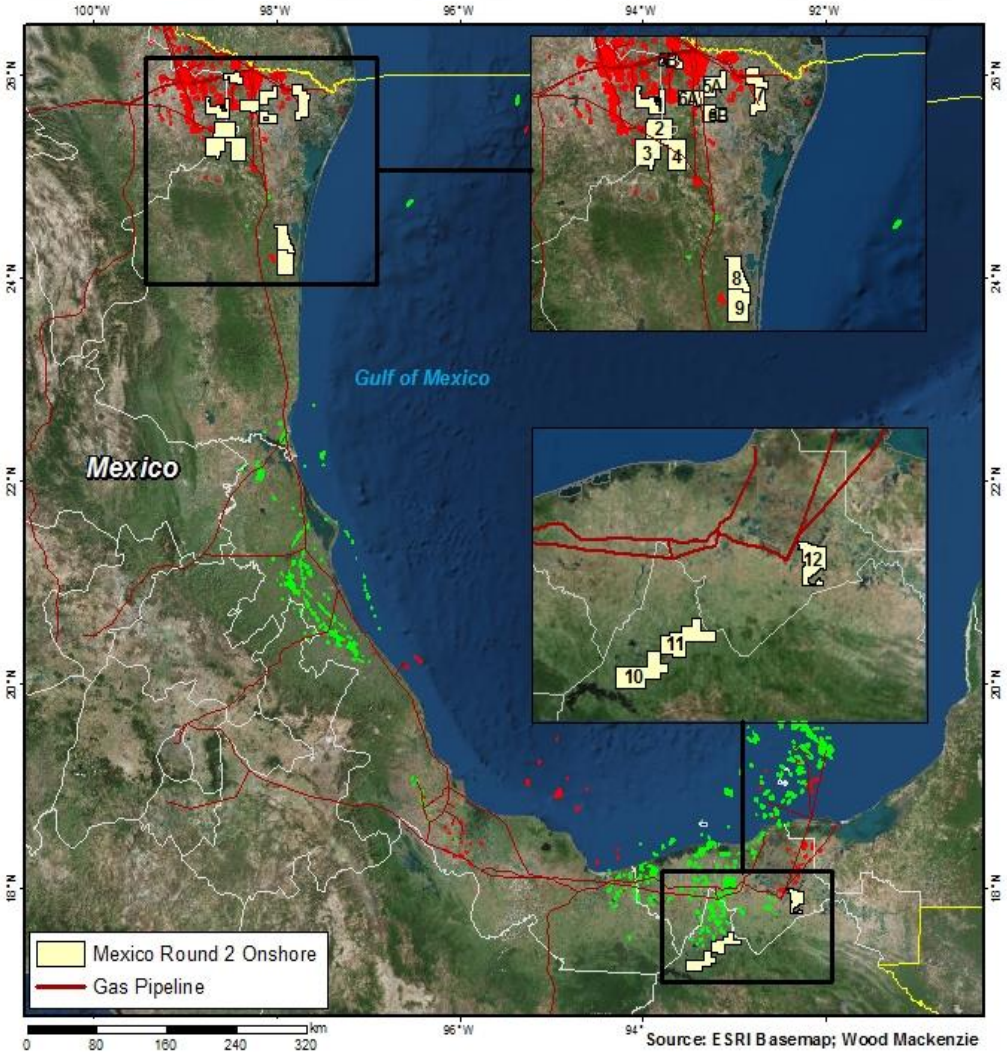
Round Two onshore – undermined by gas focus and security

- 12 blocks on offer in Burgos and Salinas Sureste
- Some small DROs included in these blocks
- Gas-prone acreage with significant above-ground risks
- Increased US imports challenge dry gas project economics
- Blocks to be awarded on 12 July 2017



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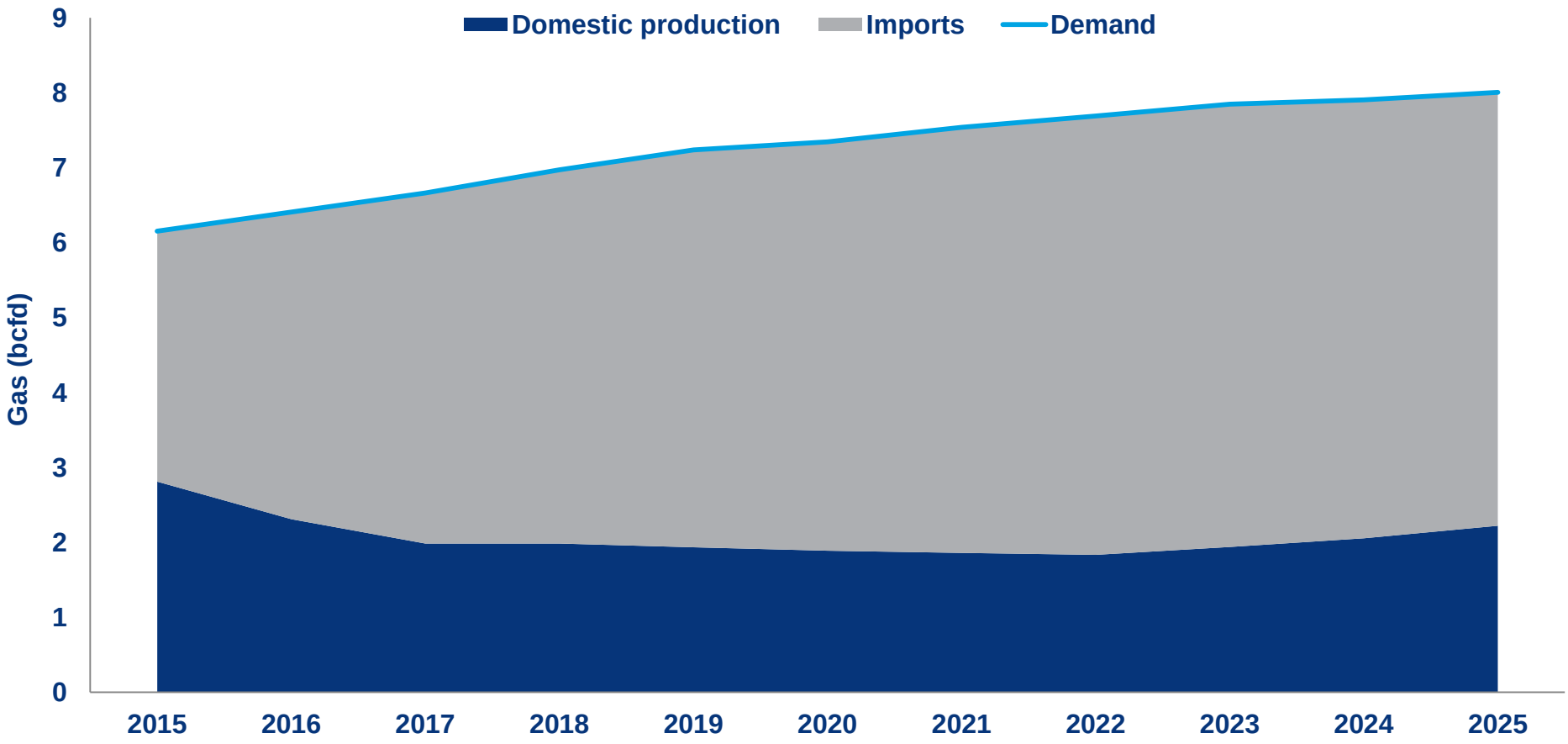
Gas imports will double by 2025 providing cheap gas

Mexico's gas balance to 2025



Source: Wood Mackenzie

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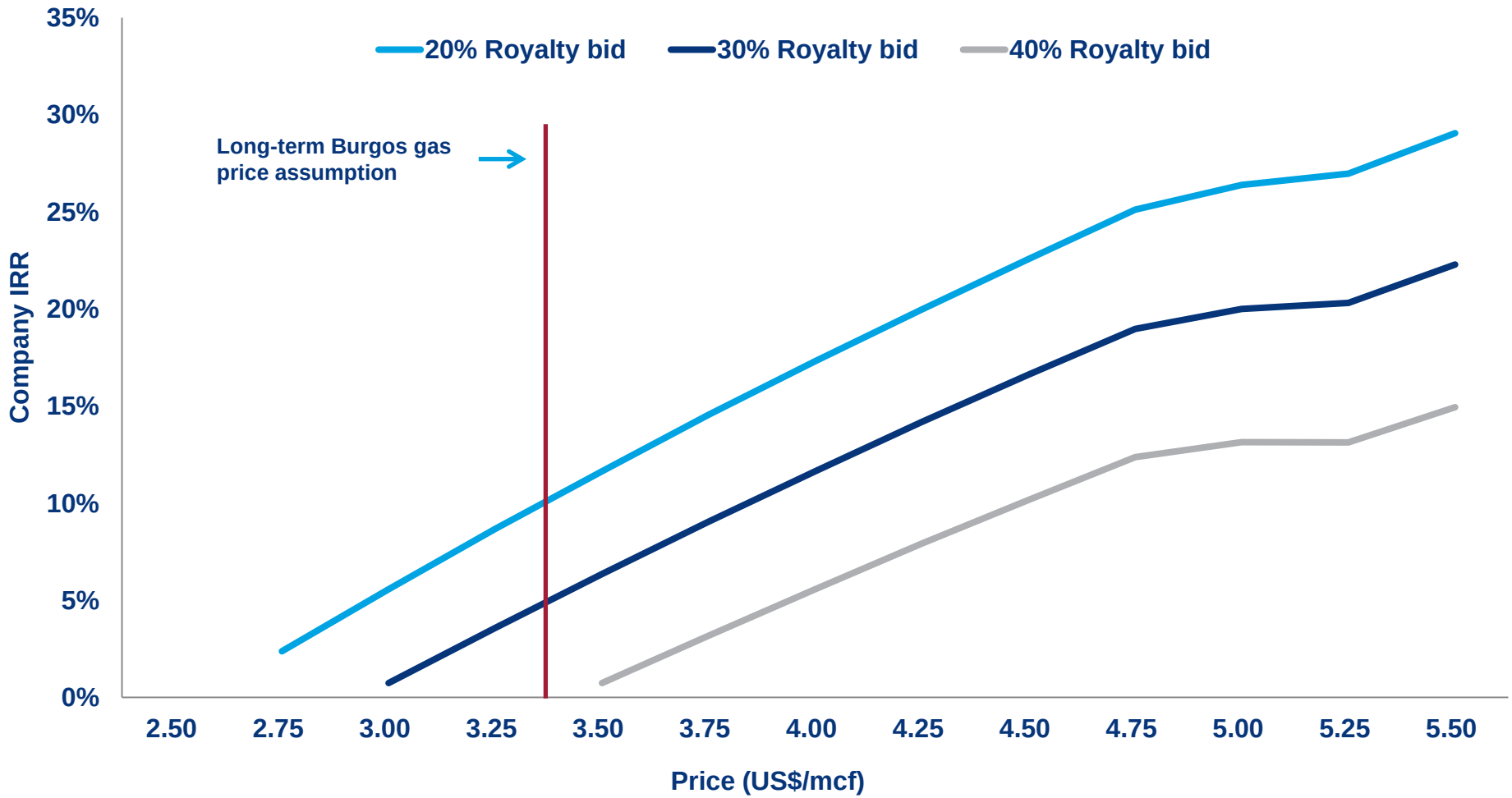
Difficult to achieve competitive returns at our forecast Burgos price

Company IRR depending on royalty bid and gas price



** Using a 100 bcf gas field, with opex of US$3.1/boe and total capex of US$145 million.*

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Big changes take time but Mexico is headed in the right direction

- The Pemex JVs are the best way to increase production in the short to medium term.
- Strong government receptiveness to feedback and commitment to improvement.
- The deepwater phase is the start of Mexico as an upstream investment destination for larger companies.
- Non-associated gas production is unlikely to be attractive due to competition from US gas imports.

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Rebalancing Gas Markets: Implications of rising exports, new Northeast pipelines, and huge Permian investments

Kristy Kramer

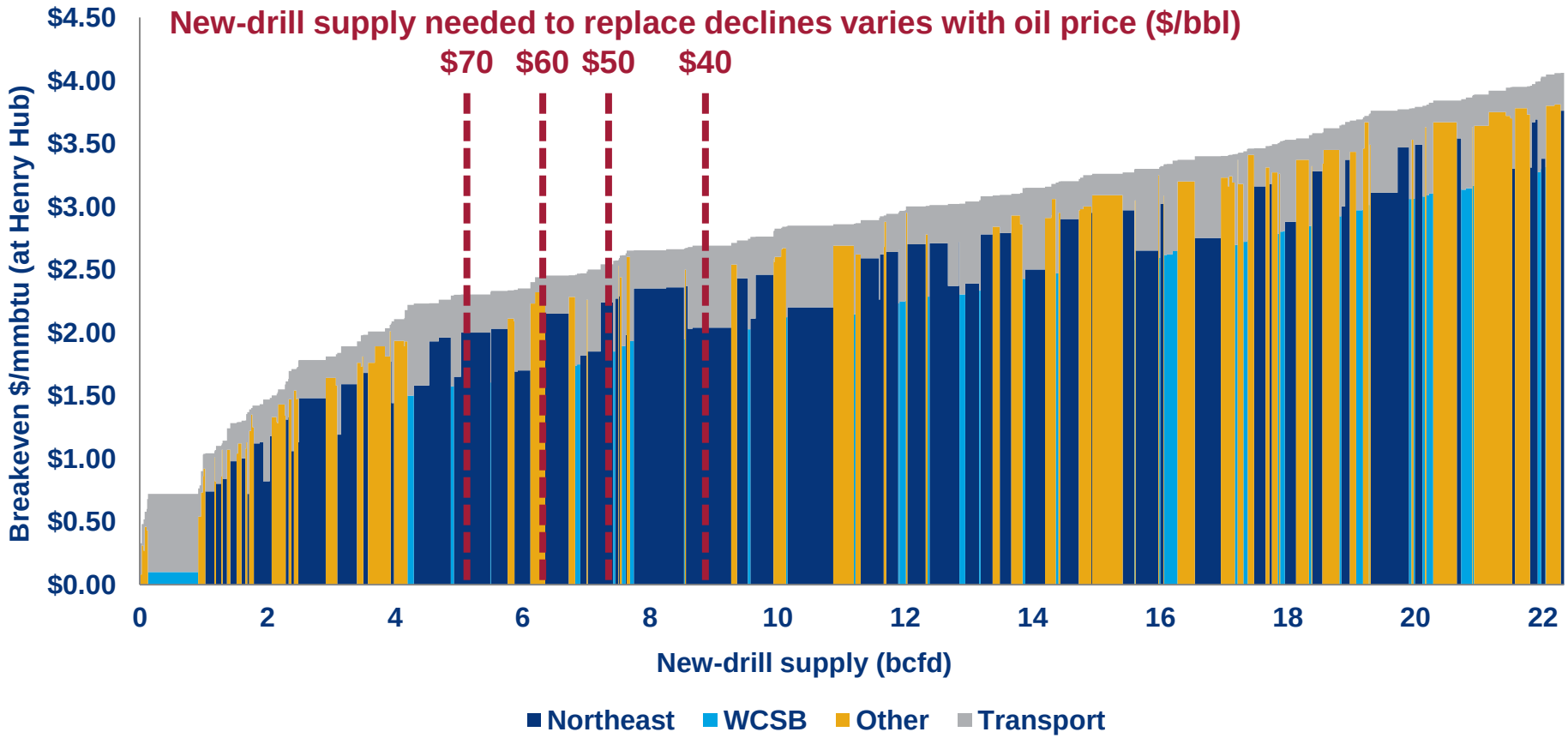
Upstream Forum

May 11, 2017

North America dry gas cost curve is flat – over 12 bcfd of new production breaks even at $3/mmbtu or less

Resources from the Northeast continue to be of the lowest cost

US L48 & Canada dry gas one-year new drill supply potential (2019-'22)



Source: Wood Mackenzie (North America Gas Tool)

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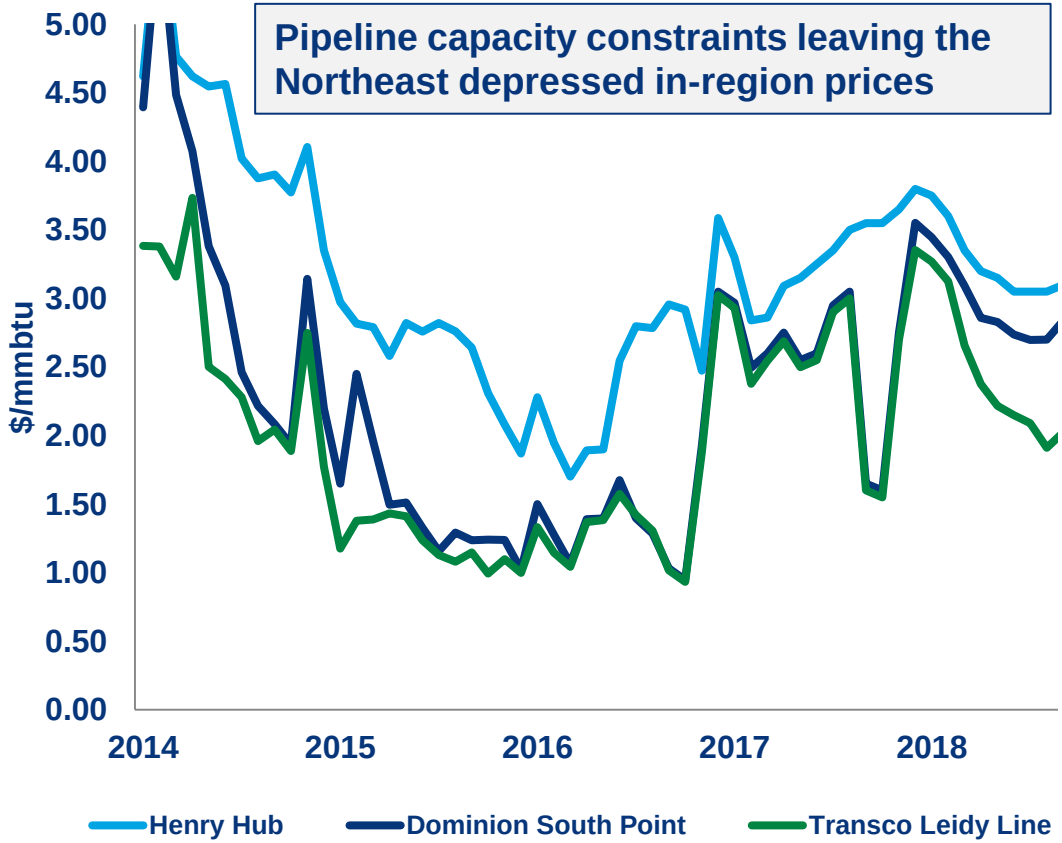
Prices in the Northeast have been driven by infrastructure limitations which may be temporarily resolved starting in 2018

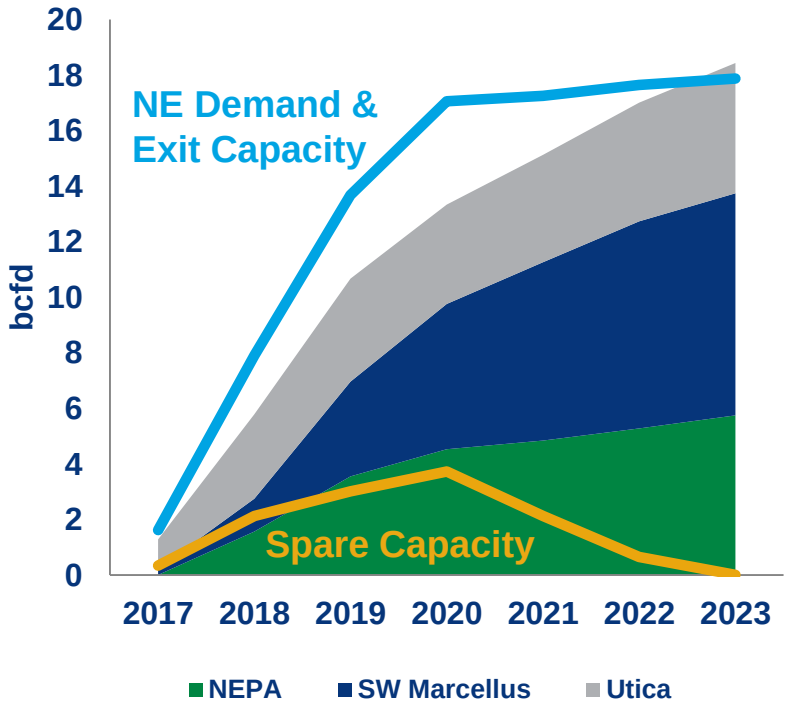
The Northeast grows from 30% of NA supply in 2018 to nearly 40% by 2023

Price outlook

Pipeline capacity constraints leaving the Northeast depressed in-region prices



Pace of pipeline build deconstrains the Northeast for a period…



Source: Wood Mackenzie, Argus

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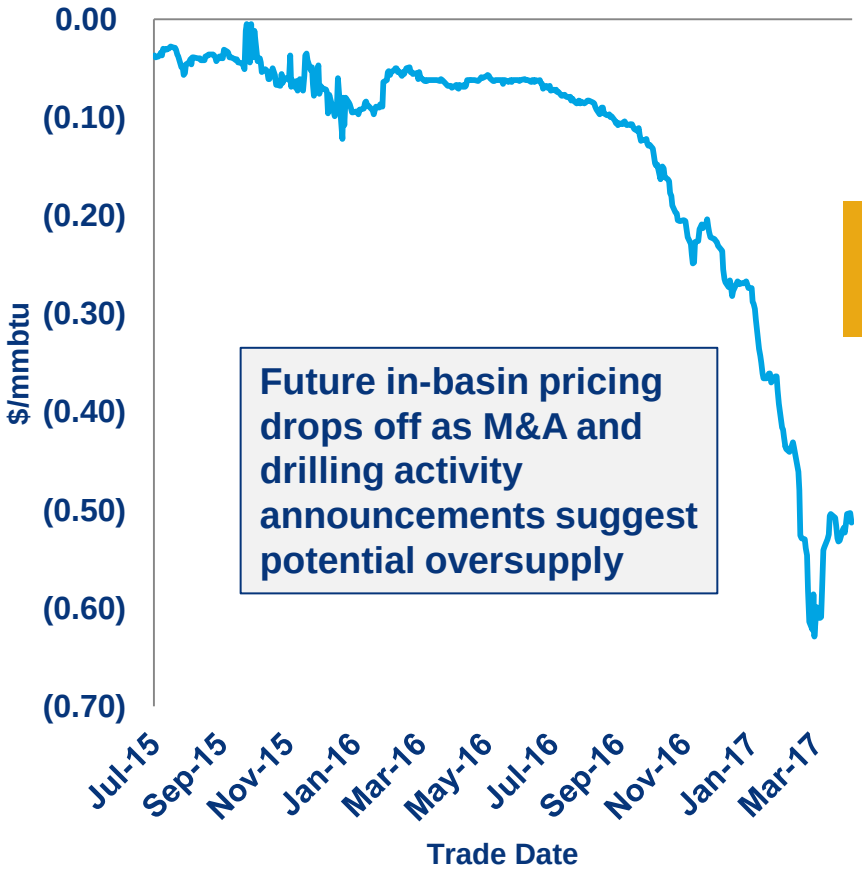
Takeaway capacity from the Permian is now influencing market sentiment… does it become the new Northeast?

New capacity proposals to South Texas offer access to growing, "reliable" markets

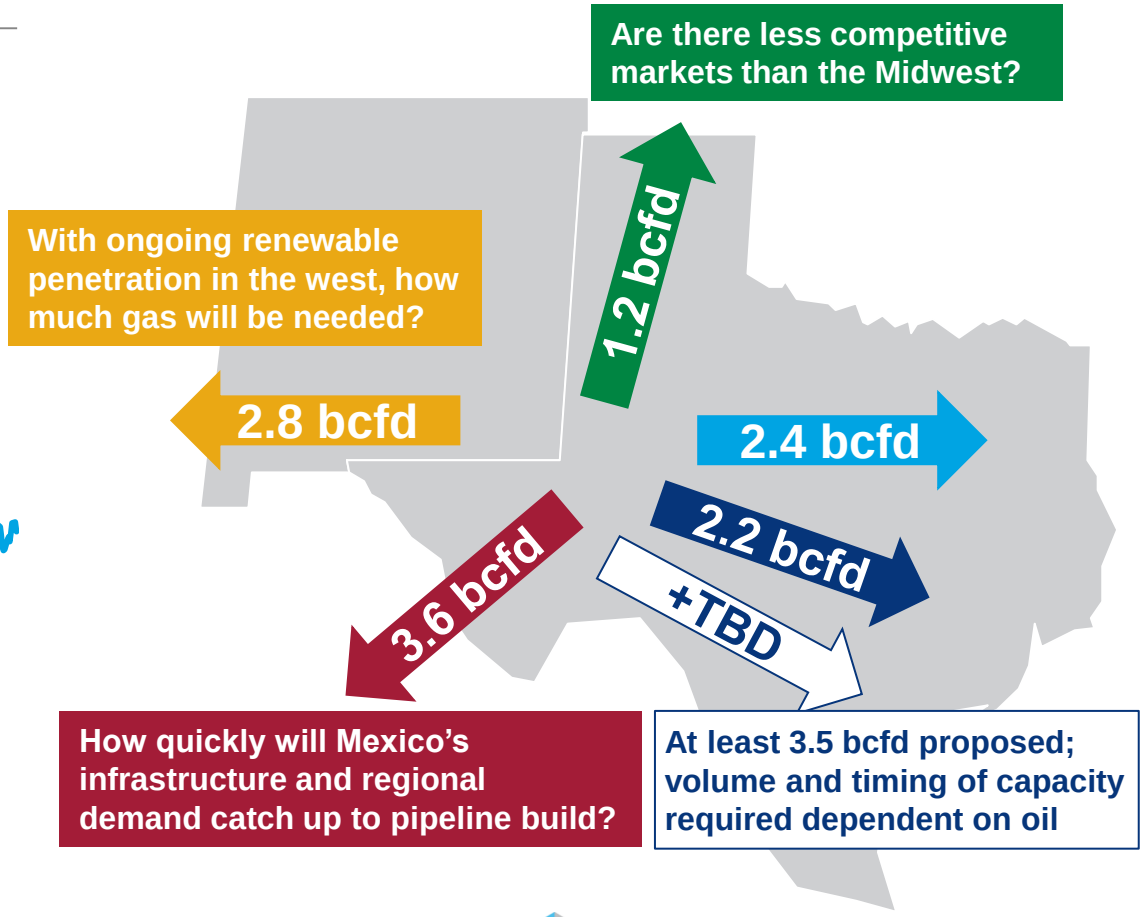
April 2018 Waha Basis Contract



Future in-basin pricing drops off as M&A and drilling activity announcements suggest potential oversupply

Source: Wood Mackenzie

Permian takeaway capacity & destination markets



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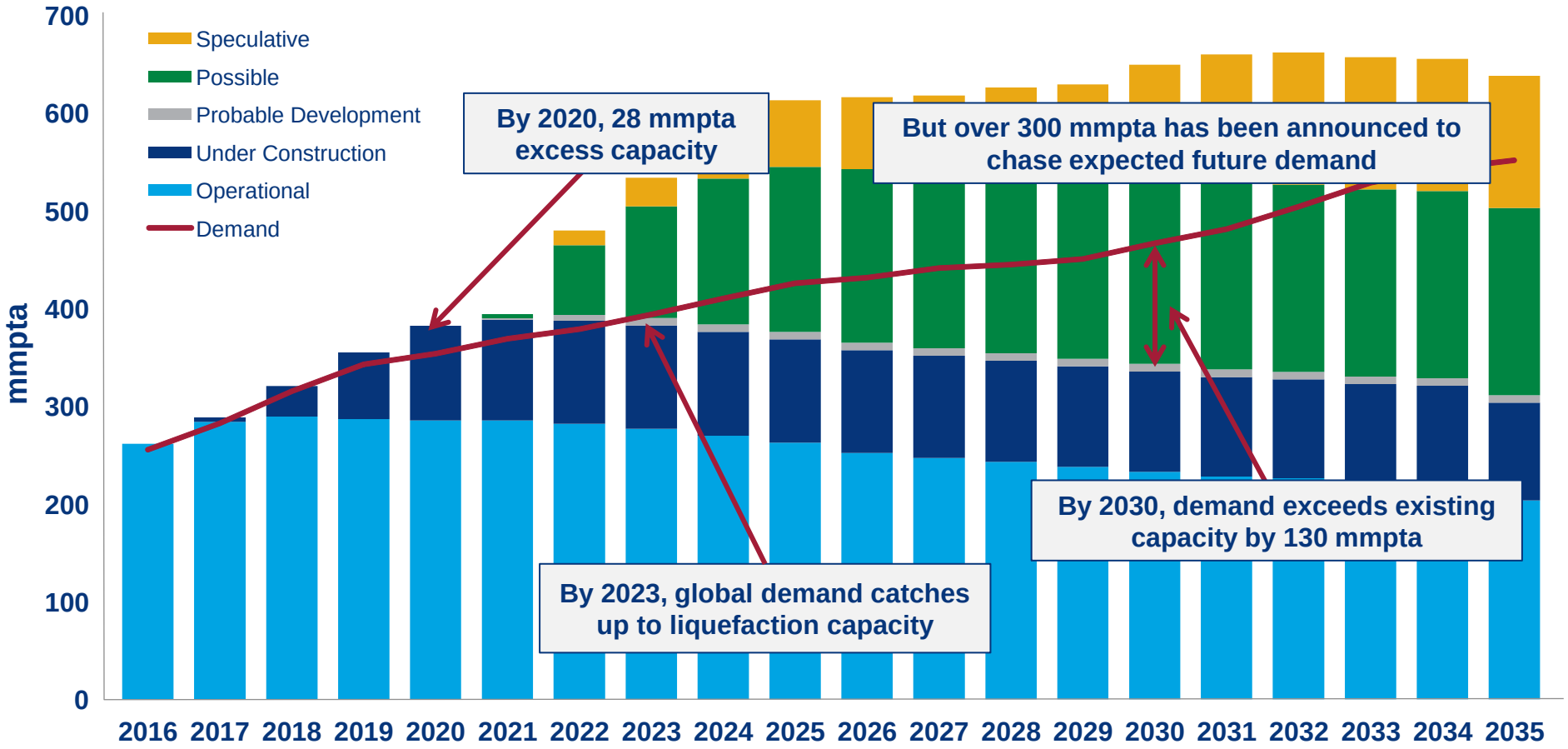
Similar to North America, global LNG supply is chasing access to demand in both the near term and long term

70 mmpta of North America capacity is nearly 20% of global capacity by 2021

Global LNG Capacity by Status vs. Demand



Source: Wood Mackenzie

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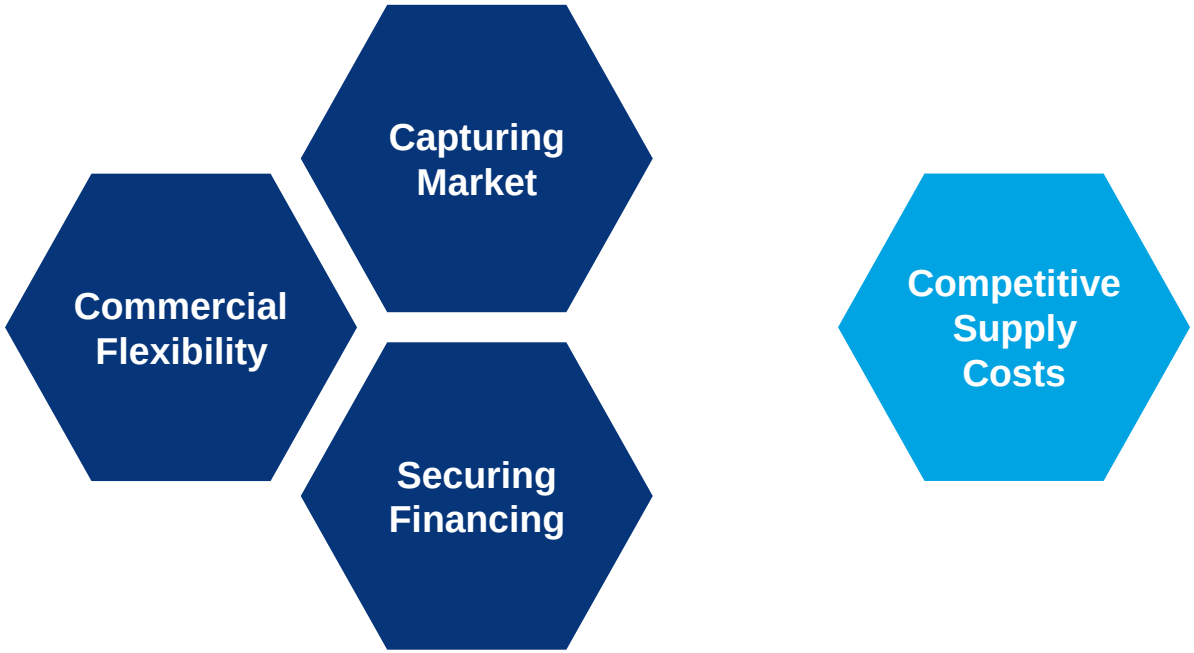
In a competitive market, which LNG projects will progress in the long term?

Key LNG Commercialization Factors



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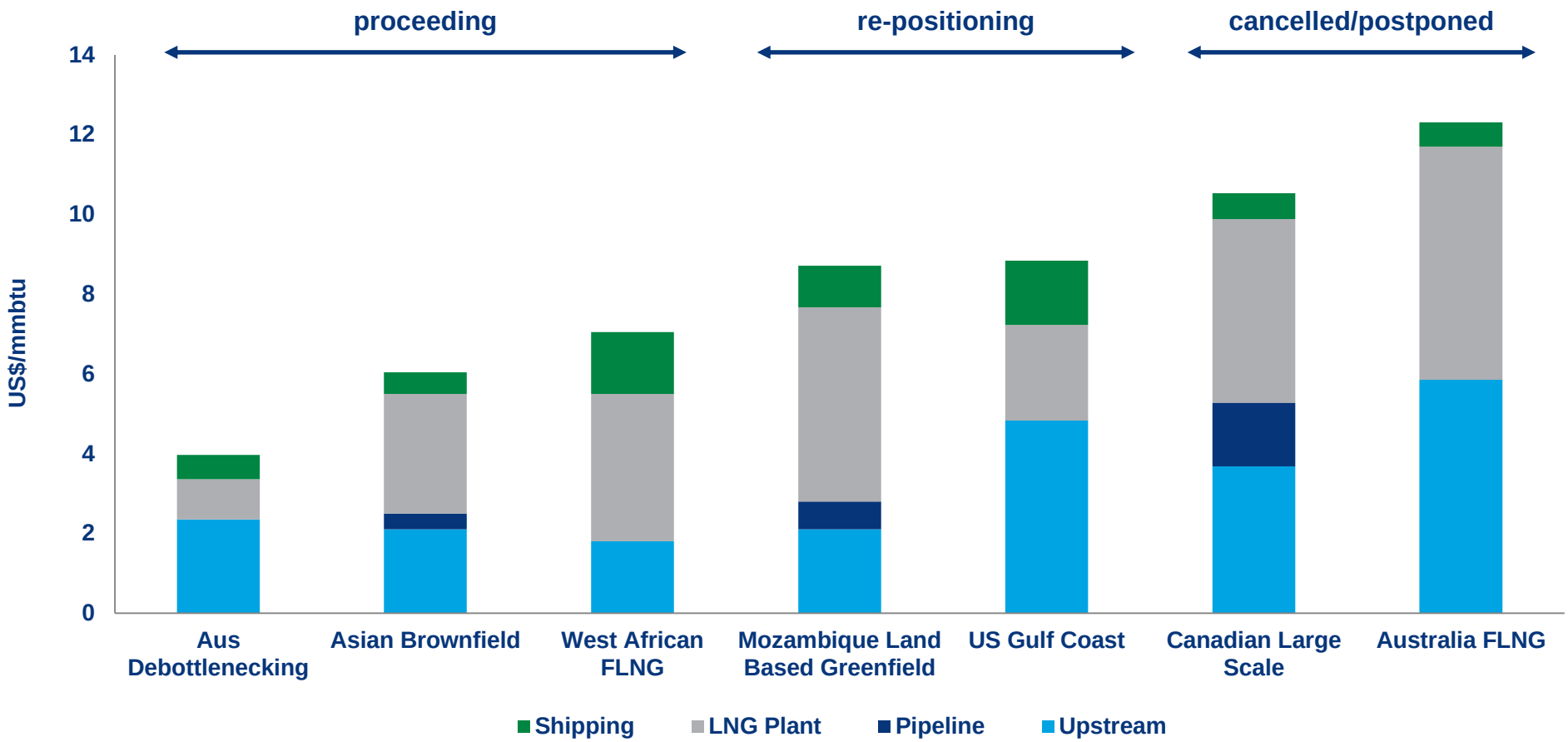
The US has been offering the most flexible LNG, but is now being challenged with lower-cost options

Representative cost stack for pre-FID projects delivered to Asia



Source: Wood Mackenzie

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North American gas and global LNG markets are increasingly subject to the same market drivers

Low-cost resources create supply competition

Access to demand remains the key commercialization challenge in the US and globally

Supplies from the US and the rest of the world are competing for the same demand

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Natural Gas-Fired Generation Dispatch – the Shape of Things to Come?

Greg Hopper

Upstream Forum

May 11, 2017

The Shape of Things to Come

1. **Producer Implications for Power and Gas Capacity Markets**
2. **Renewable One-Upmanship – Getting Serious**
3. **Natural Gas Role in Regional Power Dispatch**

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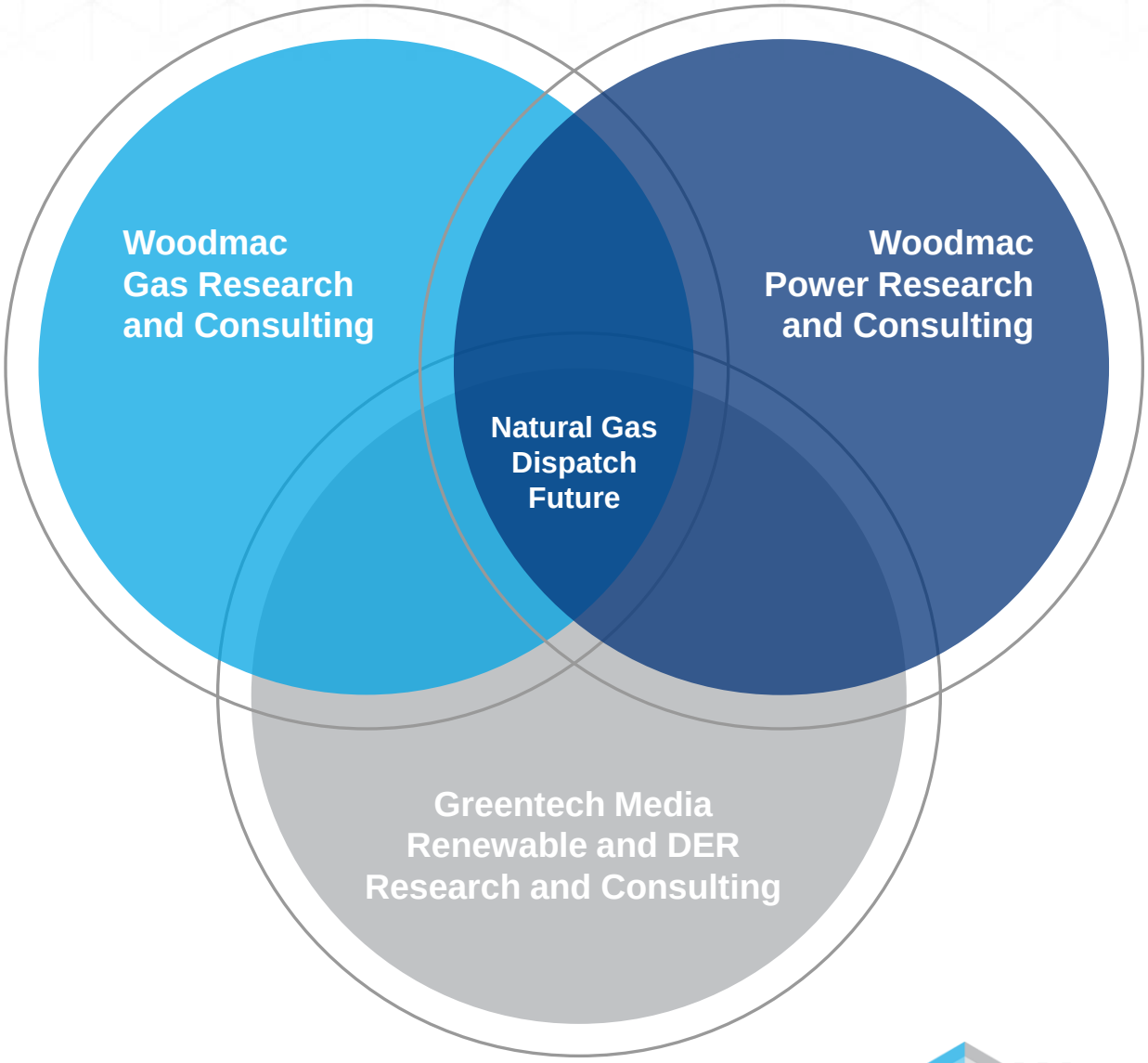
Integrated Services to an Integrated Market



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GTM is the premier market intelligence provider on the decarbonization and decentralization of energy

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With Acknowledgements – The original shape of things to come…

…did not work out well

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The Shape of Things to Come

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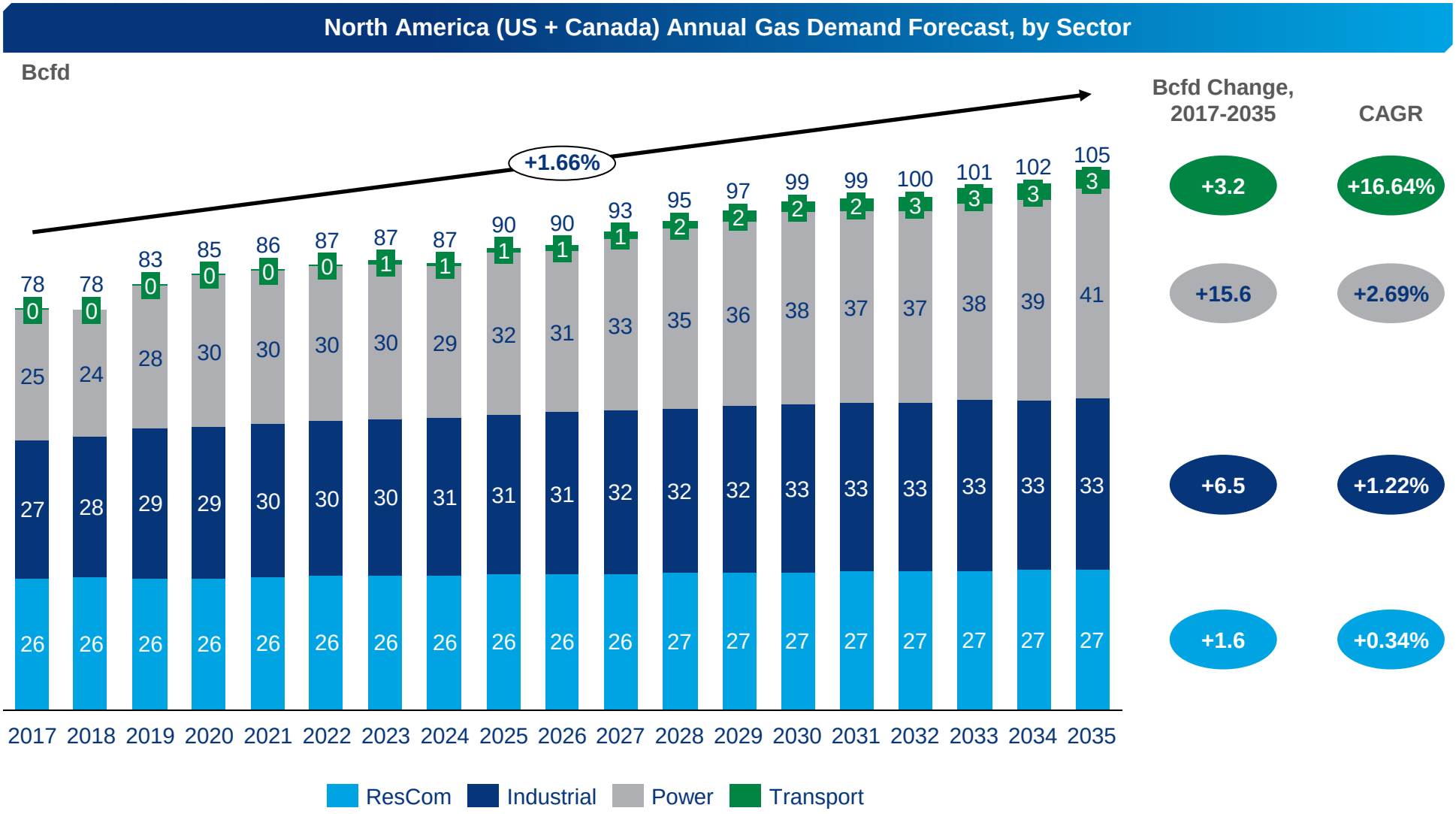
Power generation remains the fastest-growing North American gas demand sector; 58% of all projected growth through 2035



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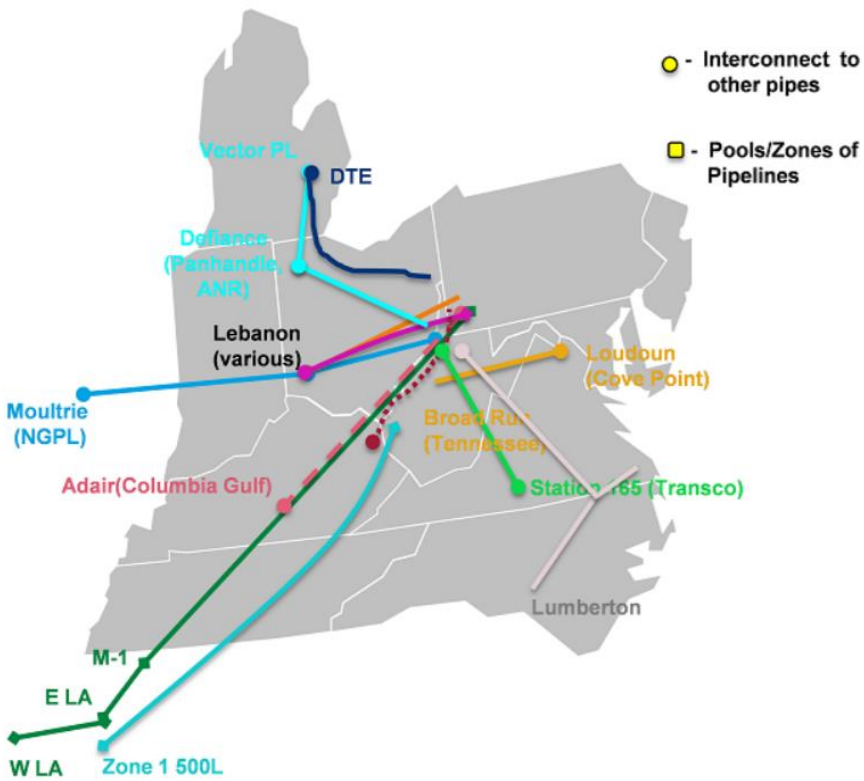
We are tracking 31 Northeast projects along 15 pipeline corridors that may be placed in service over next five years

Nearly 20 bcfd of proposed capacity



Source: Wood Mackenzie

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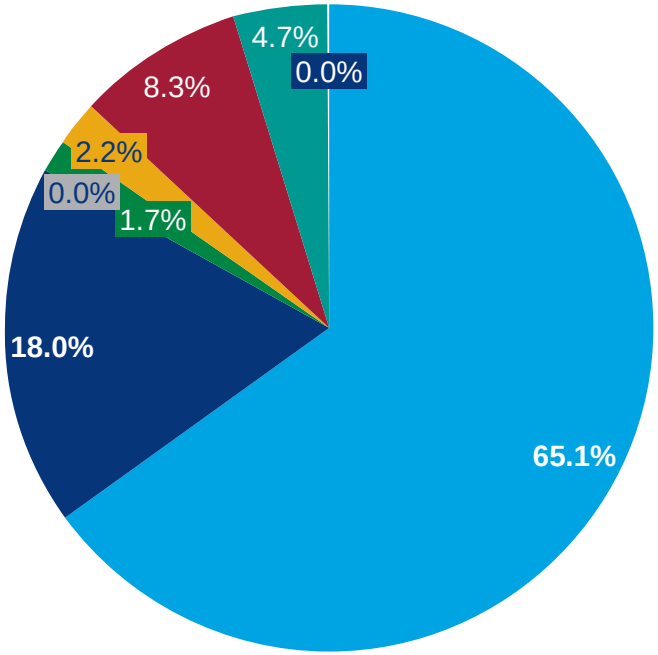
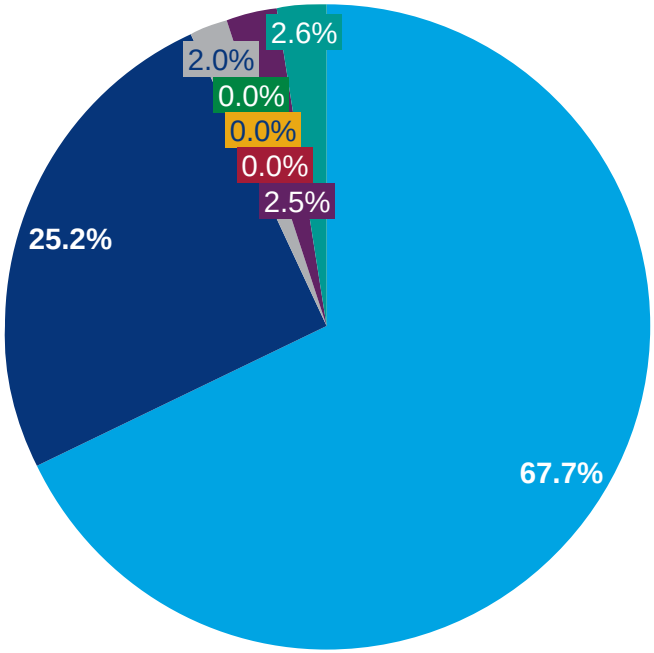
Producers are effectively underwriting 2/3rds of new project capacity through long-term firm transportation commitments

New SW PA Pipeline Project Capacity by Subscriber Type



Total Capacity: 18,026 Mdth/d

New NE PA Pipeline Project Capacity by Subscriber Type



Total Capacity: 4,773 Mdth/d

Producer **Marketer** **Trader** **Un-subscribed**
Utility **LNG** **Un-announced** **Pipeline**

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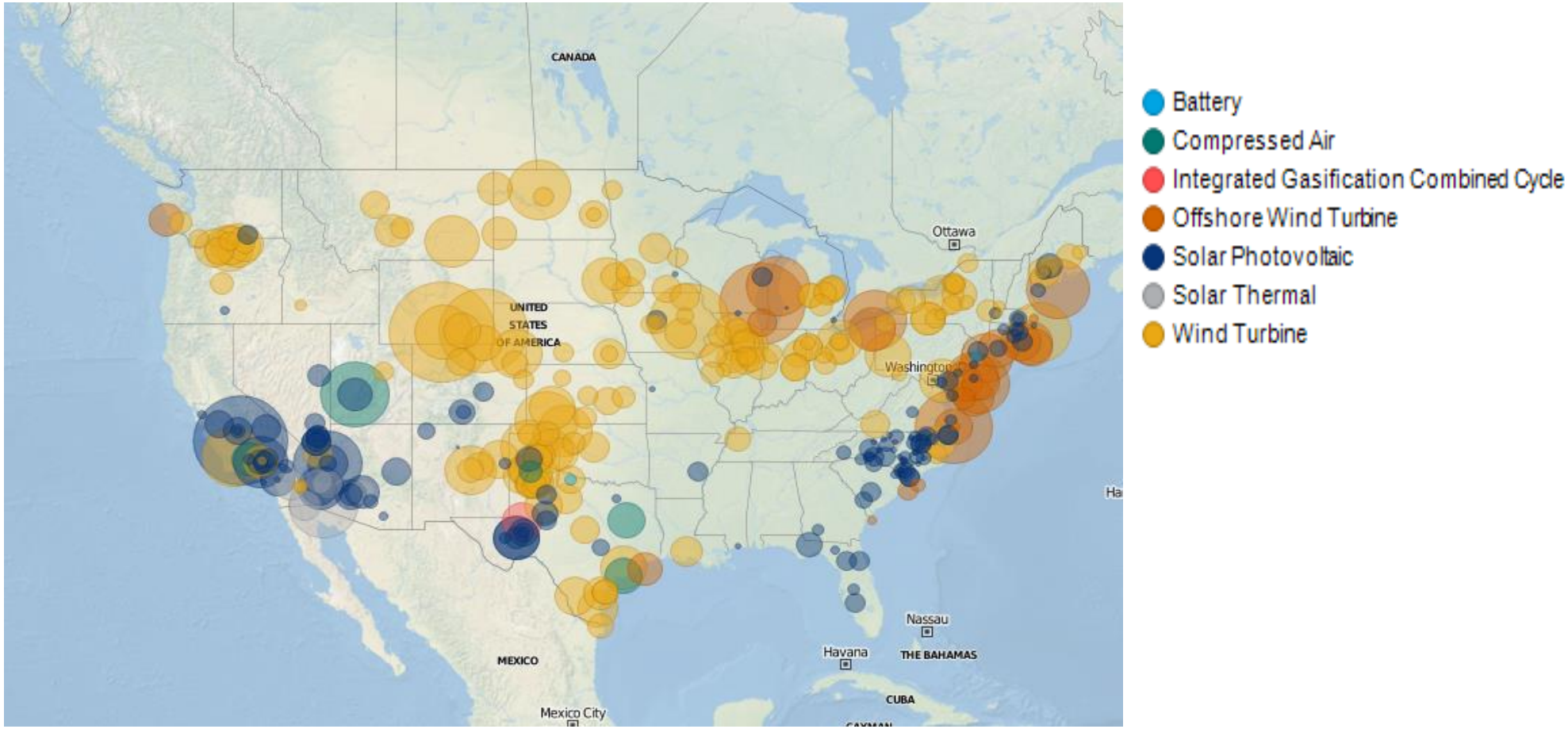
Renewable energy continues to build popular support among federal, state and local policy makers and stakeholders

Technology, cost trends, and business as usual growth propel advances



Source: Wood Mackenzie North America Power & Renewables Tool

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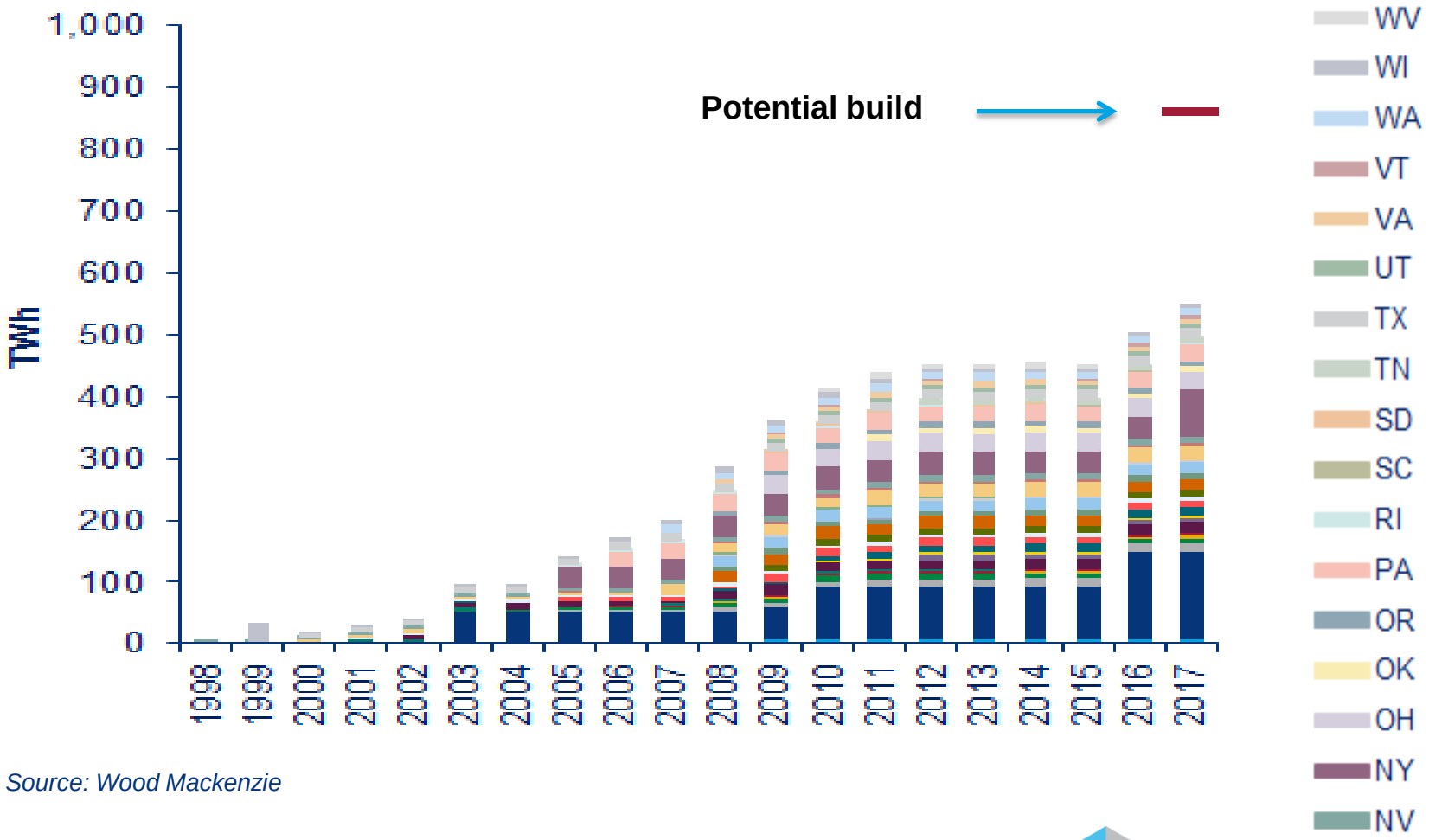
State and regional renewable portfolio standard (RPS) targets transcend administration policy

2030 RPS Targets through time



Source: Wood Mackenzie

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I will see your 20% RPS, and raise you … We will figure out how and how much it costs later

gtm: A Wood Mackenzie Business

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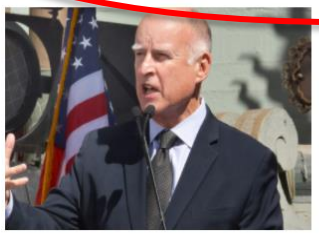
California Governor Jerry Brown Calls for 50% Renewables by 2030



Big increase in solar and wind, doubling building efficiency and fuel economy, are on inaugural wish list

by Jeff St. John
January 05, 2015

NEW YORK STATE

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DECEMBER 2, 2015

Governor Cuomo Directs Department of Public Service to Begin Process to Enact Clean Energy Standard

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Massachusetts Calls for 100 Percent Renewable Energy by 2050

March 1, 2017 | Green Building | environment-massachusetts, Massachusetts, renewable-energy, rep-marjorie-decker, rep-sean-garballey, sen-jamie-eldridge

BOSTON — Legislation introduced in January that would require Massachusetts to be 100 percent dependent on renewable energy sources by 2050 is gaining momentum with lawmakers in the state's capitol.

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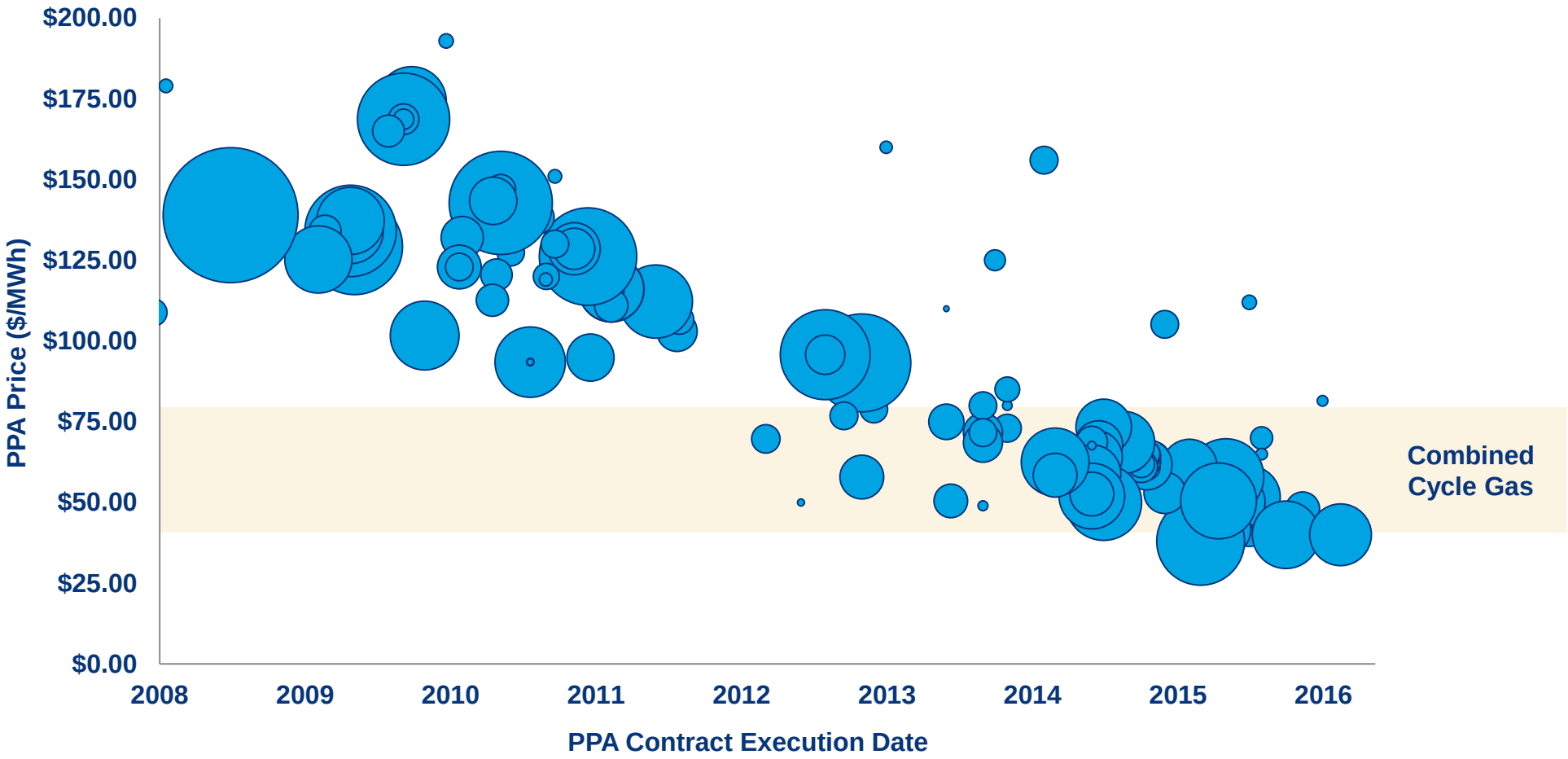
Vancouver commits to switching to 100 percent renewable energy

Vancouver, Canada, has become the latest city to commit to running on 100 percent renewable energy. Following a City Council vote on March 26 in favor of making the switch, the city formally announced its commitment late last week at the ICLEI World Conference 2015 in Seoul, South Korea. Vancouver now joins a list of more than 50 cities worldwide that have pledged to run on 100 percent renewable energy, not only for their electricity needs, but for heating and cooling as well.

Wood Mackenzie
A Verisk Analytics Business

US Power Purchase Agreement (PPA) prices for renewables keep falling

PPA Price ($/MWh)



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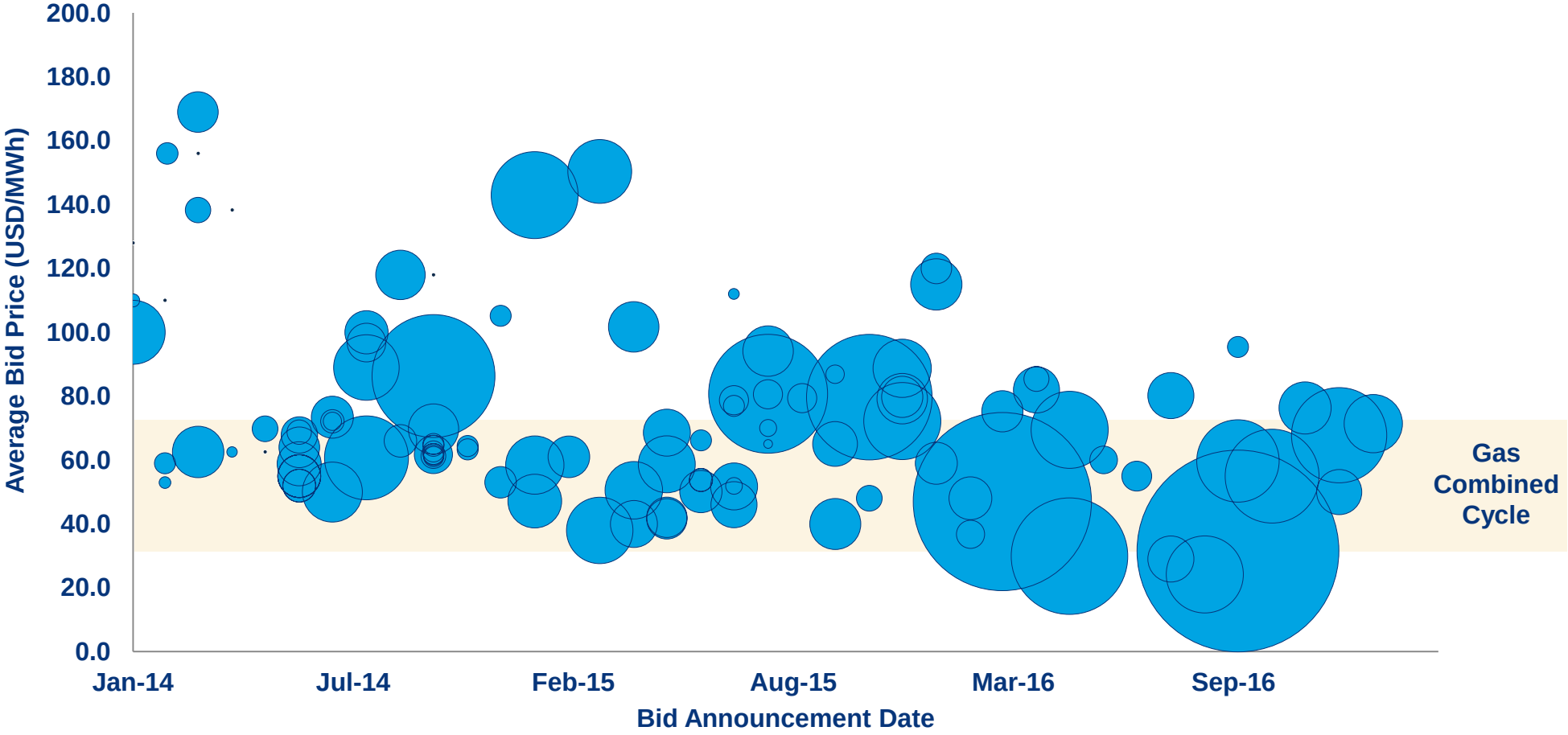
The PPA trend is global, new solar bids are coming in below $40/MWh

Global Tendered Solar Projects by Bid Price and Capacity, 2014-2016



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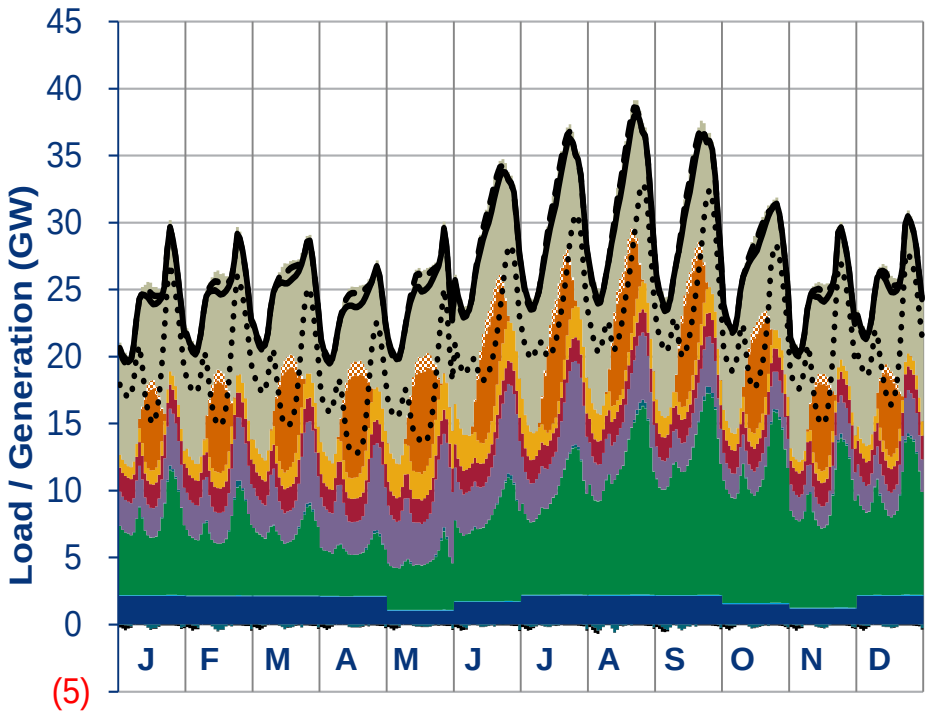
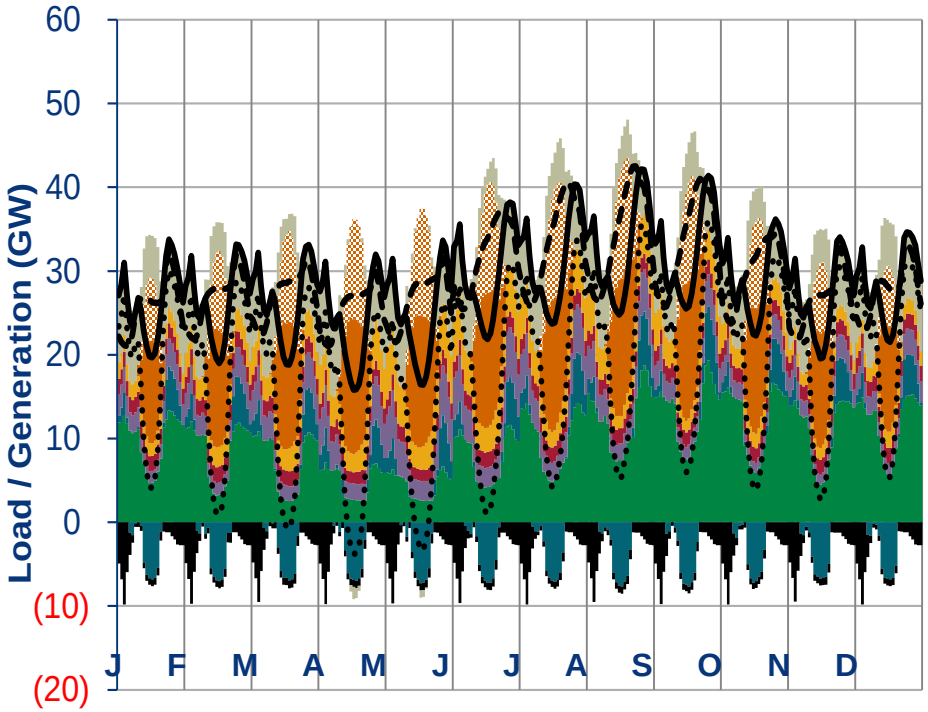
California looks to be the canary in the coal mine: Electric dispatch 2017 vs 2036 portray opportunity and challenge

California disposition 2017



Net Trade (+ imports, - exports)
Solar Distributed
Wind
Hydro
Oil
Coal
Gross Load (before DG and EV)
Final Net Load (after utility renew.)
Electric Vehicles
Solar Utility
Other
Energy Storage
Gas
Nuclear
Market Load (after DG and EV)

California disposition 2036



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Market Load (after DG and EV)

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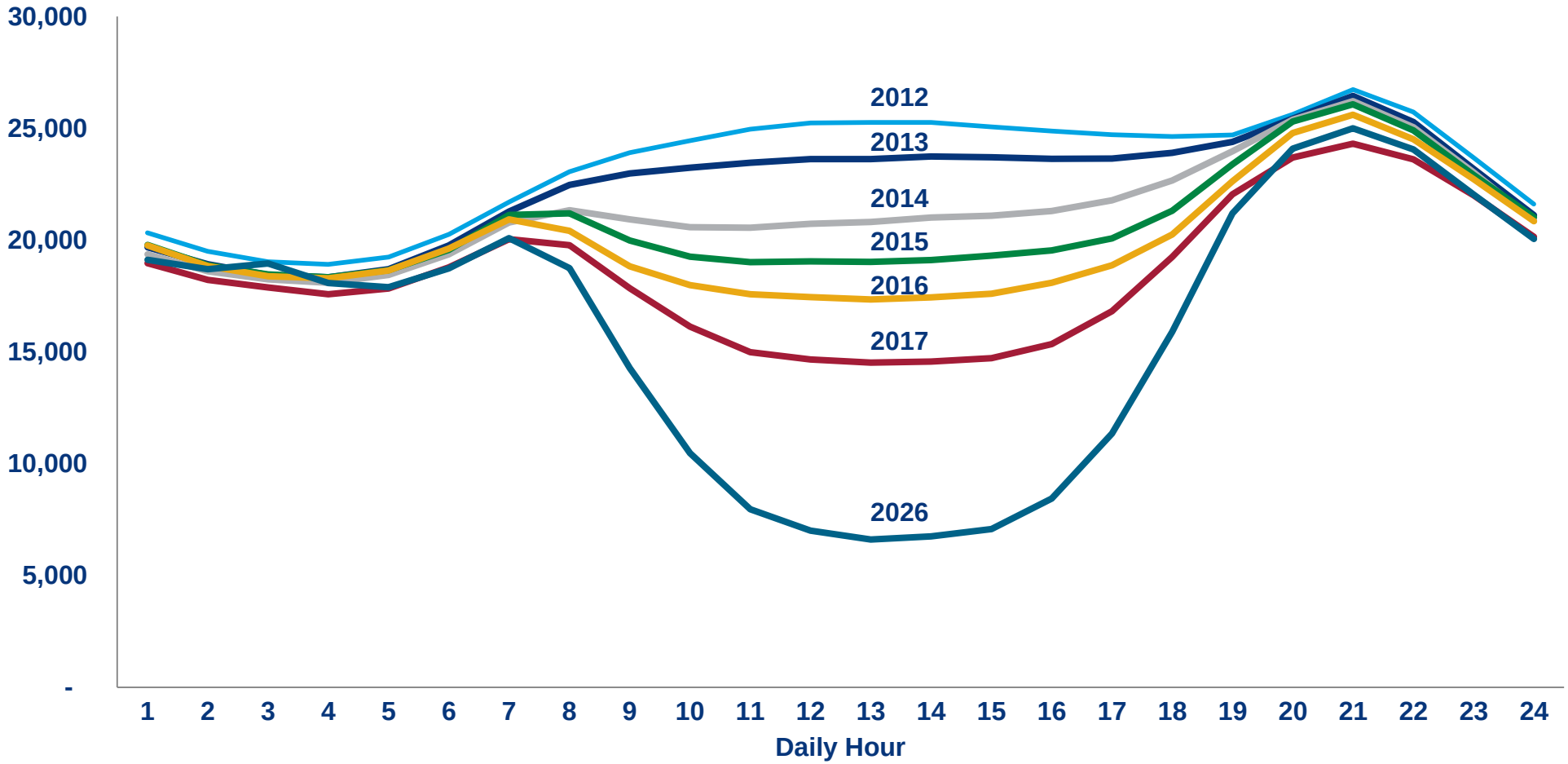
As renewables grow, so will the "Duck"

California – Average April Daily Net Load (MW)



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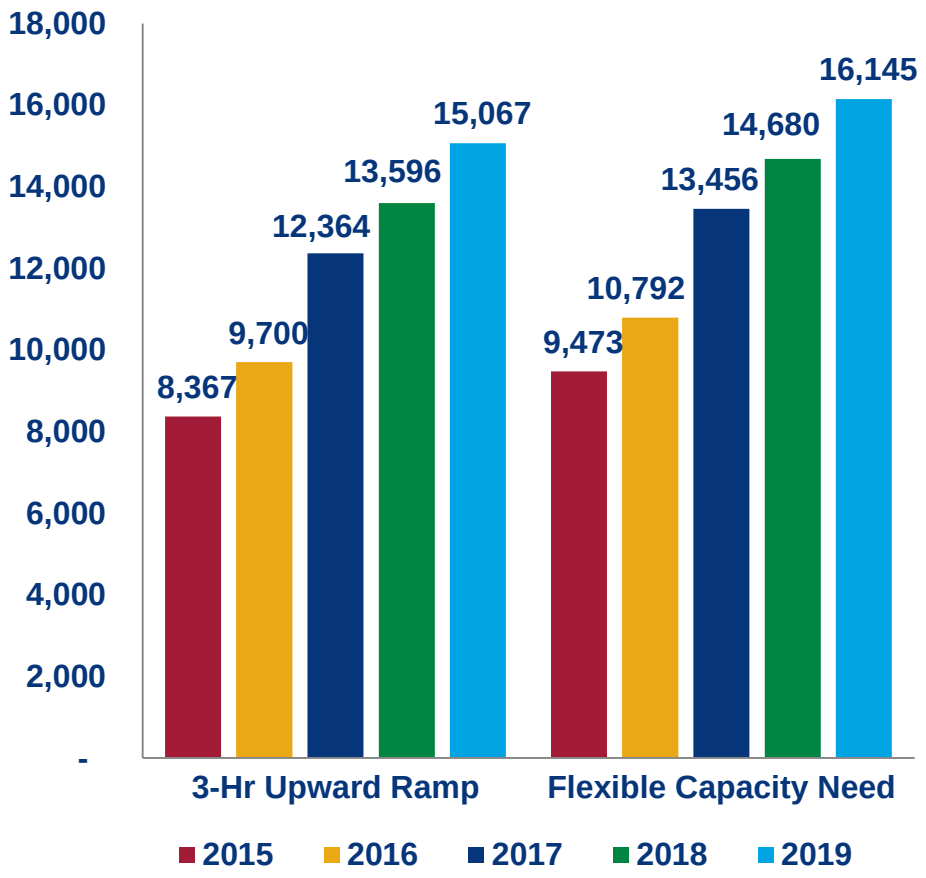
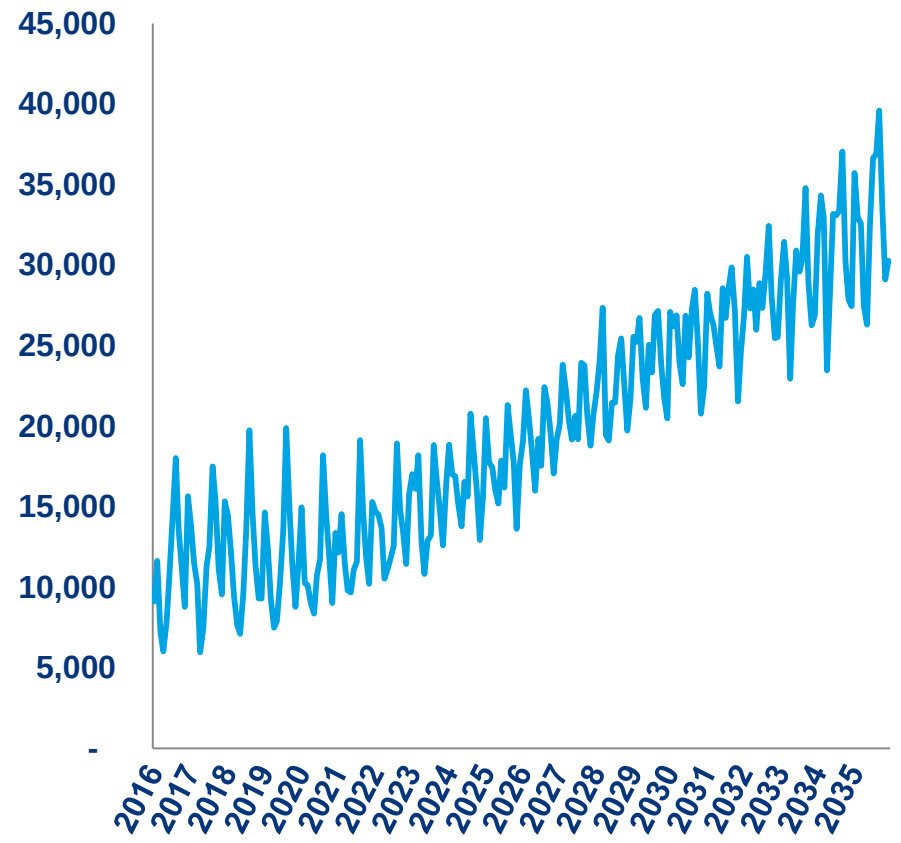
Where renewables proliferate, flexibility is paramount to reliability

California Grid – Average March (MW)



Texas Grid – Demand for Flexible Capacity (MW)



Source: CAISO, Wood Mackenzie

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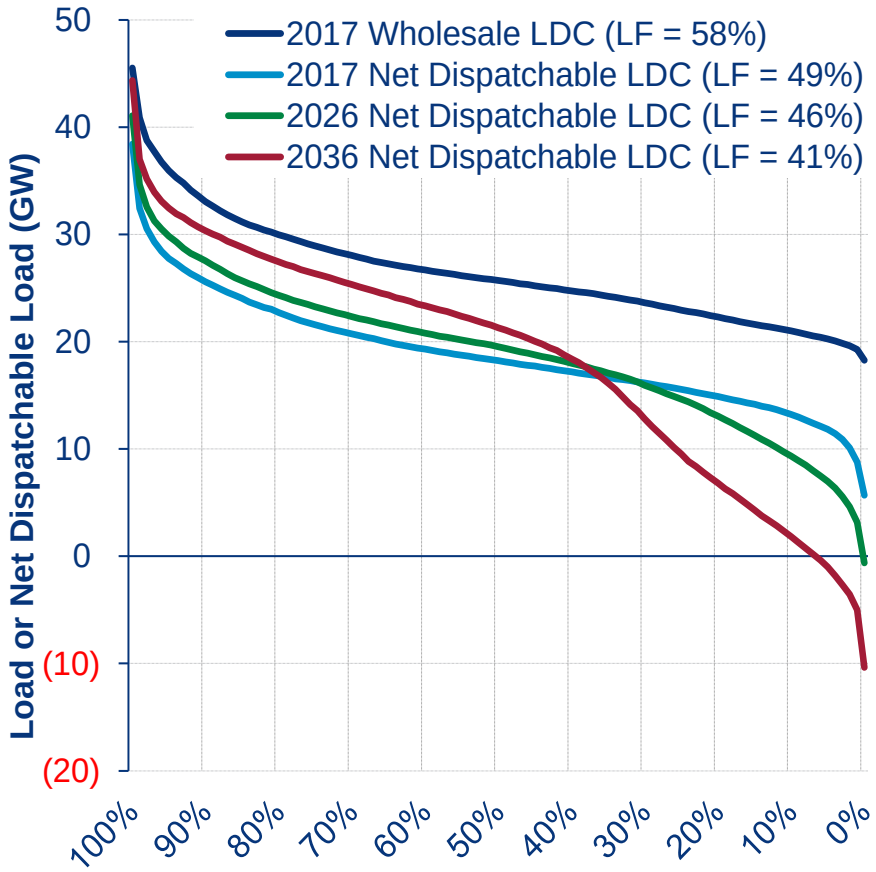
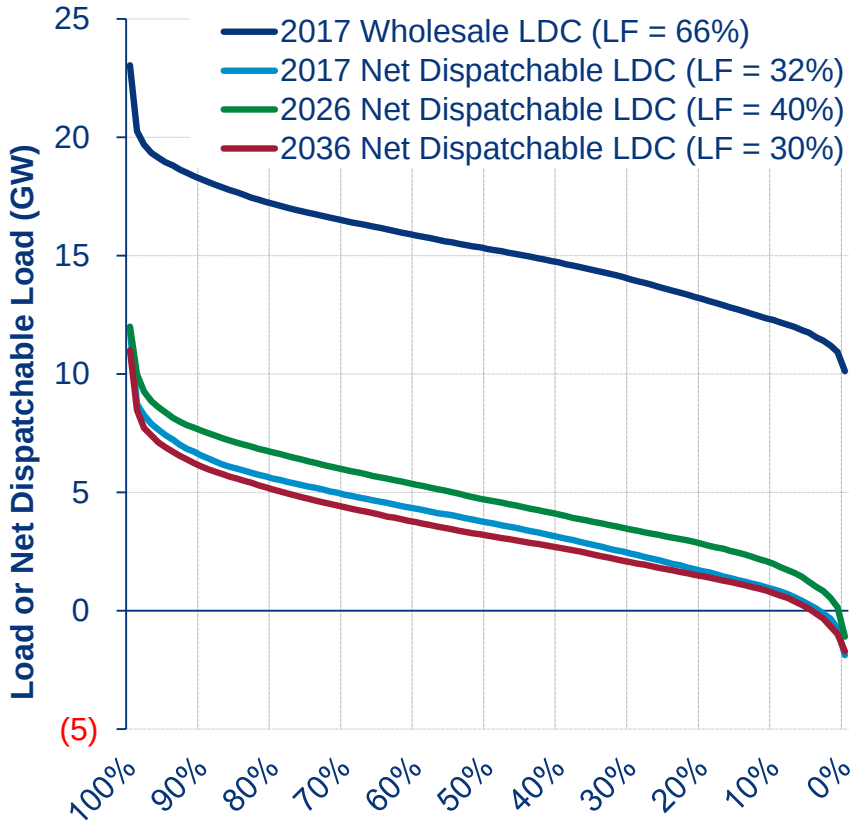
Renewables will create a new dispatchable load shape for producers, new revenue streams, and new capacity investment incentives

Net load for dispatchable resources to serve falls while net peak will stay the same or rise over time

California ISO Load Duration Curve (LDC)



Ontario IESO Load Duration Curve (LDC)



Source: Wood Mackenzie. Net Dispatchable Load = Hourly Load - Non-hydro renewable generation – Nuclear generation

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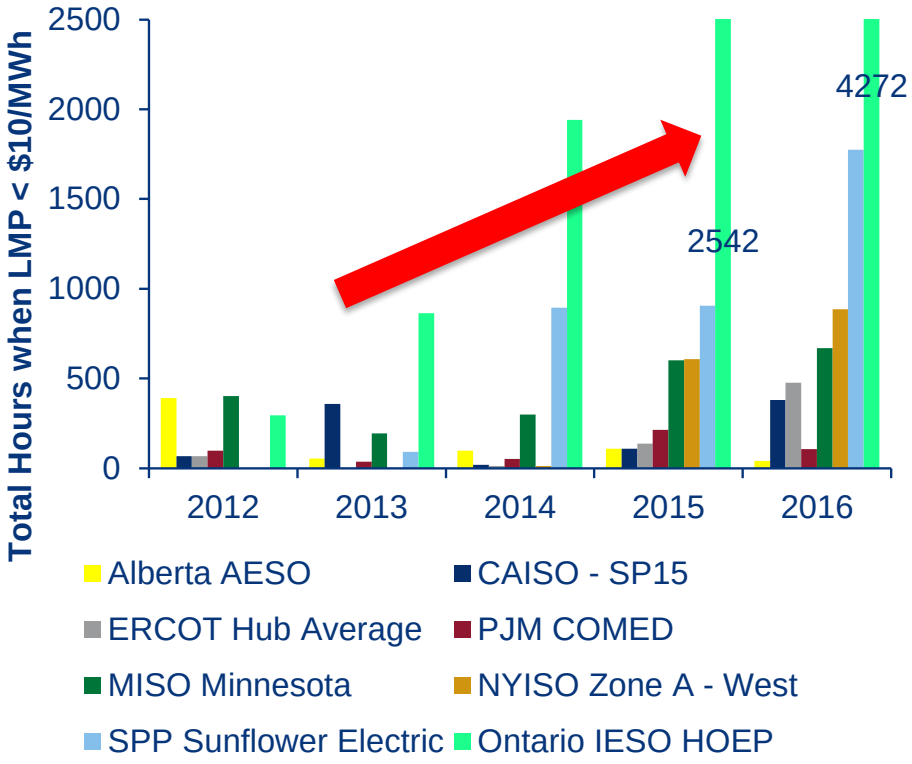
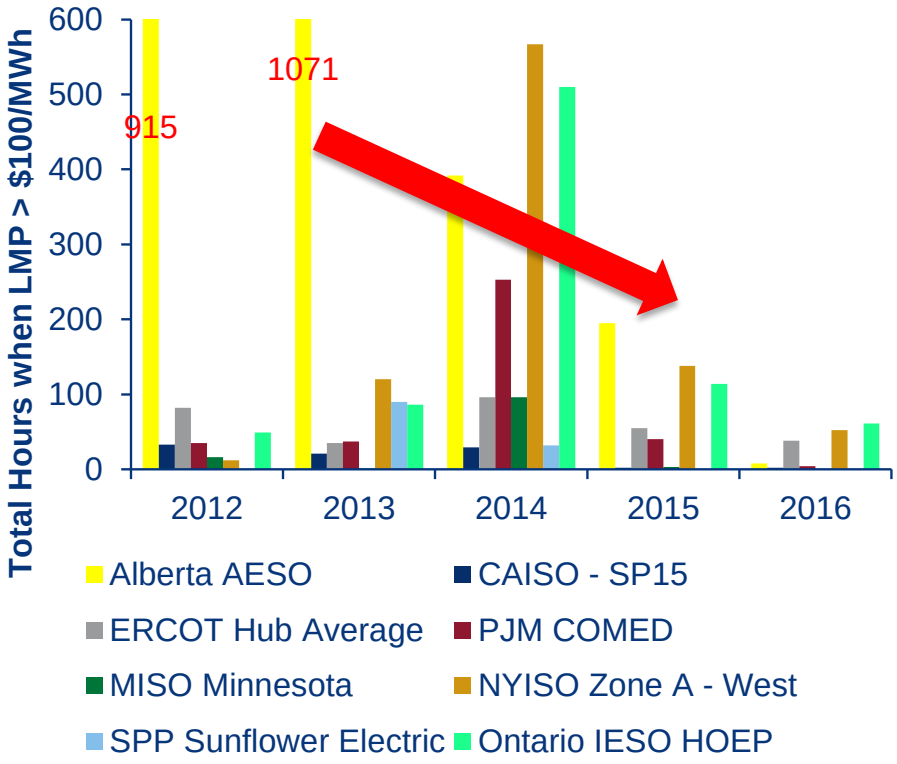
New dispatch sources drive changing power market prices and revenues that will challenge reliability service (and fuel) providers

Frequency of low prices increasing in many markets, while the frequency of high prices is decreasing (except during the 2014 polar vortex)

Total Hours when LMP < $10/MWh *



Total Hours when LMP > $100/MWh *



Source: ISO/RTO websites, Wood Mackenzie
**Note: Based upon day-ahead LMPs except AESO and IESO which are real-time*

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The shape of things to come offers opportunity and risk.

Closing thoughts:

- Power markets for fuels will vary widely – uniformity will be increasingly rare
- Natural gas sellers to the power market must extract greater revenues in support of service reliability and flexibility
- Collaboration among companies in the gas supply chain is more valuable than ever
- Producers will be well-served to engage regional power grid organizations and management process, pushing for a seat at the table and a level playing field

Thank you.

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US GoM Deepwater: weathering the oil price storm

Gordon Loy

Upstream Forum

May 11, 2017

Agenda

1. Production and investment outlook
2. Rig market
3. Drilling efficiency
4. Lower Tertiary progress
5. Can GoM compete
6. Deepwater going forward

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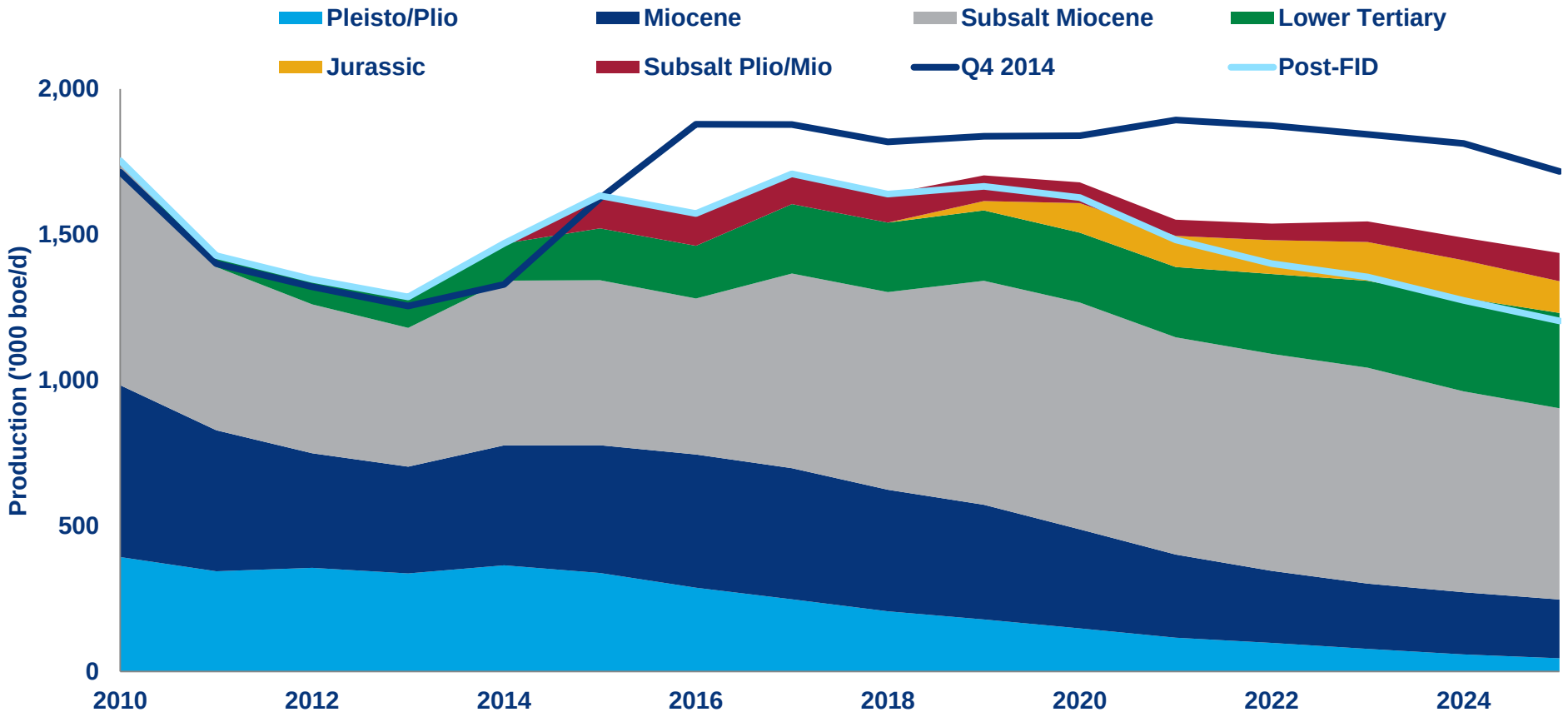
As the region hits a new post-Macondo peak in 2017, production continues to ramp up, driven by Subsalt Miocene projects

Production forecast (current view vs. Q214 view)



Source: Wood Mackenzie

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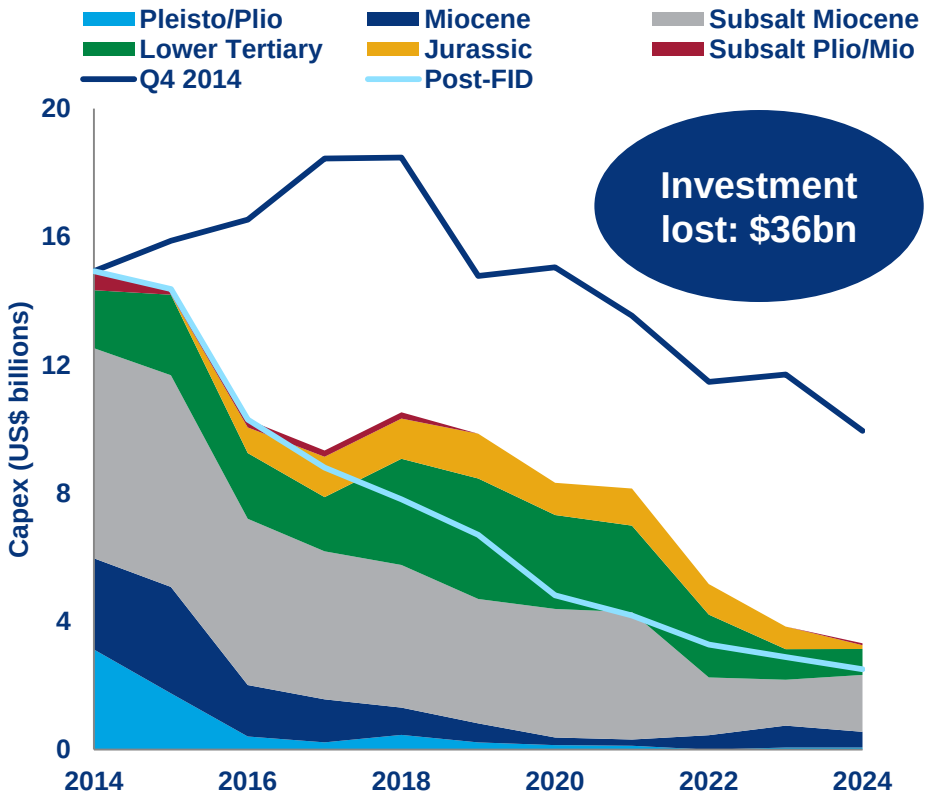
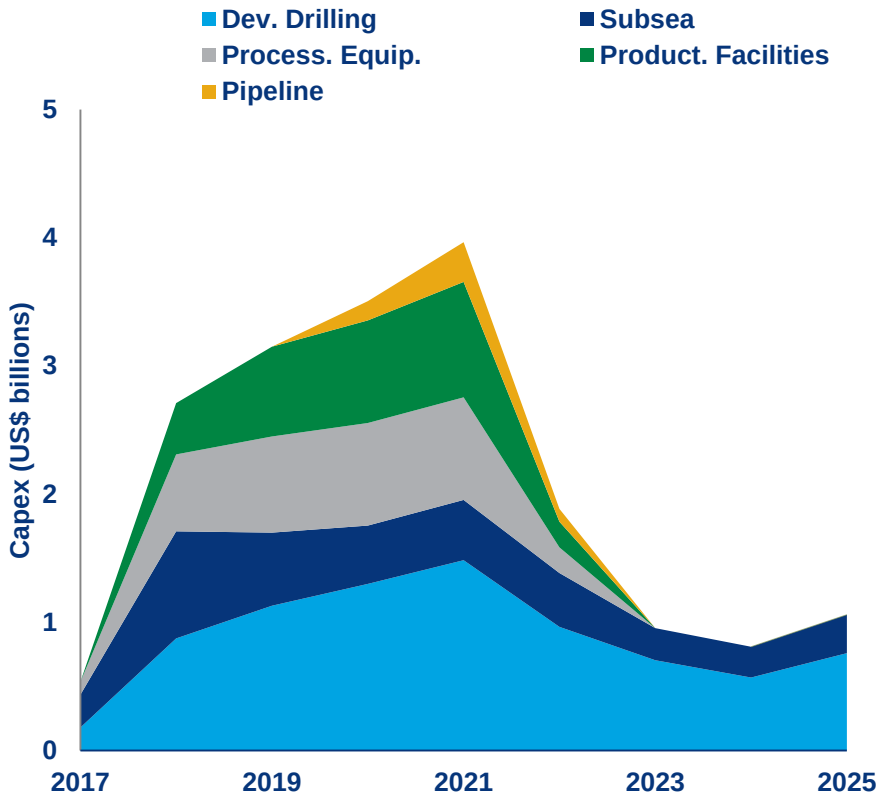
US$36 billion in capex deferred since the collapse of oil prices; post-2017 recovery dependent on Lower Tertiary projects moving forward on schedule

Capex forecast vs Q4 2014



Capex forecast for probable fields



1) Cancellations | **2) Redesigns** | **3) Delays**

Source: Wood Mackenzie

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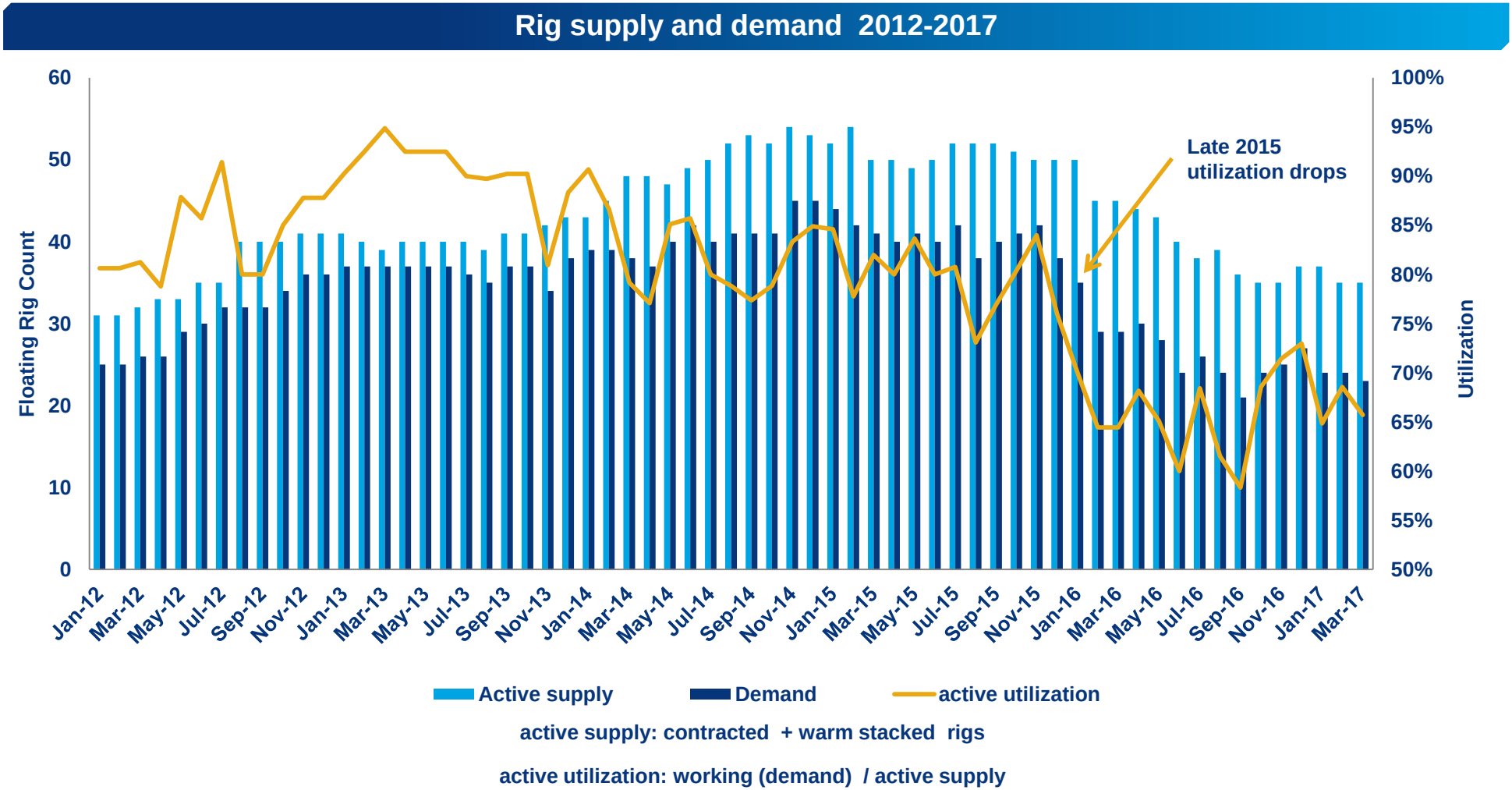
Lagging effect: approximately 12 months into down-turn before average utilisation dropped below 80% in US-GoM



Source: Wood Mackenzie

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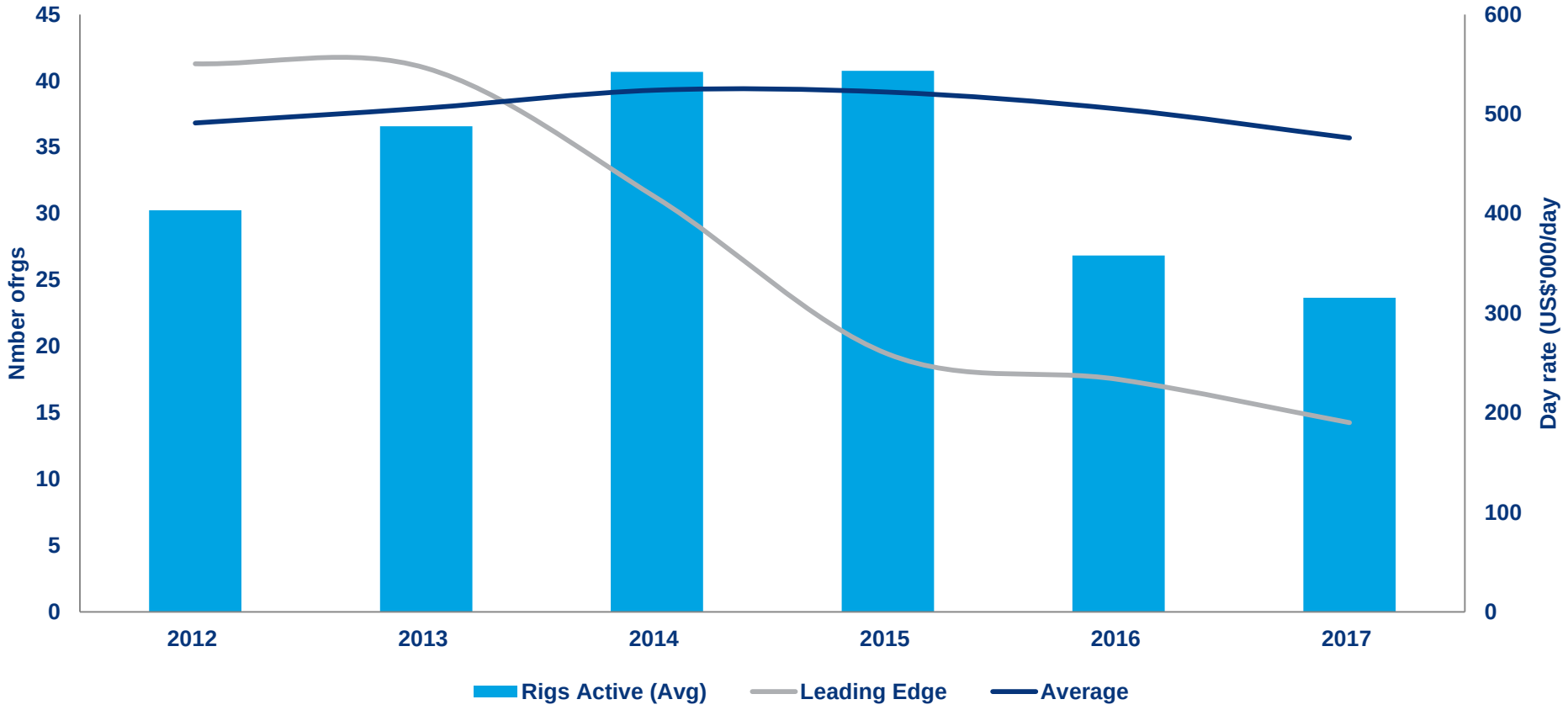
Average rig rate buoyed by remaining long-term contracts, but the existing oversupply has lead to sharp declines in leading edge rates

Historical active rig count and day rates 2012 - 2017



Source: Wood Mackenzie

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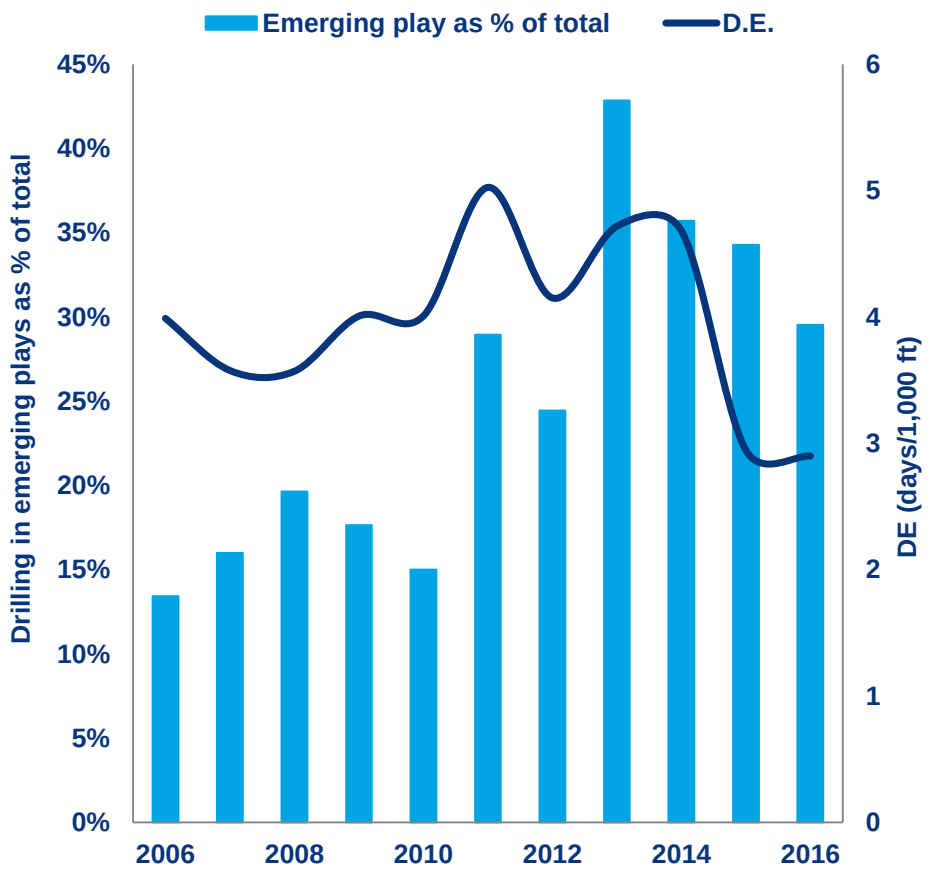
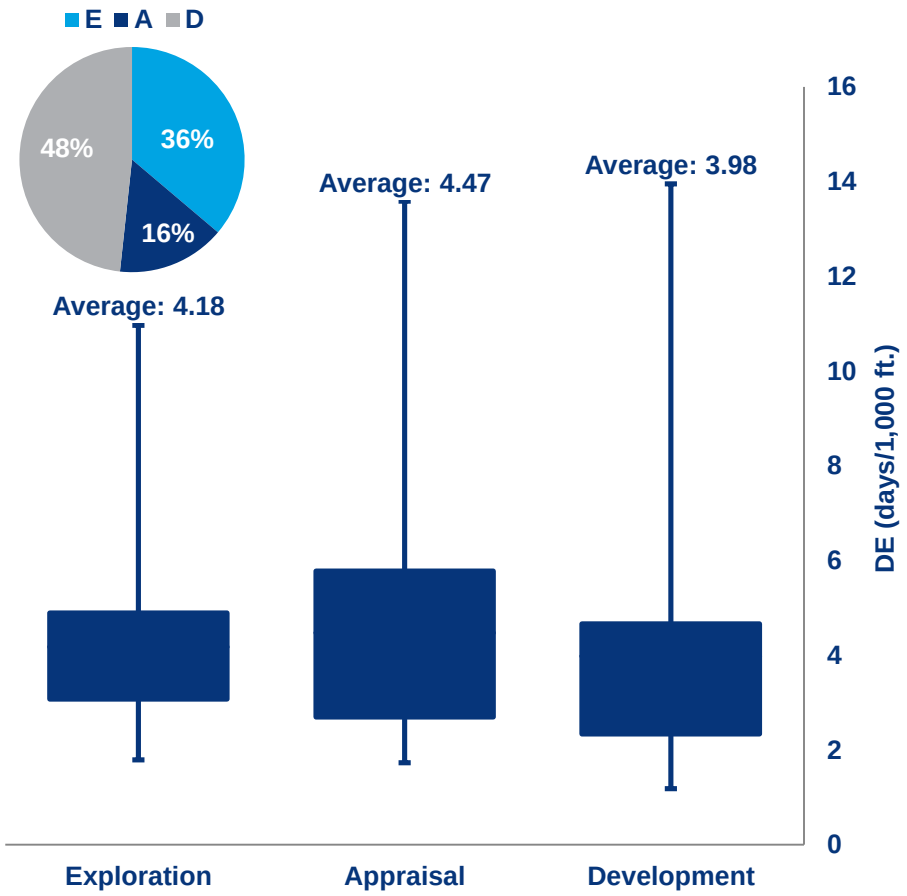
Drilling efficiency has improved the past few years as simpler wells are drilled in low risk plays

DEs and percent of activity in emerging plays



DE by well type (2006-2015)



Source: Wood Mackenzie

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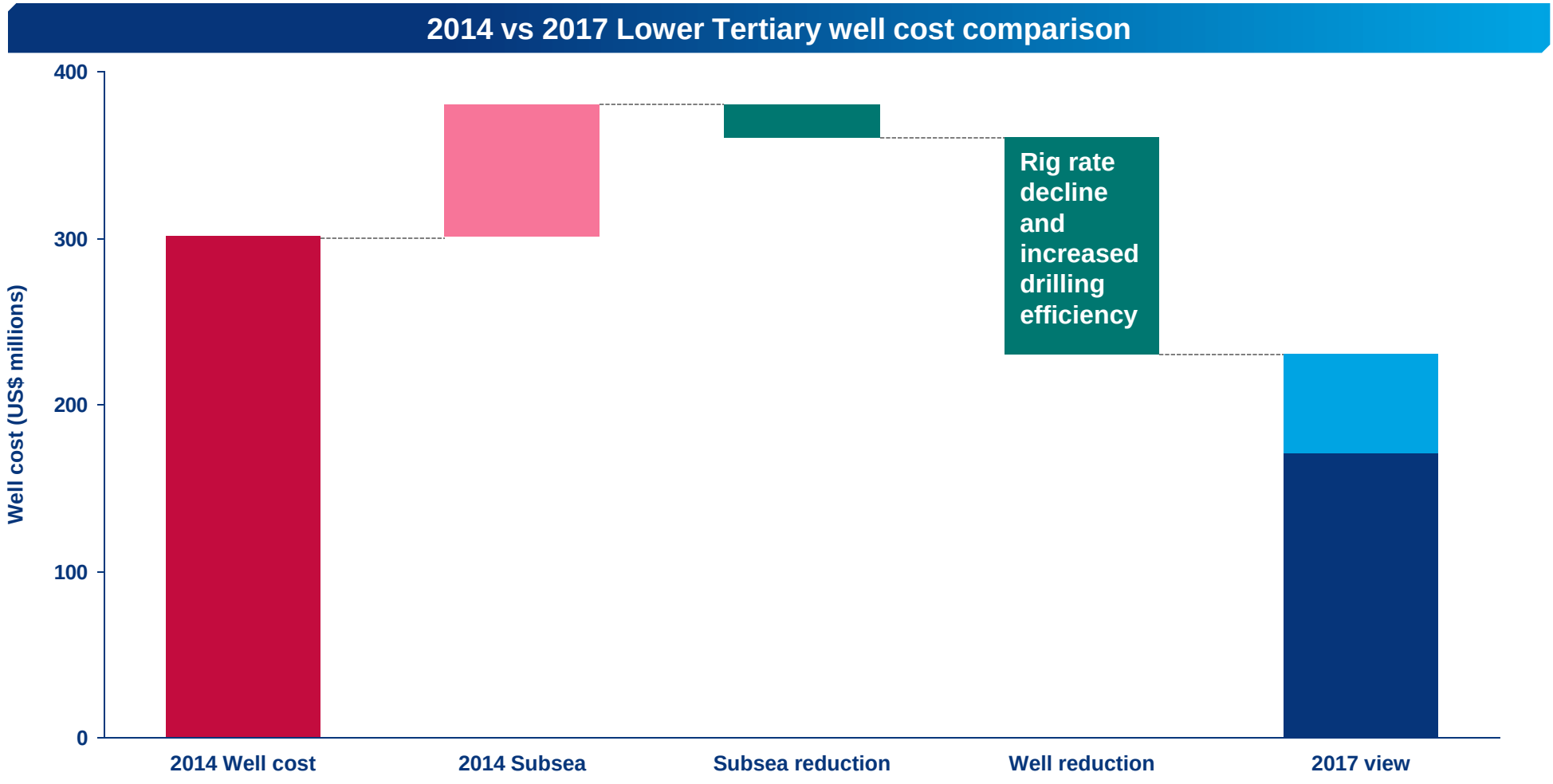
Supply chain deflation and efficiency gains drive Inboard Lower Tertiary well cost reductions



Source: Wood Mackenzie

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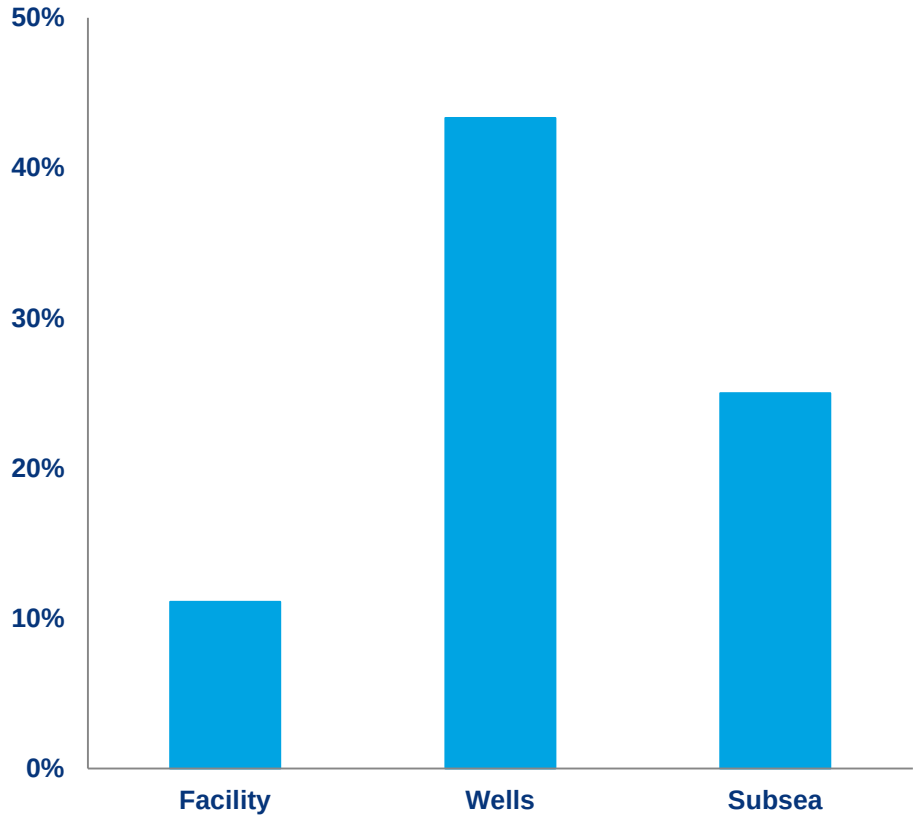
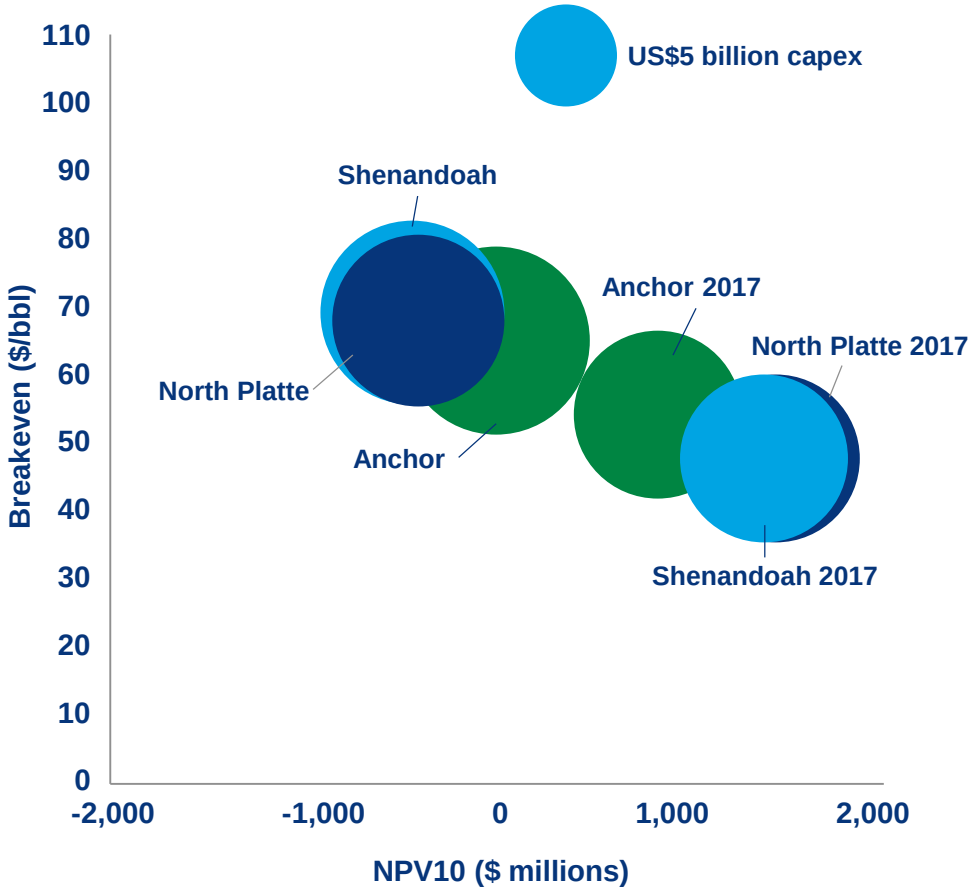
Viability of Inboard Lower Tertiary fields is improved since price collapse, but execution challenges persist

Inboard Lower Tertiary cost reductions



Economic gains from 2015 to 2017



Source: Wood Mackenzie

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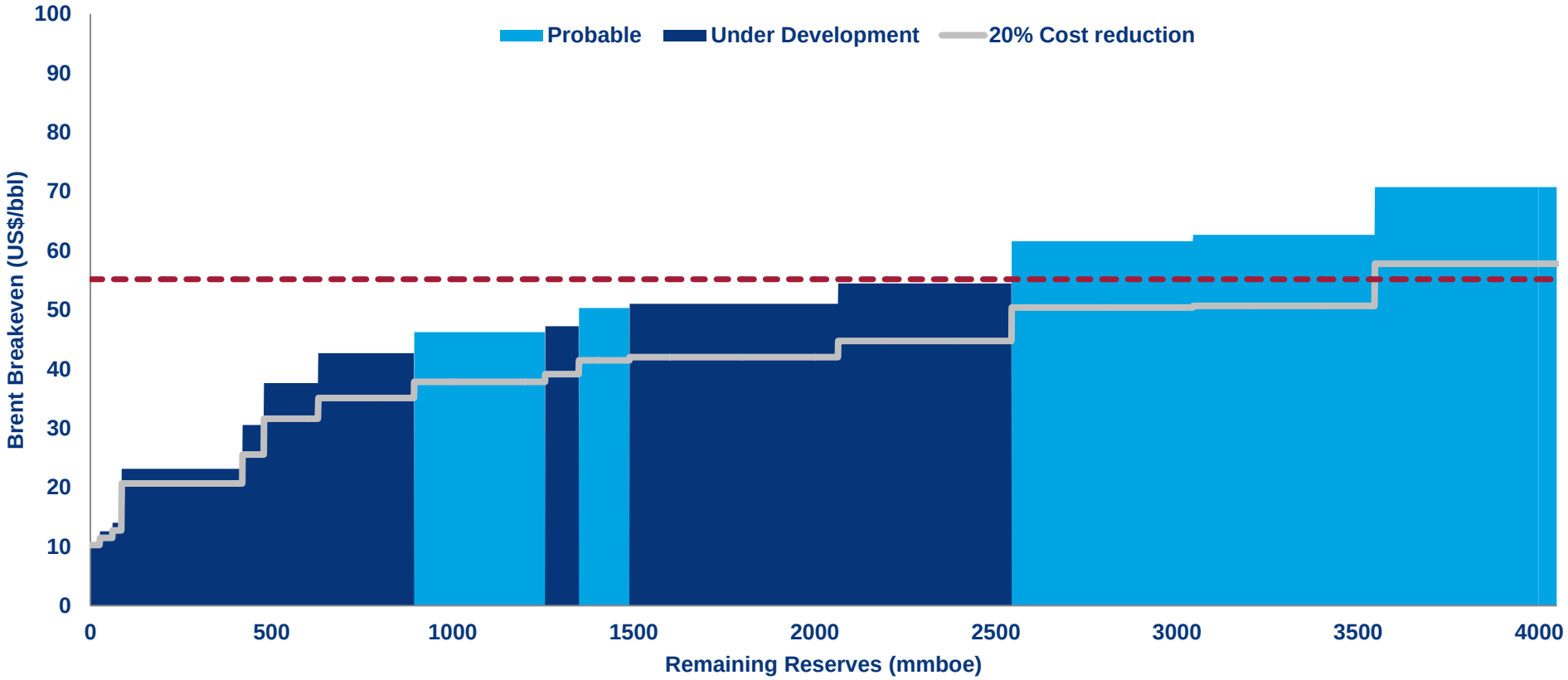
Majority of pre-first oil GoM projects economic under the current environment. Upper range of cost curve concentrated in the Lower Tertiary

GoM remaining reserves by breakeven



*Source: Wood Mackenzie. *Breakevens run on 15% discount rate*

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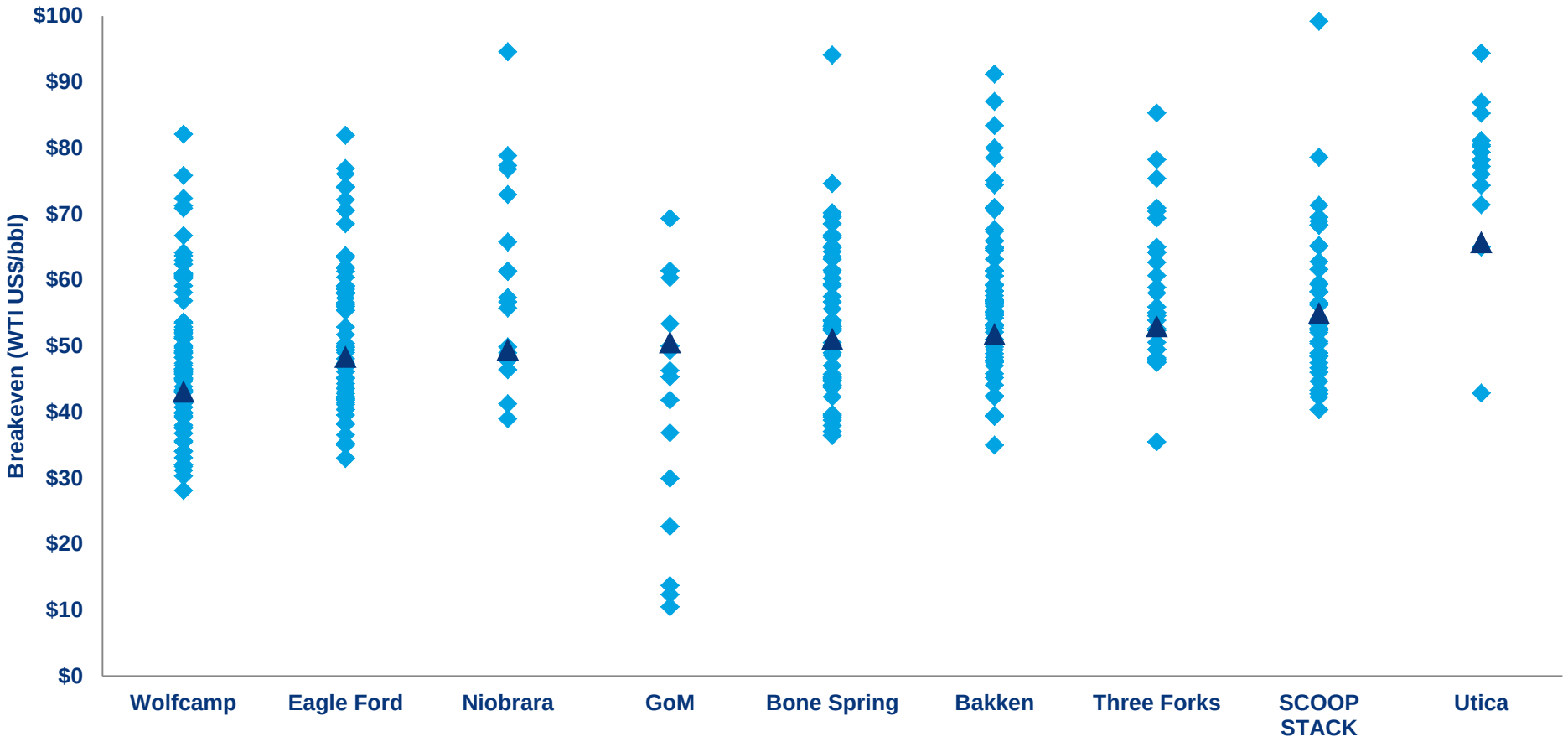
Project re-design and cost deflation allows GoM to compete with Lower 48

Weighted average breakevens (L48 undrilled and pre-first oil DW GoM projects)



Source: Wood Mackenzie

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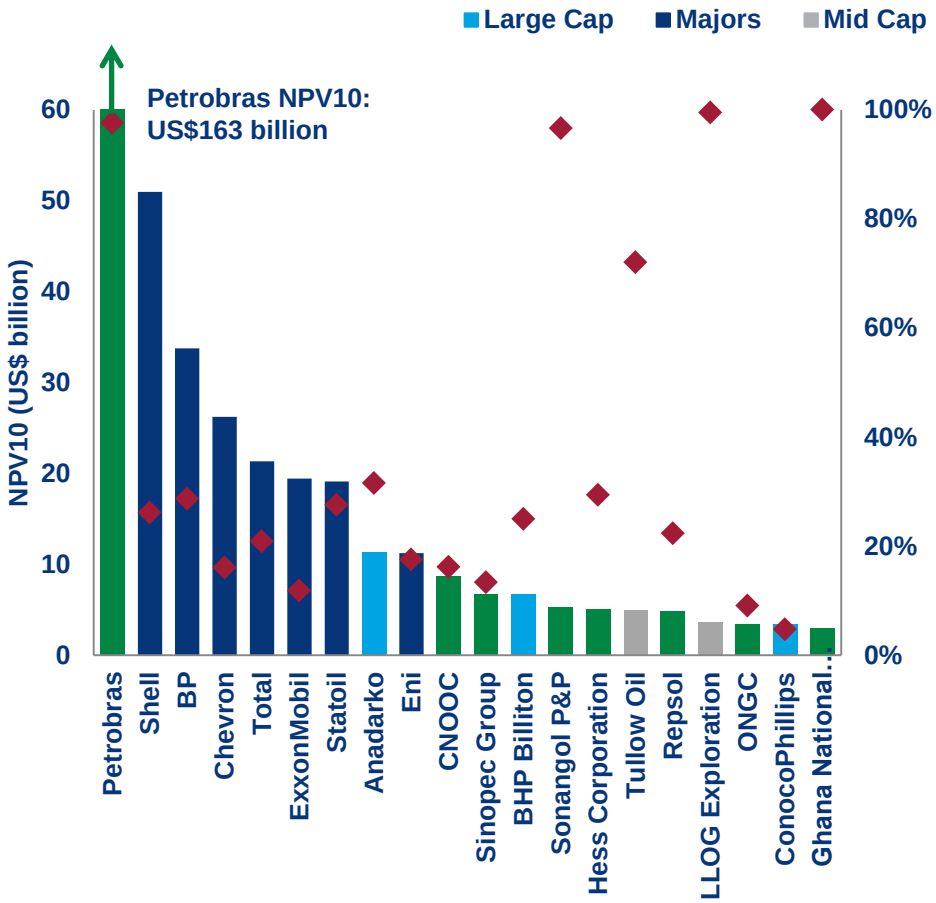
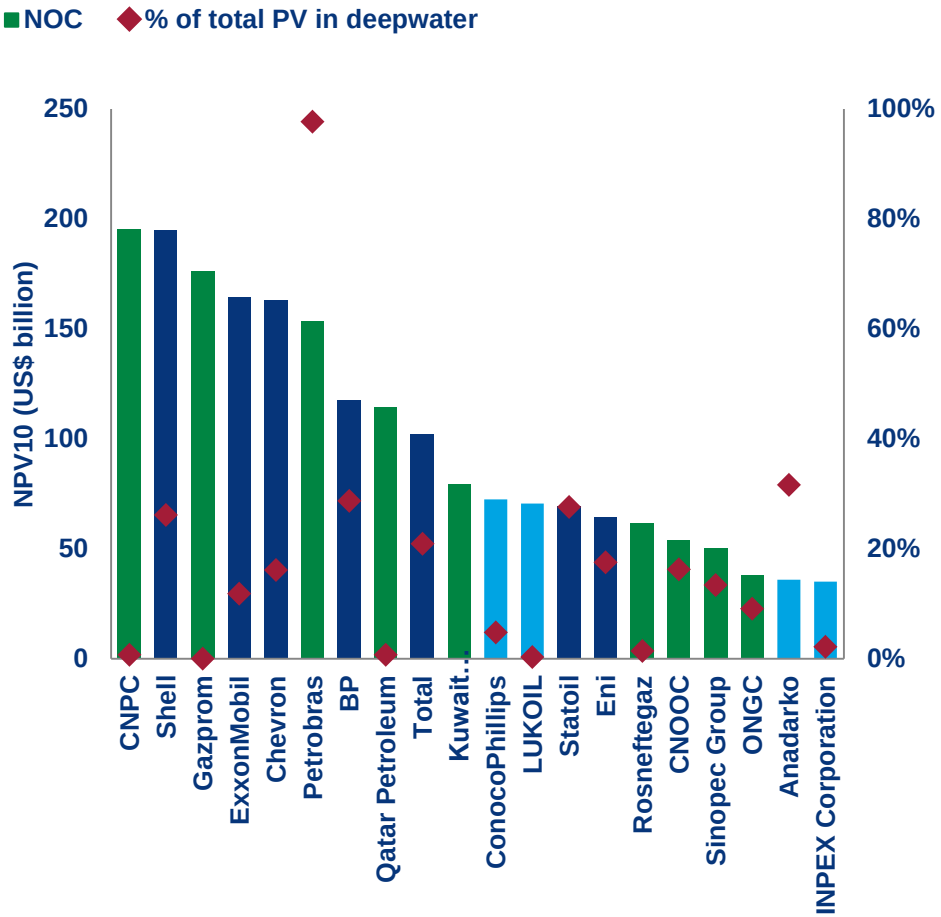
Deepwater remains a key resource theme for many leading E&Ps, and GoM remains a leading Deepwater regime

Remaining value (NPV10) of top deepwater portfolios



Remaining value (NPV10) of top overall portfolios



Source: Wood Mackenzie

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Energy in the Trump era: are the expectations too lofty?

Jonathan Garret, Clay Lightfoot, Andy McConn, Jen Snyder

Upstream Forum

May 11, 2017

Wood Mackenzie

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Speaker Bios

Upstream Forum

May 11, 2017

Ed Rawle

Chief Economist, Global Research

T +1 713 470 1695

E ed.rawle@woodmac.com

- Ed leads Wood Mackenzie's global crude oil research and is also responsible for Wood Mackenzie's global macroeconomic outlook. He joined Wood Mackenzie in 2009 and has spent 10 years working across the energy and metals space. Ed built out Wood Mackenzie's macroeconomics team – now a global team of economists responsible for our global macroeconomic outlook to 2035. Using Wood Mackenzie's upstream analysis, his team have developed a specialisation in the threats and opportunities facing commodity producing economies. In 2016 Ed became responsible for Wood Mackenzie's oil price outlook, including the development and commercialisation of our Oil Price Model.
- Throughout his career, Ed has focused on macroeconomic forecasting and econometric modeling. Prior to Wood Mackenzie, he headed CRU's Econometrics team in London – responsible for developing price forecasting models for base metals and steel. Before moving into commodities, Ed held Senior Economist positions at HM Treasury and the UK Debt Management Office where he briefed former Prime Ministers Tony Blair and Gordon Brown. Ed also served as an Economist at the Home Office in London, and the European Central Bank in Frankfurt where he focused on Latin America.
- Ed holds an MSc in Economics from Southampton University, and a BSc in Economics from The University of Birmingham. He is also an alumnus of the London School of Economics.

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Julie Wilson

Research Director – Global Exploration

T +1 713 470 1627

E julie.wilson@woodmac.com

- Julie has covered global exploration since January 2011, following 11 years at Wood Mackenzie split between the upstream consulting and research divisions. She has worked closely with clients advising on global and local industry issues, with a recent focus on exploration strategy and performance.
- Julie moved to Houston from the UK in November 2000 in an upstream consulting role. She helped to build the Houston consulting practice and managed a wide variety of international consulting engagements, including corporate strategies, exploration and country entry strategies, competitor analysis, gas supply and market analysis. In 2006 she moved across to the research division and built the Houston-based team focusing on the deepwater US Gulf of Mexico.
- Prior to joining Wood Mackenzie, Julie worked in BP's upstream business for eight years in London and Aberdeen in a variety of political, commercial, and financial analysis roles, spanning international and domestic North Sea operations and exploration.
- Julie graduated from Heriot-Watt University in Edinburgh, Scotland with a BA Honours degree and from University of Strathclyde in Glasgow, Scotland with an MSc.

Andrew McConn

Senior Analyst, Corporate Research

T +1 713 468 1690

E andrew.mcconn@woodmac.com

- Covers North American mid- and large-cap oil-and-gas companies for Wood Mackenzie's Corporate Service team. Analyzes companies' performance, strategic options and financial outlooks. Previously specialized in asset valuations, fiscal systems and other economic modelling for the Canada and Alaska regions.
- Holds a Bachelor of Arts in Corporate Communication with a minor in Economics from the University of Houston in 2010.

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Caitlin Shaw

Research Director – Upstream Supply Chain

T +1 713 470 1932

E caitlin.shaw@woodmac.com

- Caitlin is currently a Research Director in the Upstream Supply Chain research team, responsible for the delivery of in-depth commercial analysis of global supply and demand dynamics from exploration to development and through life of field. She will help expand Wood Mackenzie's market offerings focusing on the global upstream supply chain to provide critical analysis on cost, capacity and supply issues affecting offshore project executions.
- Caitlin also provides Subject Matter Expertise on the global subsea market focusing on supply and demand of subsea production systems, globally. She is also well versed in the entire deep water development cycle. She has worked with many E&P companies, members of the supply chain, and financial institutions, providing strategic market analysis, intelligence and support to project teams, procurement groups and market research.
- Caitlin has over 15 years experience in the oil and gas industry – most of which was spent focusing on the deep water development and subsea space. She joined Wood Mackenzie as part of the acquisition of Quest Offshore's data & subscription business in 2016. She previously worked for a small consulting company in Houston, TX providing customized solutions to increasing reporting efficiencies for oil companies.
- Caitlin holds a BS in Marine Biology from Texas A&M University at Galveston.

Jackson Sandeen

Senior Research Analyst, Lower 48

T +1 713 470 1600

E jackson.sandeen@woodmac.com

- Values and analyzes Permian Basin assets of upstream oil & gas operators, assists with consulting projects and publishes topical reports on key regional trends.
- Prior to joining the Lower 48 team, worked on the Deepwater Gulf of Mexico team focusing on the rig market, play-level economics and the commercial impact of emerging plays.
- Earned dual degrees in Economics and Broadcast Journalism from Boston University.

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R.T. Dukes

Research Director – US Lower 48 Upstream Research

T +1 713 425 5812

E rtdukes@woodmac.com

Twitter @rtdukes

- R.T. has held various research and consulting roles within Wood Mackenzie. Currently, he contributes to the company's detailed analysis of major upstream developments in North America. He also serves as a advisor for the company's Macro Oils (Oil Price Outlook) service.
- In prior roles, he led a U.S. upstream research team and was an upstream consultant. Mr. Dukes still contributes to Woodmac's consulting practice and has participated in projects that account for billions in upstream transactions. He has led and been involved in projects ranging from asset opportunity screenings, third-party valuations, due diligence, and strategic reviews.
- He is regularly interviewed and quoted by major news outlets – Chron, WSJ, FT, Bloomberg, etc.
- Prior to Wood Mackenzie, R.T. led a company investing in oil and gas working interests and royalties.
- Mr. Dukes graduated Cum Laude from Texas A&M University with a bachelors degree in accounting and a masters degree in finance. He currently serves on the Former Student Advisory Board for the Professional Program in Accounting.

Benjamin Shattuck

Principal Analyst – Lower 48 Upstream Research

T +1 713 470 1811

E benjamin.shattuck@woodmac.com

- Benjamin works as an analyst on the Lower 48 team at Wood Mackenzie. His responsibilities include developing asset valuations, analysing corporate landscape, forecasting expenditures and production, and consulting. His work within the Permian includes pulling the plays apart at a sub-play level and providing granular reports detailing the landscape of the region.
- Benjamin earned a Bachelors Degree in International Business from Northwest Missouri State University. He also holds an MBA and Masters in Petroleum Economics from the University of Oklahoma and French Institute of Petroleum. While studying in at the petroleum institute he focused on modelling global upstream fiscal regimes and project evaluation.

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Andrew Shepard

Research Analyst – Refining and Oil Markets

T +1 713 468 1911

E andrew.shepard@woodmac.com

- Andrew Shepard is an analyst for Wood Mackenzie's Refining and Oil Markets team. He is responsible for developing analysis on crude oil and refined product markets in North America on a short and long-term basis. Additionally, he has supported clients on a number of bespoke consulting studies including transaction support and market analysis. Andrew graduated summa cum laude from Texas State University with a BBA in Economics.
- Andrew graduated summa cum laude from Texas State University with a BBA in Economics and a minor in Mathematics.

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Kristy Kramer

Principal – Americas Gas and Power

T +1 713 470 1883

E kristy.kramer@woodmac.com

- Kristy Kramer joined Wood Mackenzie as a Principal in 2016, focusing on delivering gas, power, and LNG consultancy engagements. Kristy has been involved in helping clients determine and evaluate midstream investment opportunities, design portfolio strategy, and understand associated market responses.
- Prior to Wood Mackenzie, Kristy worked eight years at ExxonMobil, on portfolio optimization, strategy analysis and design, and operational transactions. She has experience in the flowing gas, LNG, and exploration businesses and with key joint venture partners in the Americas, Middle East, and Africa.
- Kristy holds an MBA from the Olin Business School at Washington University in St. Louis and a degree in Mechanical Engineering (magna cum laude) from Washington University in St. Louis.

Simon Flowers

Chairman, Energy and Chief Analyst Wood Mackenzie

T +44 131 243 4312

E simon.flowers@woodmac.com

- Simon Flowers was appointed Chairman, Energy for Wood Mackenzie in April 2016. He has led the commodities, global trends and corporate analysis research over the last few years and has been Chief Analyst since July 2015. He re-joined Wood Mackenzie in 2010, and has over 20 years of experience in the oil, gas, utilities and mining sectors, working with the boards of many energy companies on strategic issues. His views on major industry issues are regularly sought by the media in Europe, the US and Asia.
- Simon was MD and Head of Pan European Utilities Research with Bank of America Merrill Lynch from 1998, covering the major European utilities. The team was in the Top 3 ranked in the sector for over a decade and Simon was involved in most of the major European privatisations in the sector during this period, including Enel, EdF and GdF.
- Simon was a No.1 ranked oil analyst with NatWest Markets from 1992 to 1998, covering the E&P and Gas sectors. Prior to joining NatWest, he had worked for Ord Minnett Securities in Sydney as an energy and mining analyst in the Australian market.
- Simon graduated in geology from the University of Edinburgh, and worked for two years as a geologist in the oil industry working in the Netherlands and offshore Egypt. Simon originally joined Wood Mackenzie in 1983 as an analyst in the North Sea and NW Europe Services.

Pablo Medina

Senior Analyst, Latin America Upstream Research

T +1 713 470 1891

E pablo.medina@woodmac.com

- Pablo joined Wood Mackenzie in 2012 as part of the Latin America Upstream Research team. Pablo focuses mostly on Mexico, Argentina and Brazil. Within his role, Pablo is responsible for valuing upstream assets in the region as well as following the energy markets, fiscal regimes and developments in the region.
- He has presented about the Mexican Energy Reform to numerous audiences and frequently shares his views with the international media, including writing for Wood Mackenzie's Forbes blog.
- Pablo is a member of COMEXI, the Mexican Council on Foreign Relations. He is also part of the Energy Workgroup within COMEXI. The group published the report "Mexico and the Energy Revolution", which was quoted in President Peña Nieto's energy reform proposal.
- He is also a member of the University of Southern California's US-Mexico Network, the Atlantic Dialogues Emerging Leaders Program, the Argentina Institute of O&G and the Gas Mexico Forum Technical Committee.
- Pablo holds an Economics degree (BA) from the University of Texas – Austin.

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Greg Hopper

Vice President and Head of Americas Gas & Power Consulting

T +1 713 470 1968

E greg.hopper@woodmac.com

- Greg Hopper is Vice President and Head of Americas Gas & Power Consulting at Wood Mackenzie, Inc. He has primary responsibility for the client engagement and business development. Mr. Hopper is an expert in wholesale energy market matters, with emphasis on North American natural gas midstream and global LNG markets. He advises clients on strategy, transactions and investments, regulatory policy, portfolio development, contract negotiations, asset valuation, market analyses, and price forecasting.
- Prior to Wood Mackenzie, Mr. Hopper was Vice President of ICF International where he lead the company's Oil & Gas advisory group and was director of the Houston office. Her was also Managing Director of Natural Gas and Power Fuels at Black & Veatch Management Consulting, and a founding partner and Vice President of Lukens Energy Group, an energy consulting partnership which became part of Black & Veatch in 2005.
- Mr. Hopper began his energy career in investment banking before joining Williams Gas Pipelines where he led and managed investments in natural gas midstream assets, and the strategic and financial evaluation of acquisitions and joint ventures to leverage the company's entry into new markets.

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Gordon Loy

Research Analyst – Deepwater Gulf of Mexico Upstream Research

T +1 713 470 1817

E gordon.loy@woodmac.com

- Gordon Loy is currently a Research Analyst working on the Deepwater Gulf of Mexico Upstream Research team. He develops asset valuations, assists with consulting projects, and authors ad-hoc reports on regional trends. Previous areas of focus have consisted of play level economics and well performance.
- Gordon graduated from the University of Texas – Austin with a B.S. in Mathematics.

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Jonathan Garrett

Principal Analyst – Lower 48 Upstream Research

T +1 713 470 1685

E Jonathan.Garrett@woodmac.com

- Jonathan currently works on the US Lower 48 Upstream Research team, focusing on the Rocky Mountains and Northeast regions. Jonathan specializes in decline curve analysis, economic modelling, and onshore asset valuation. Recent work includes studying Bakken operator activity, production trends, crude export capacity and enhanced completions.
- Prior to joining Wood Mackenzie, Jonathan worked for Schlumberger, both as an offshore field engineer and in completions product development. Jonathan's work mainly focused on reservoir monitoring and control.
- Jonathan holds MSE and BSE degrees in Industrial and Operations Engineering from the University of Michigan.

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Jen Snyder

Senior Vice President Natural Gas

T +44 (0)123 456 7890

E jen.snyder@woodmac.com

- Directed the launch of Wood Mackenzie's North American gas service in 2003; current member of EPRI's Advisory Council Executive Committee.
- 20 years of experience analyzing the North American gas industry, including stints at CERA and National Economic Research Associates, Inc.
- Holds a BS from the Massachusetts Institute of Technology and an MA from the University of Pennsylvania.

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A Verisk Analytics Business

Clay Lightfoot

Research Analyst – US Lower 48

T +1 713 470 1912

E clay.lightfoot@woodmac.com

- Clay is a Research Analyst in Wood Mackenzie's US Lower 48 research team. His research is currently concentrated on the Gulf Coast region with a focus on the Haynesville, Eagle Ford and Barnett shales.
- Prior to joining Wood Mackenzie in January 2015, Clay worked for Hess Corporation in New York City and in the US Senate, focusing on energy policy.
- Clay graduated from Texas Christian University in 2007 and received an MBA from the University of Oklahoma in 2014.

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Wood Mackenzie
A Verisk Analytics Business

Europe	+44 131 243 4400
Americas	+1 713 470 1600
Asia Pacific	+65 6518 0800
Email	contactus@woodmac.com
Website	www.woodmac.com

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