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BERNSTEIN

North America Oil & Gas Exploration & Production

Energy (Oil & Gas) Market Dynamics: Investments, Trading and Price Interactions

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North American Oil & Gas Exploration & Production team

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Bob Brackett is the Senior Research Analyst covering **North American Oil & Gas Exploration & Production**. He is currently recognized as All-American #1 by Institutional Investor (for the 5th year in a row). Previously, Bob was Director of E&P Planning and also Director of Corporate Strategy for Hess Corporation. Before Hess, Bob was an Engagement Manager with McKinsey & Company's Petroleum Practice, serving the majority of the world's largest oil companies across five continents and 30 countries throughout the petroleum value chain. Bob began his career with ExxonMobil, spending eight years in positions in Exploration, Business Development, Development and Research. As a NASA Space Grant Fellow, Bob received his PhD in Earth & Planetary Sciences from Washington University – St. Louis. He received his MBA from Rice University in Houston. He also holds a BS in Geophysics and a BA in Astronomy from the University of Texas.

Key points

Why US oil supply response matters so much

Global supply (outside of 3 countries) isn't growing

How do E&Ps think about funding

Cash in ~ cash out (except when greedy or scared)

How E&Ps won the shale war

Our forecast of US supply

Oil price, reinvestment rate, inflation, and well efficiencies drive result

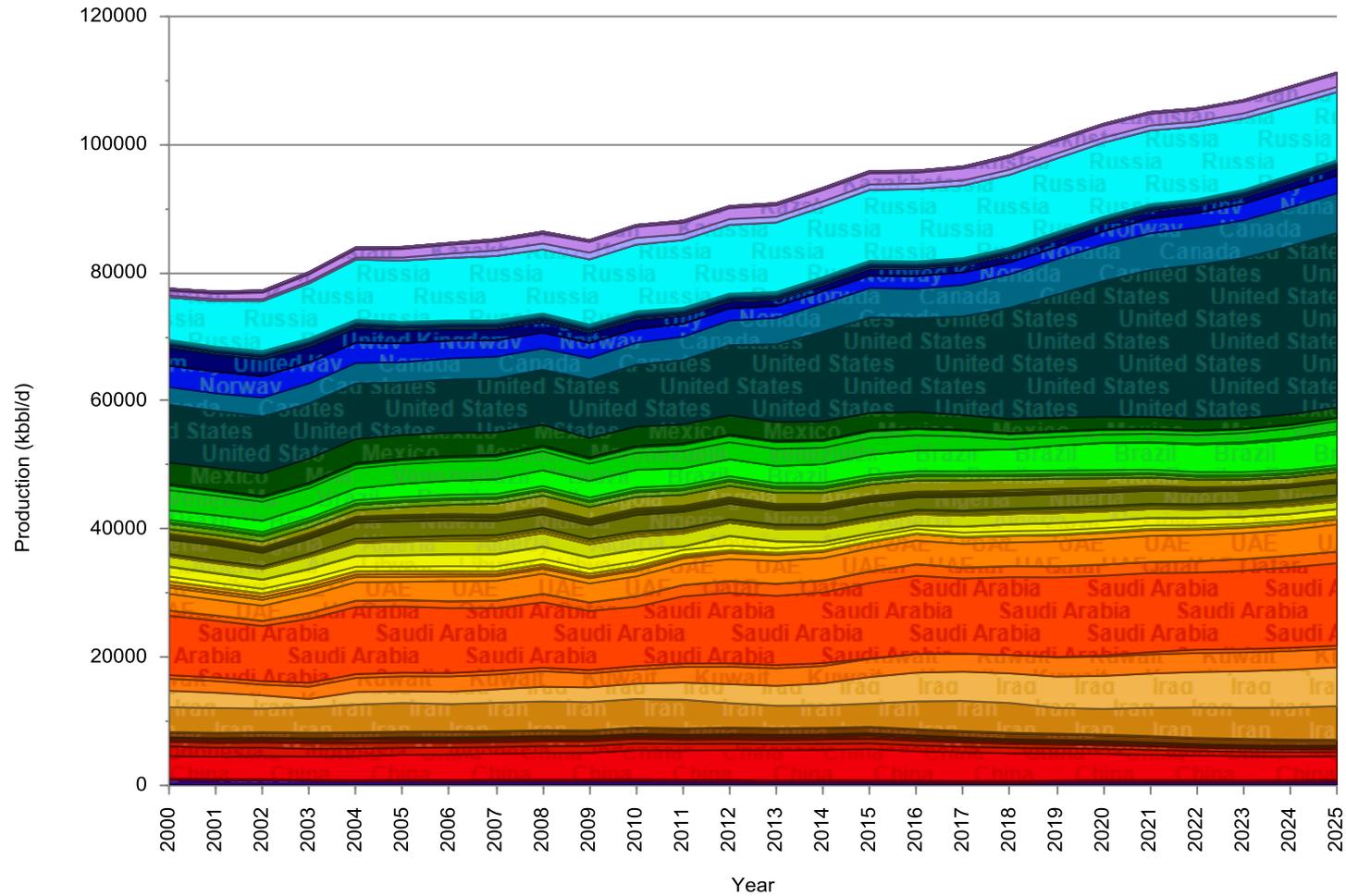
Why the “predator prey” model is so important

Lotka-Volterra equation

Midstream the current investment gating factor

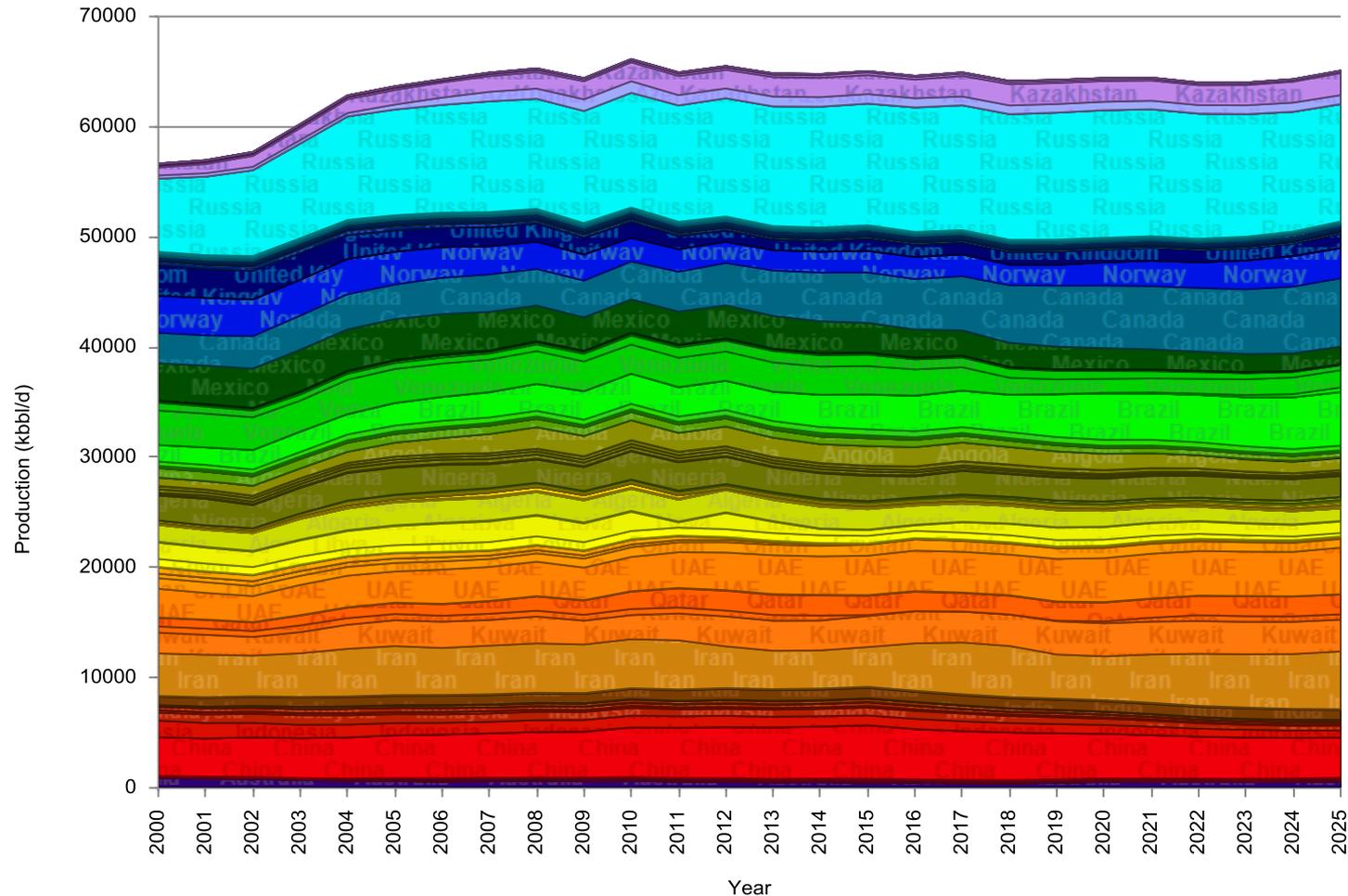
Natural gas falls prey to oil market and lack of demand

Remember – oil supply isn't growing if we strip out US, Saudi Arabia, and Iraq



Source: Rystad Energy UCube

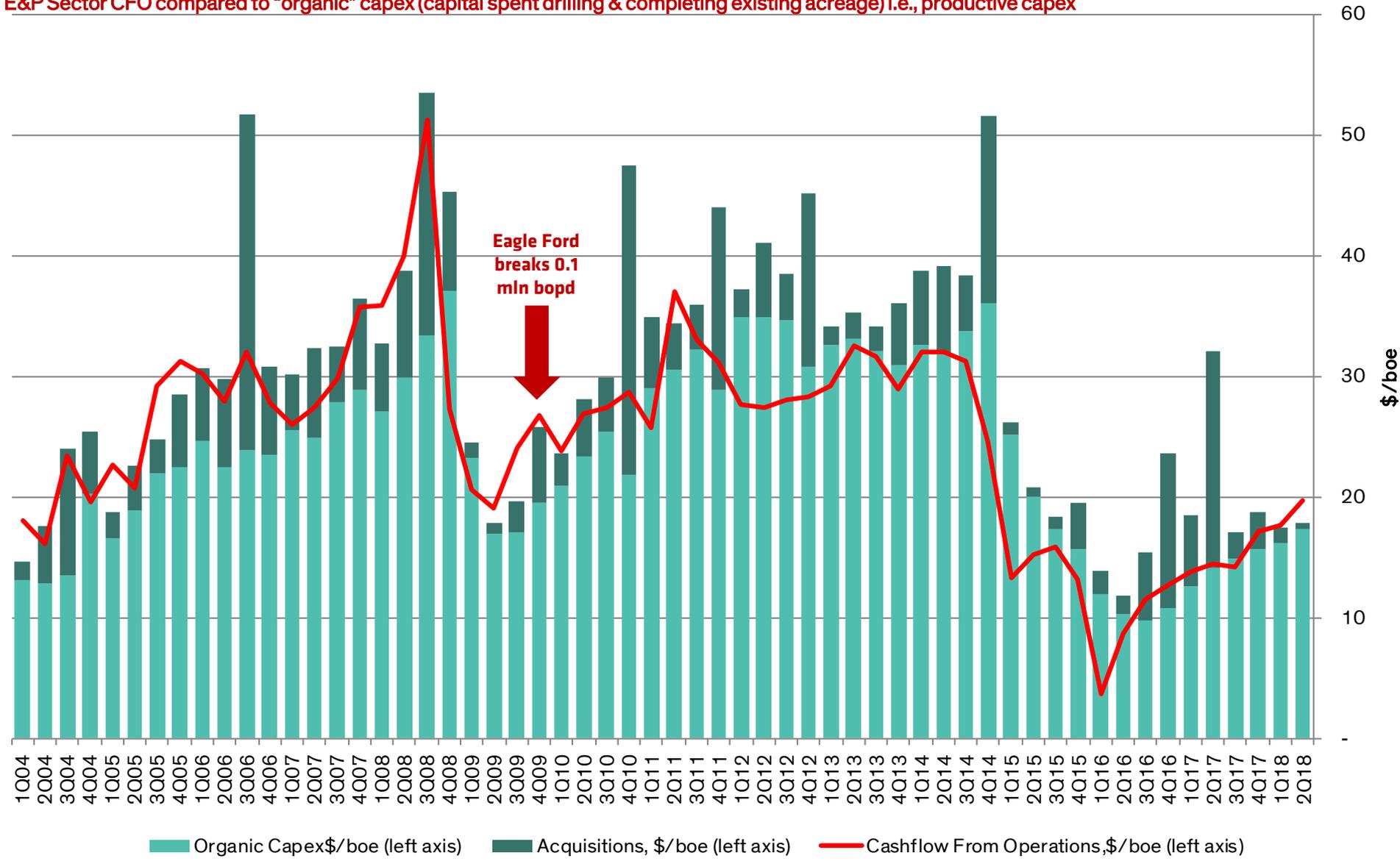
Remember – oil supply isn't growing if we strip out US, Saudi Arabia, and Iraq (and Saudi Arabia and Iraq follow different 'feedback' rules)



Source: Rystad Energy UCube

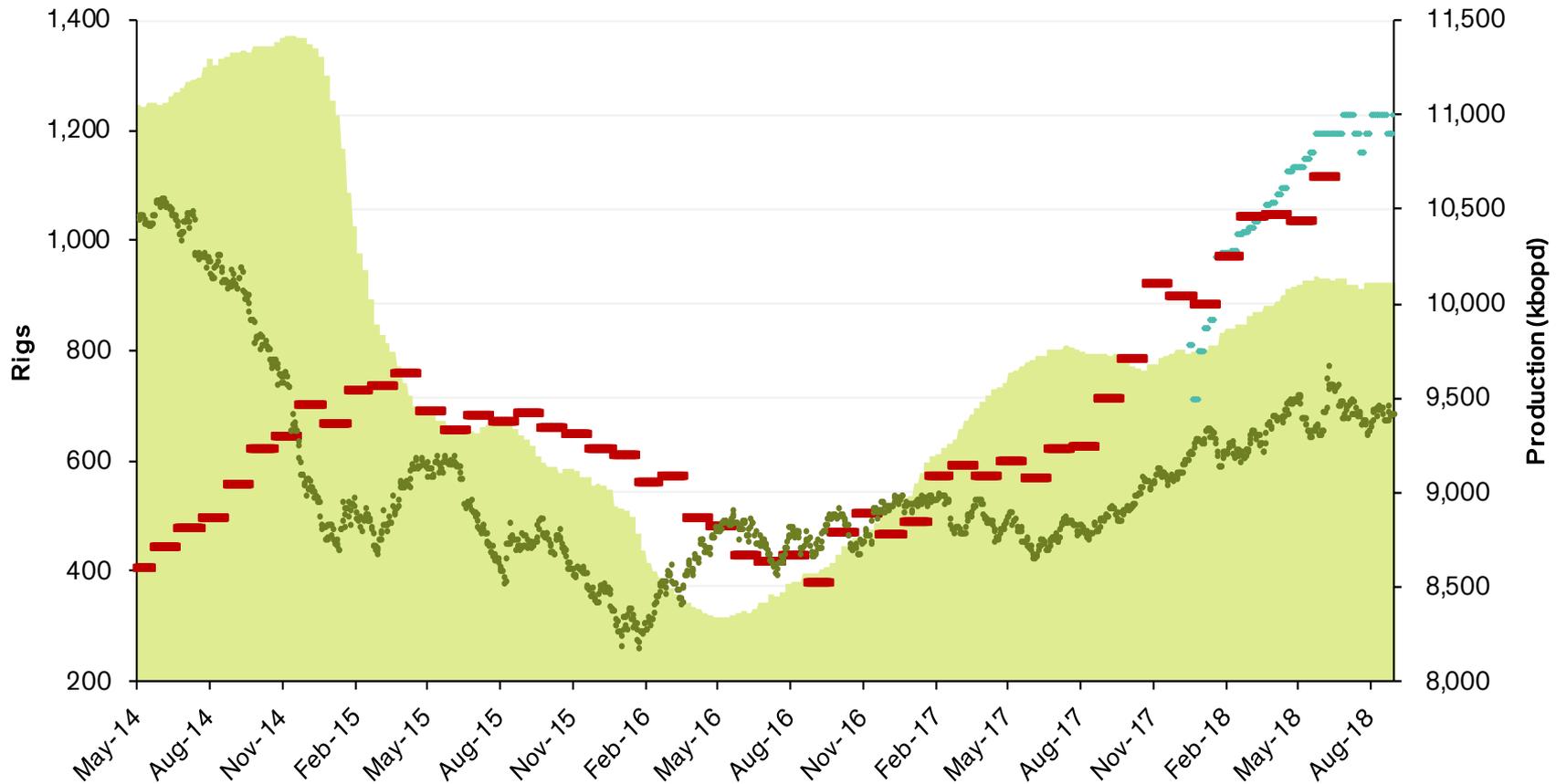
Shale Era Business Model: Cash In ~ Cash Out (except when greedy or scared...)

E&P Sector CFO compared to "organic" capex (capital spent drilling & completing existing acreage) i.e., productive capex



Price → cash flow → capital plan updates → rig count → production

EIA Weekly Production Estimates and Actual Monthly Data (with rig count and WTI)

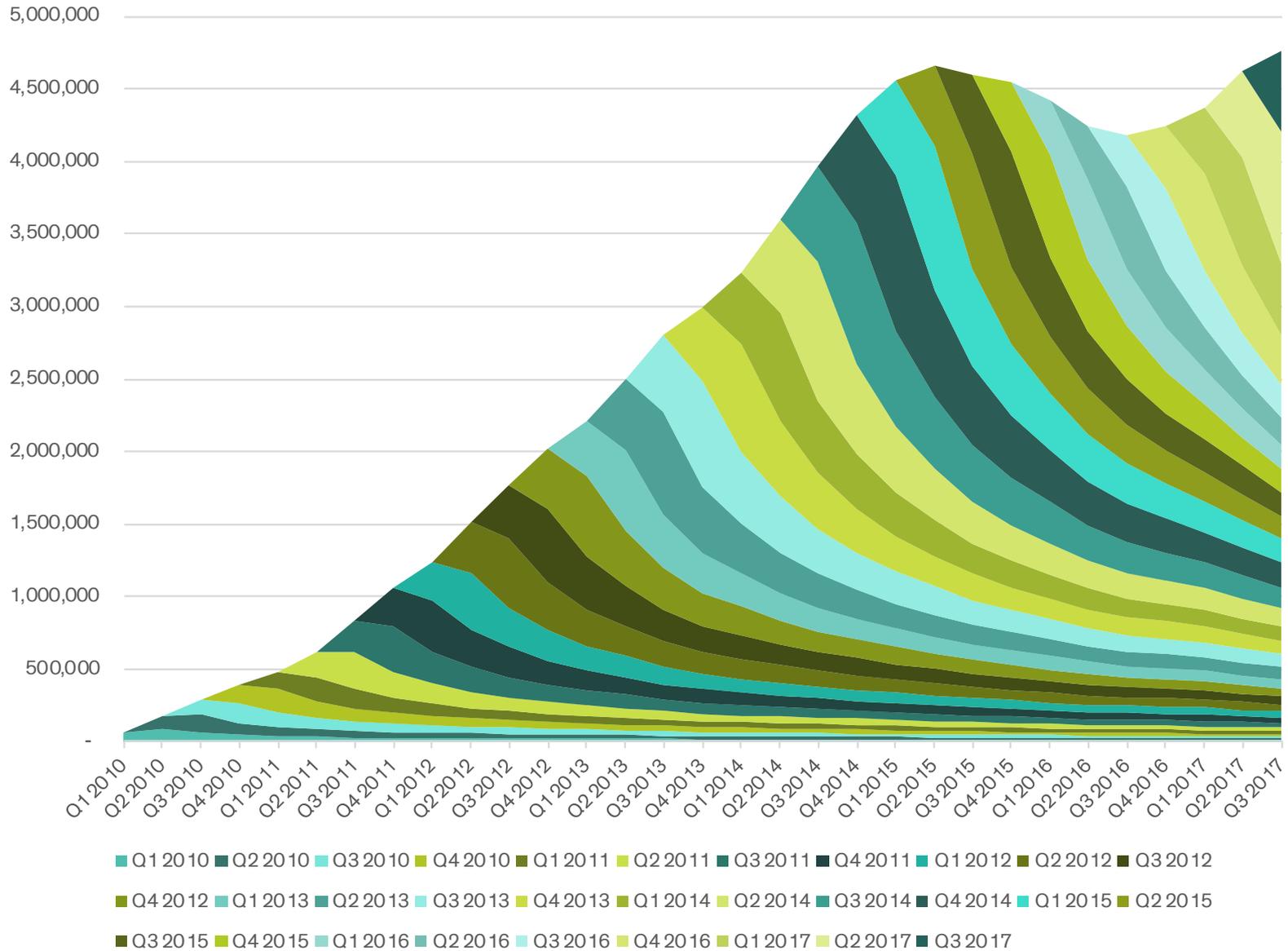


■ BHI Hz US Rig Count [LHS] ● Weekly Estimates [RHS] ■ Monthly Actuals [RHS] ● Oil Price (x10) [LHS]



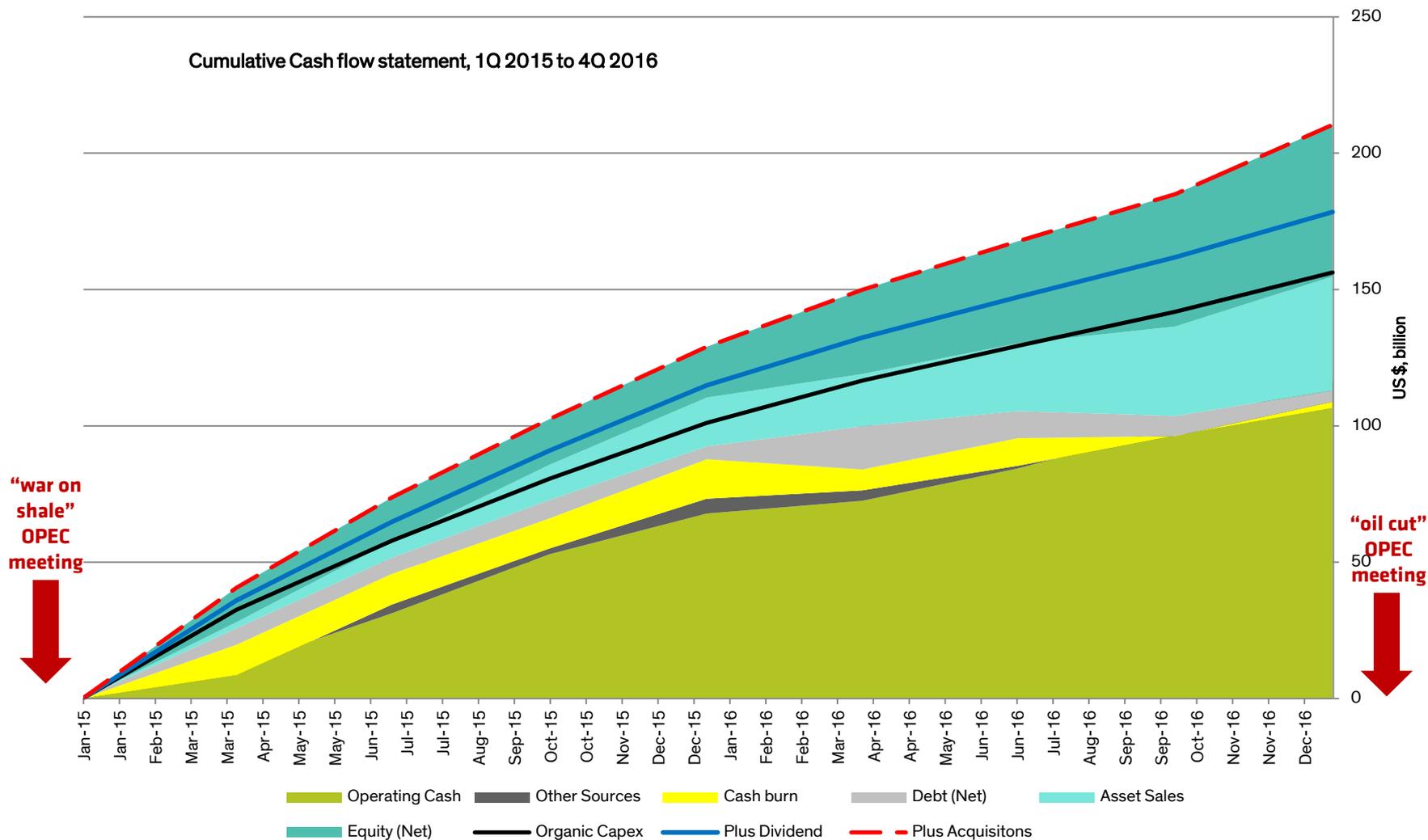
Lion's share of CFO goes to capex to create a quarterly wedge...

Shale Contribution by Quarter (bopd)

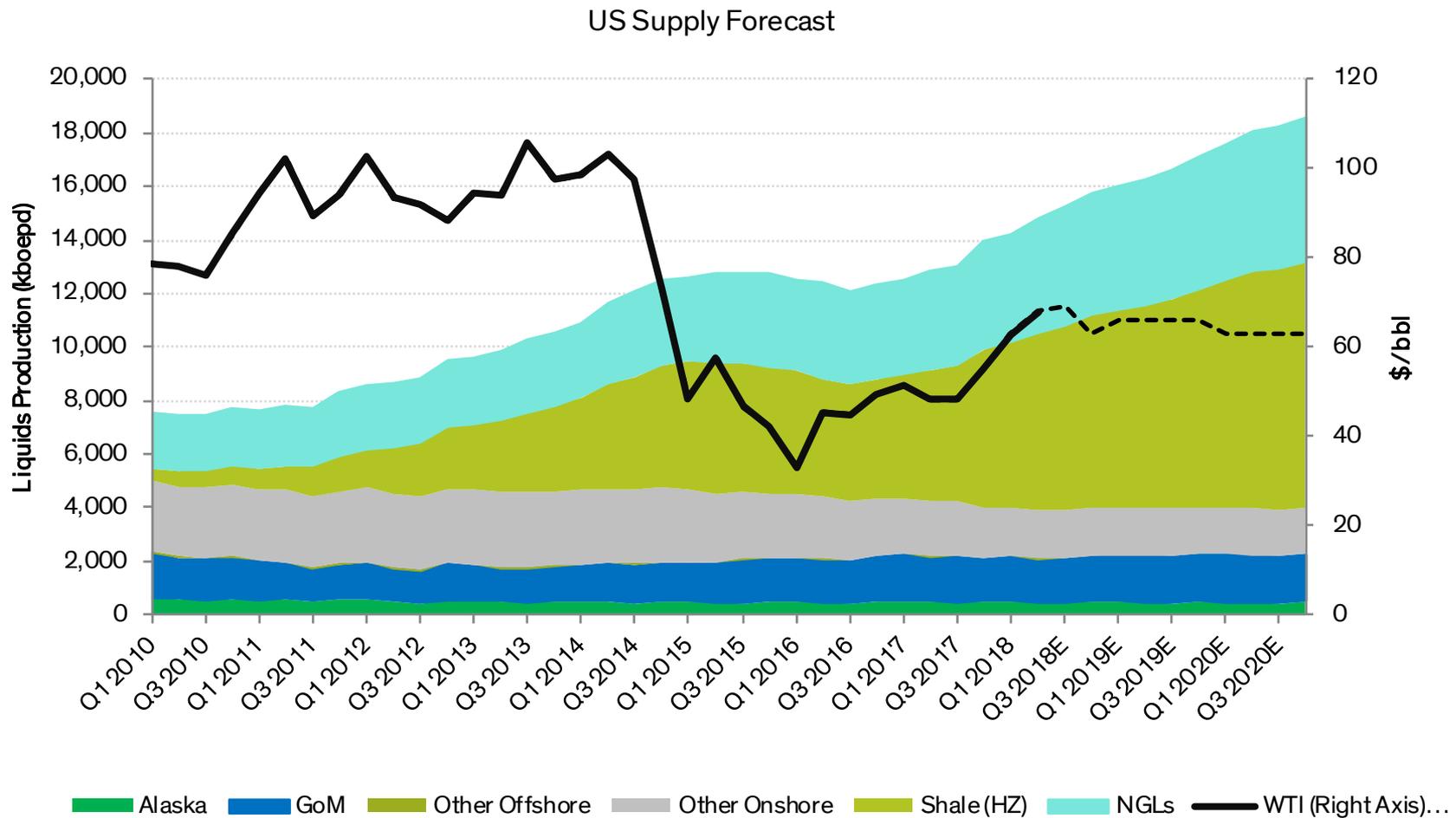


How E&Ps won the shale war...

...same way we won the revolutionary war...with help

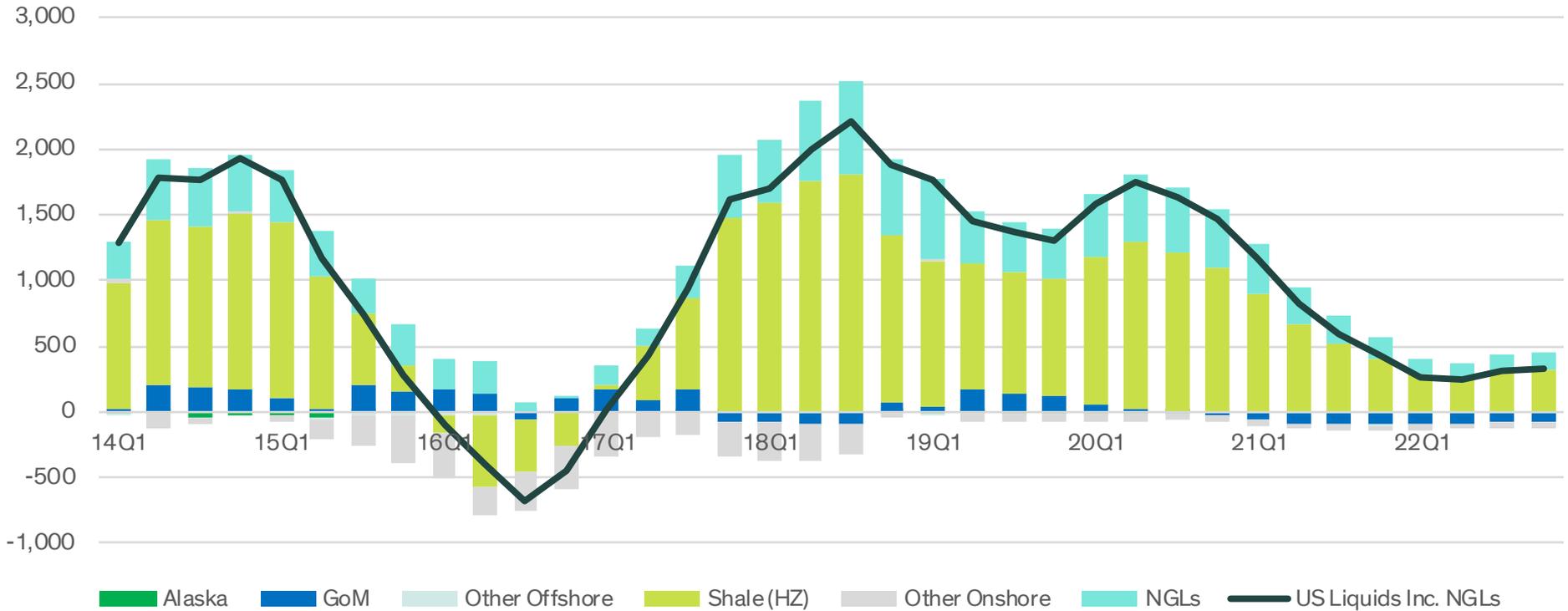


Our forecast of US liquids volumes

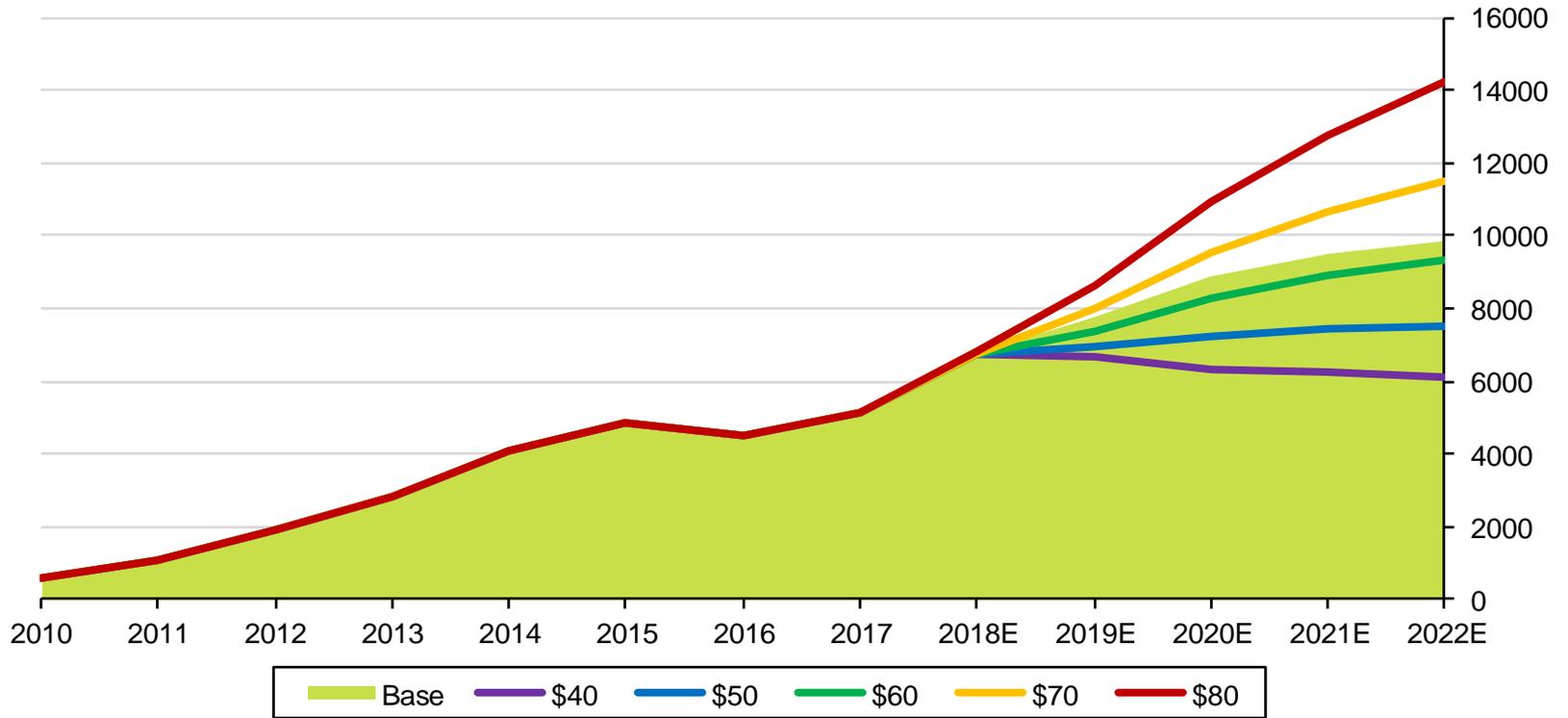


Our forecast of US liquids growth...oil price, reinvestment rate, inflation, and well efficiencies drive result

US Total Oil & NGL Supply - Yearly Change

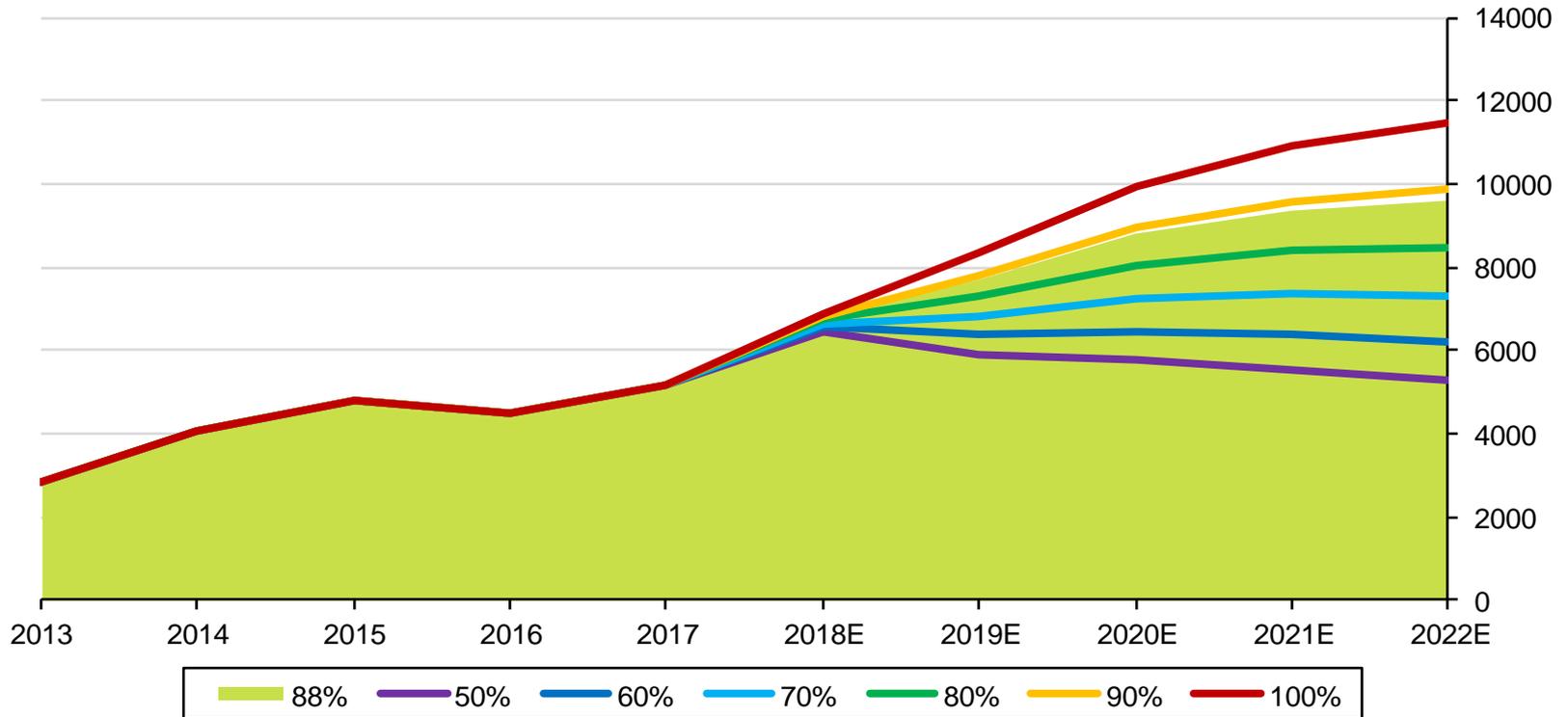


Shale Production Sensitivity to Oil Price



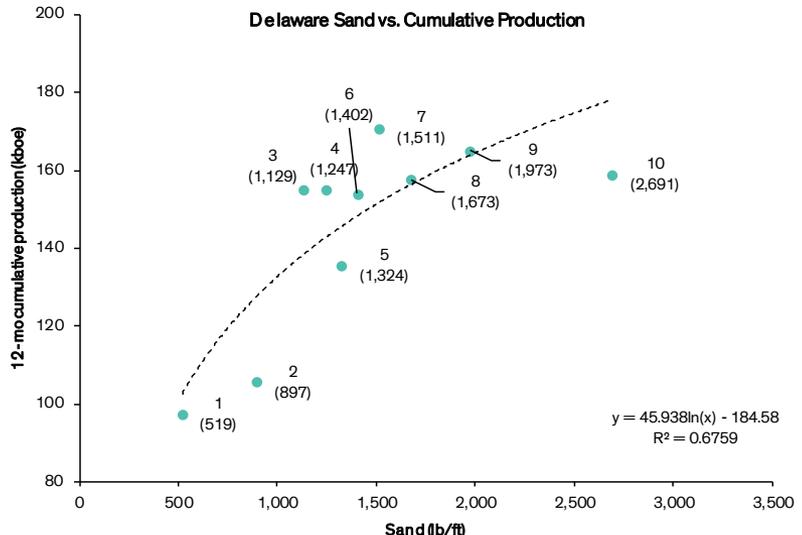
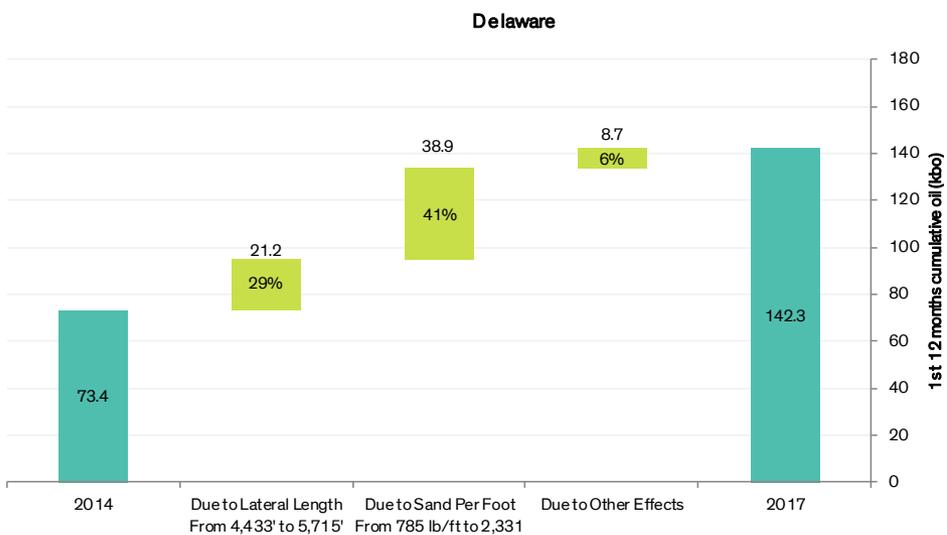
Impact of reinvestment rate

Shale Production Sensitivity to Reinvestment of CFO

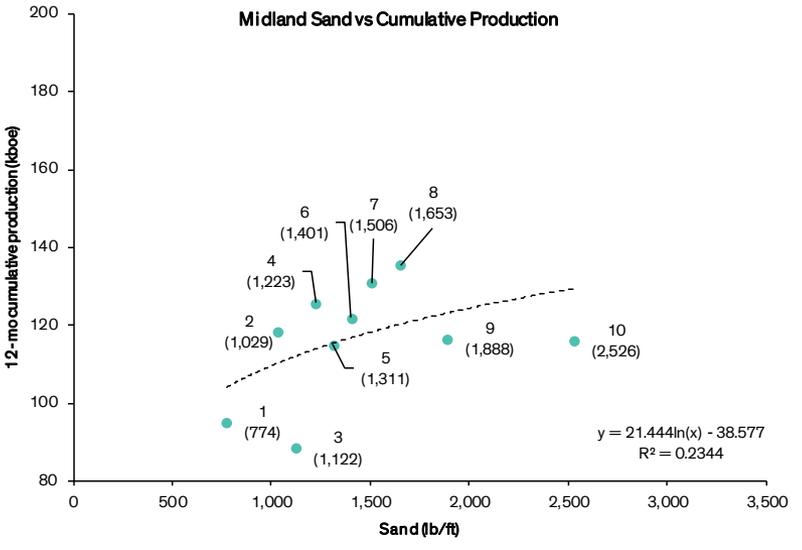
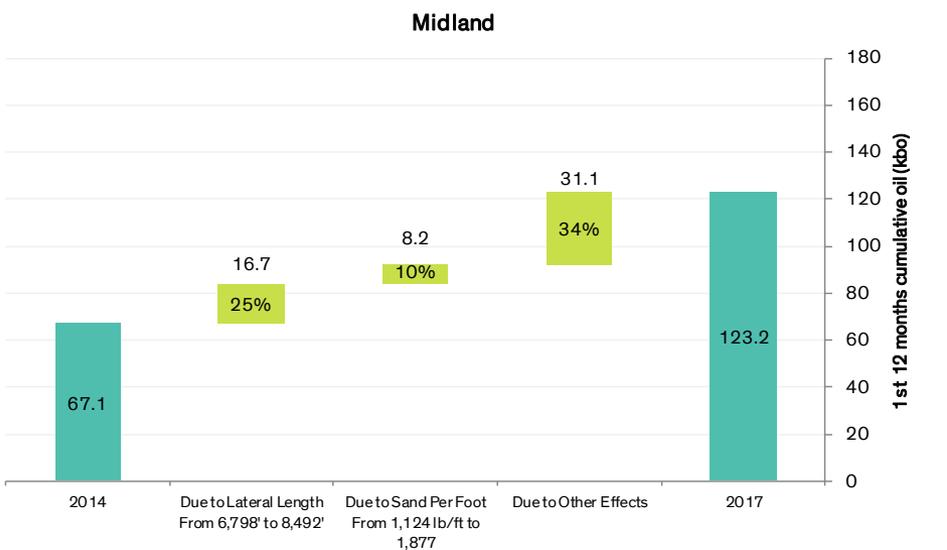


What drove productivity...the Permian example

Productivity has increased in the Delaware largely due to rapid sand/ft increase (and lateral length)

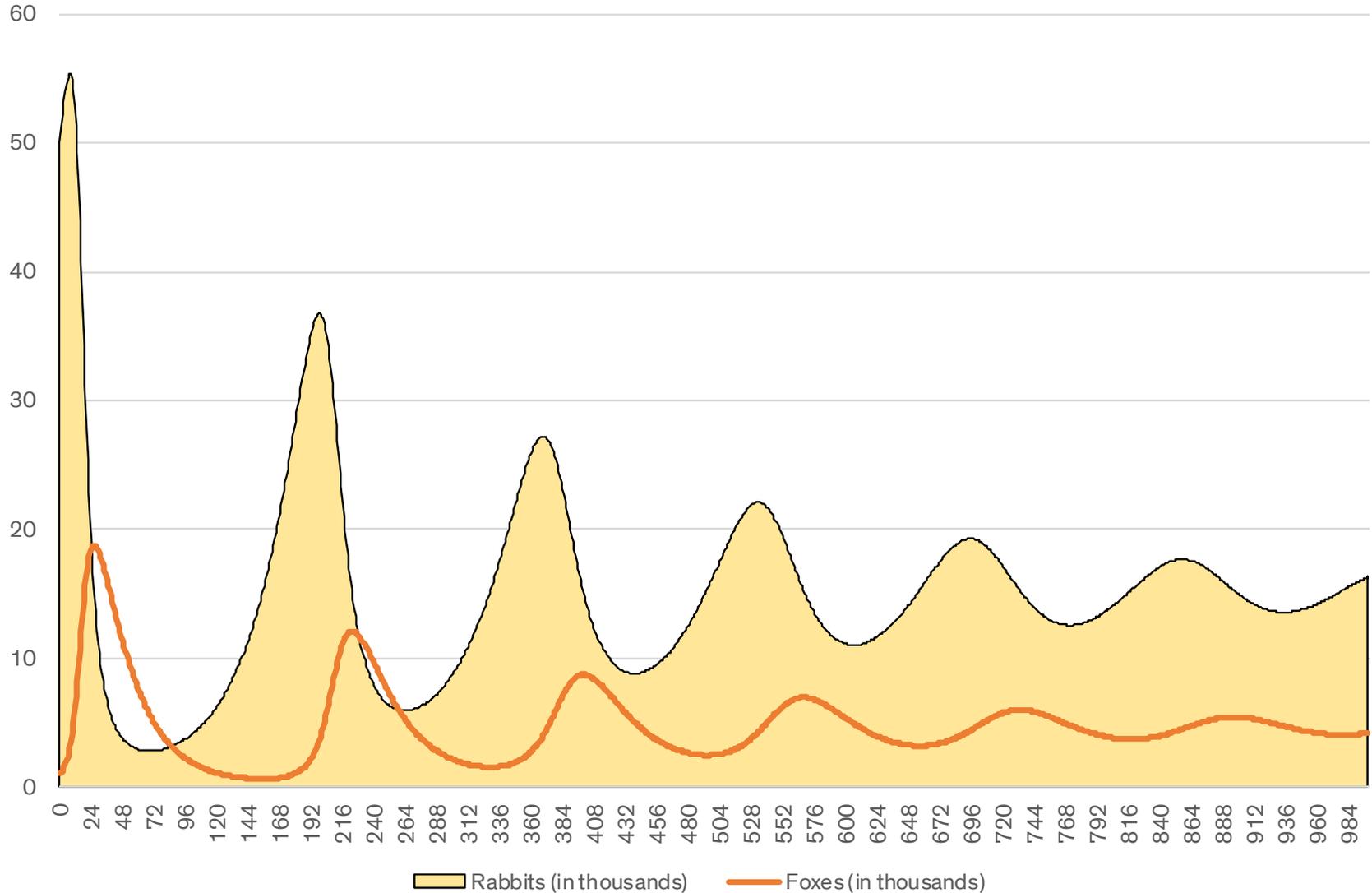


Productivity increases in the Midland were more dominated by other effects (as lateral length and sand count already high years ago)



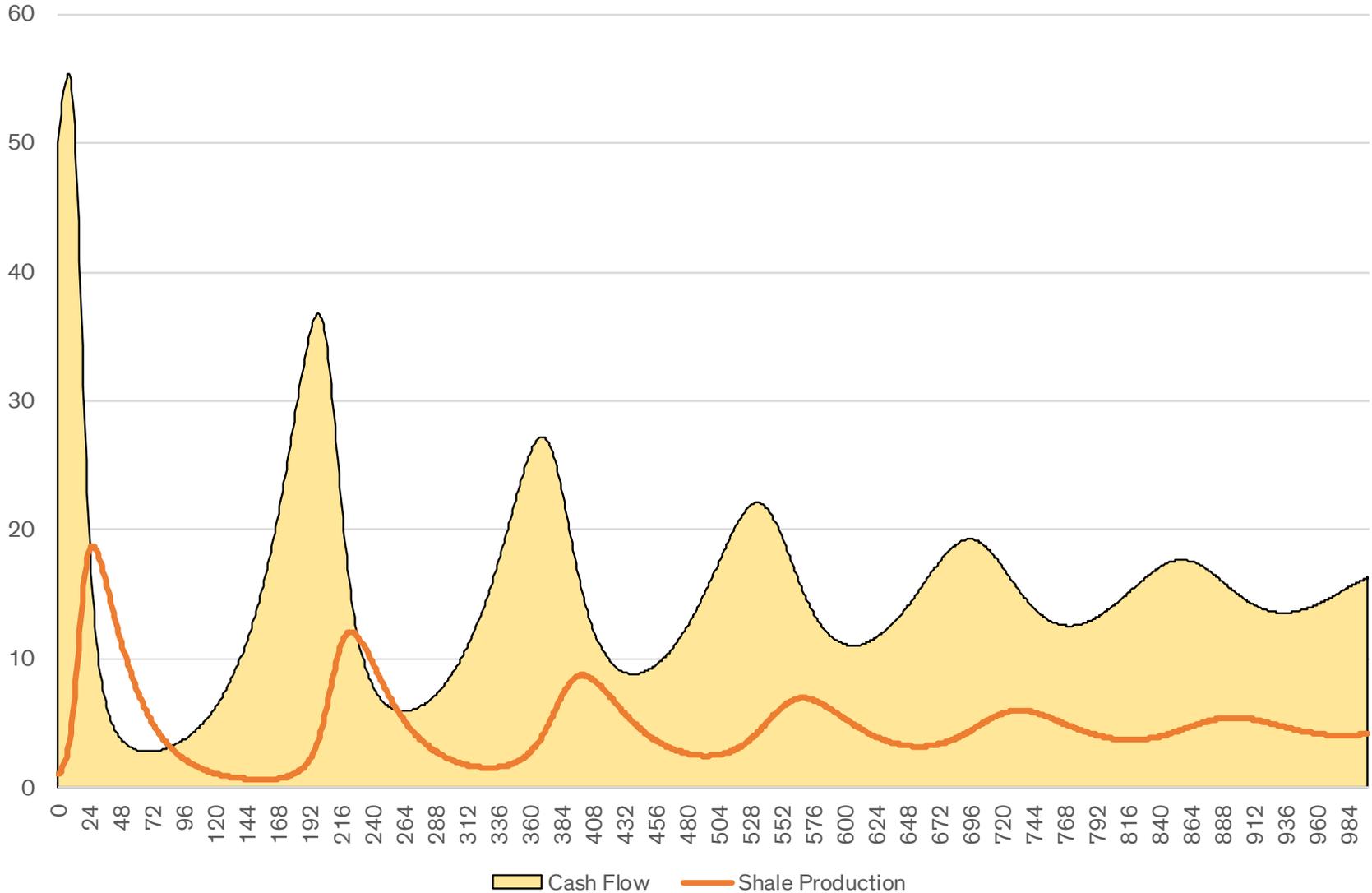
Lotka-Volterra (1st order nonlinear differential equations describing biologic systems)

Predator-Prey Model (Lotka-Volterra)



Shale is not a thermostat - it induces waves (and needs culling!)

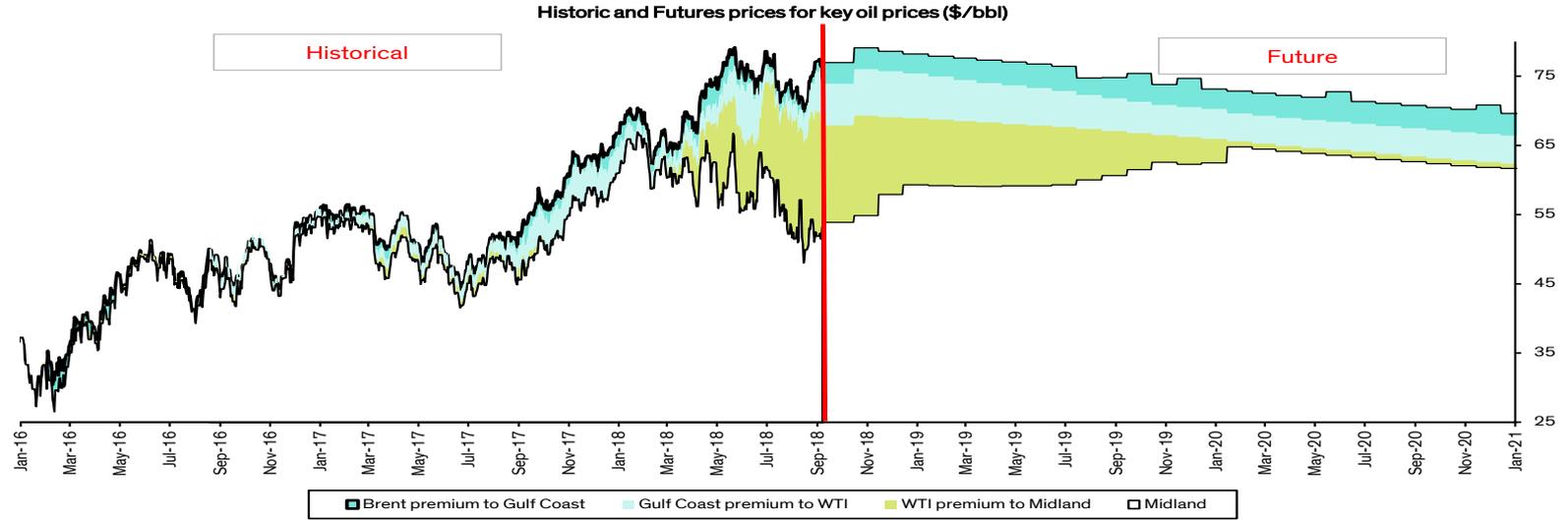
Predator-Prey Model (Lotka-Volterra)



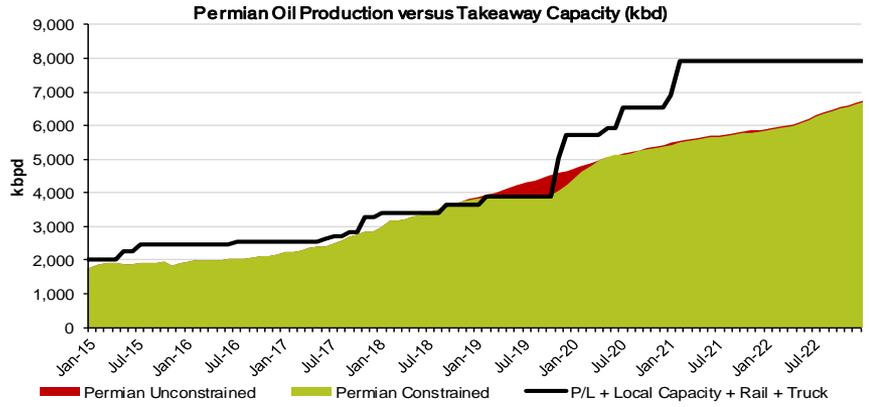
... "equilibrium price" is not a static equilibrium

Midstream investment (not upstream) is gating factor for now

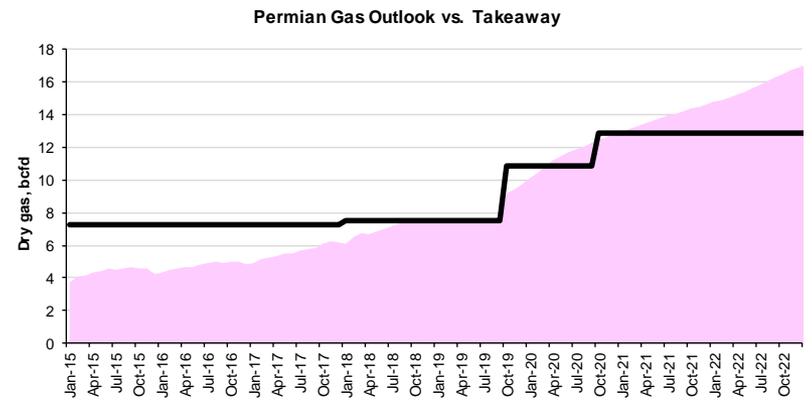
The Midland – WTI differential currently sits around $-\$15/\text{bbl}$ and is expected to remain wide until pipelines come online in 2019



Black line below shows takeaway...the Permian would 'like' to grow faster than takeaway next year (but can't). The red area shows 'the lost barrels' which peak at 0.5 mln bopd...the green line is our forecast with constraints (note that constraints involve both volume and also pricing – higher differentials)

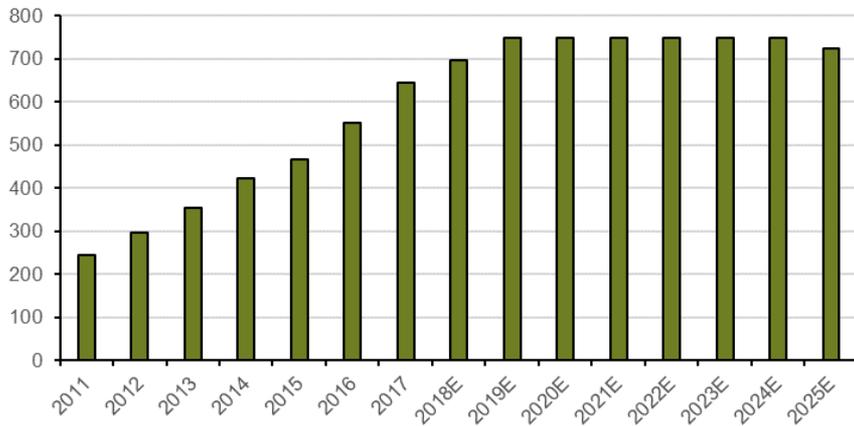


In our model, Permian gas doesn't fill pipes right away, but by 2021 needs more pipes

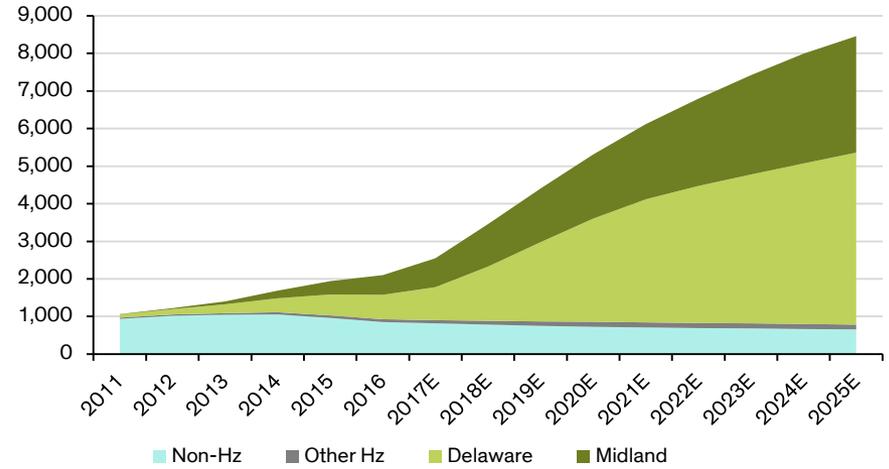


Permian wells keep getting better....this brings an astounding amount of gas byproduct

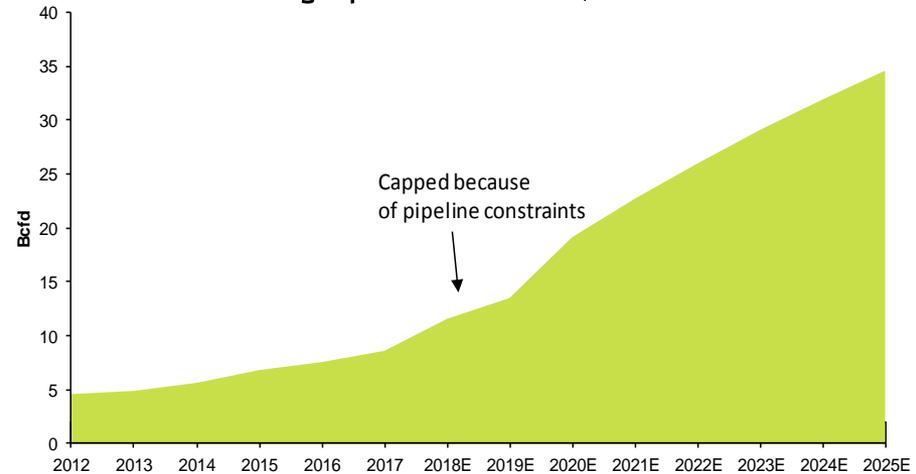
Del Oil Initial Production rate (bopd)



Permian Basin Oil Production (kbopd)

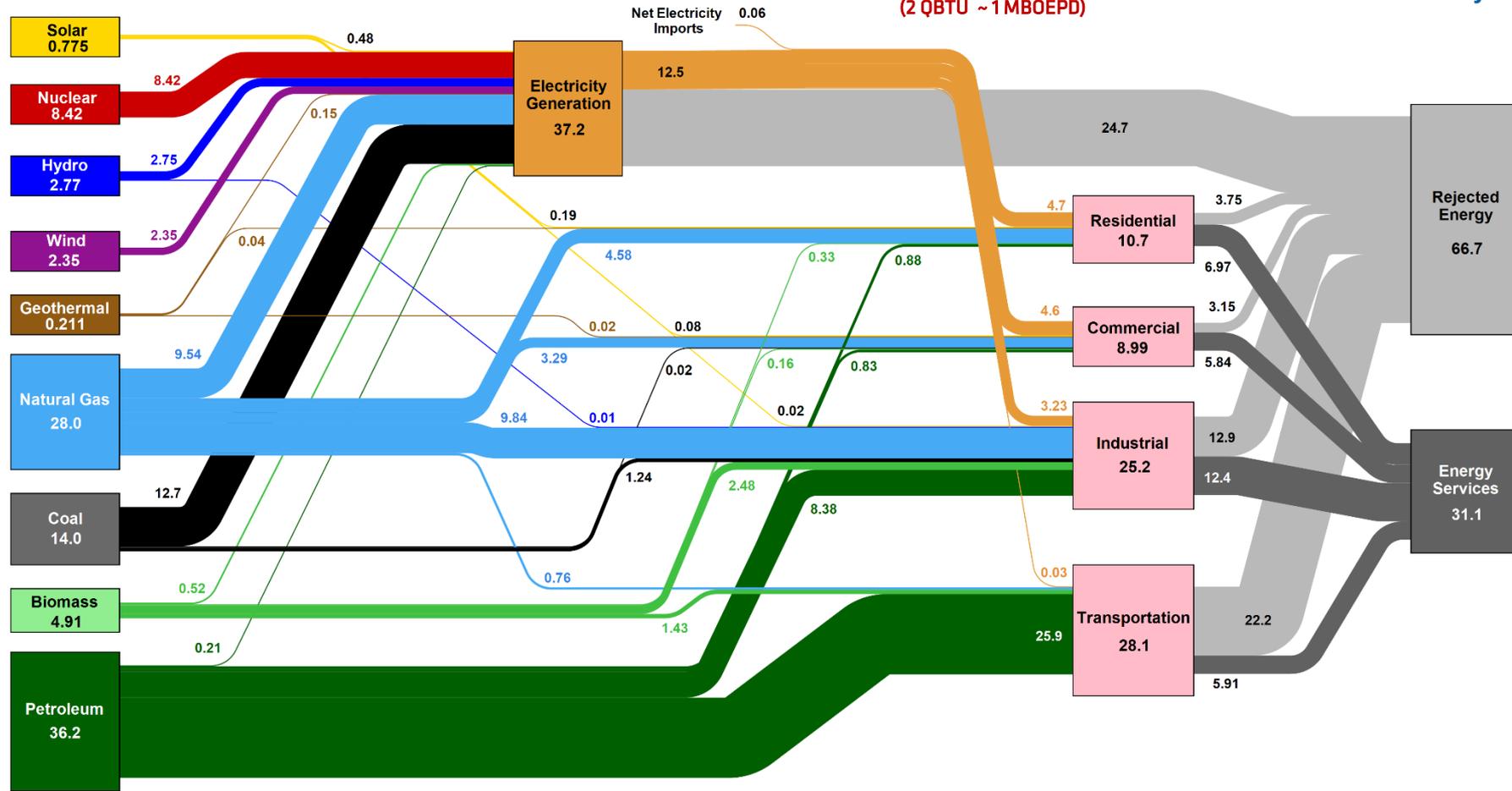


Permian gas production outlook, bcfd



Future gas demand driven by U.S. energy chessboard

Estimated U.S. Energy Consumption in 2017: 97.7 Quads

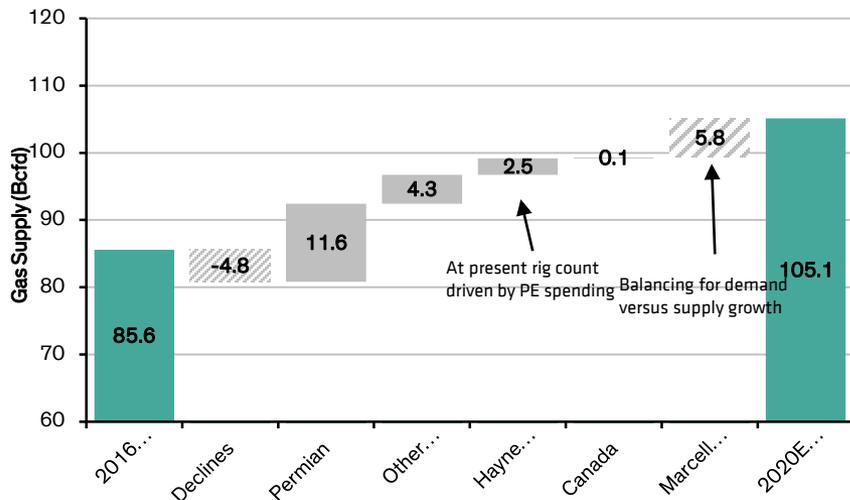


Source: LLNL April, 2018. Data is based on DOE/EIA MER (2017). If this information or a reproduction of it is used, credit must be given to the Lawrence Livermore National Laboratory and the Department of Energy, under whose auspices the work was performed. This chart was revised in 2017 to reflect changes made in mid-2016 to the Energy Information Administration's analysis methodology and reporting. The efficiency of electricity production is calculated as the total retail electricity delivered divided by the primary energy input into electricity generation. End use efficiency is estimated as 65% for the residential sector, 65% for the commercial sector, 21% for the transportation sector, and 49% for the industrial sector which was updated in 2017 to reflect DOE's analysis of manufacturing. Totals may not equal sum of components due to independent rounding. LLNL-MI-410527

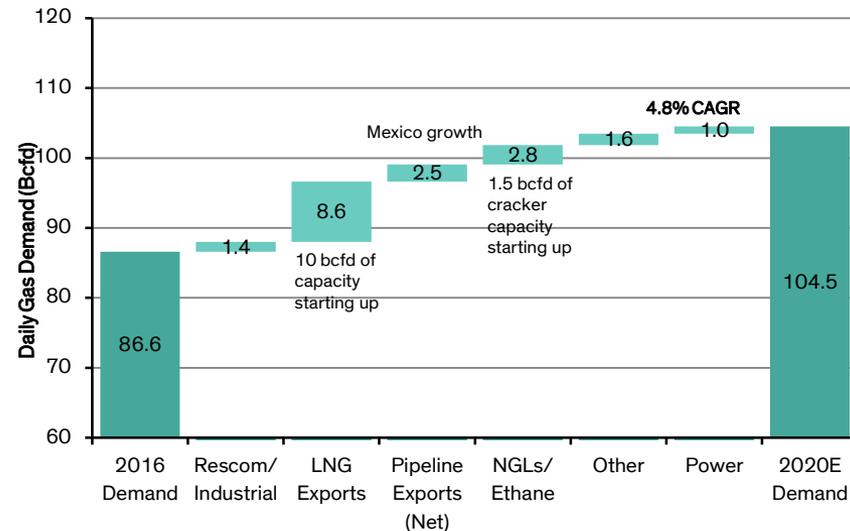


Natural gas supply / demand balance 2016-2020

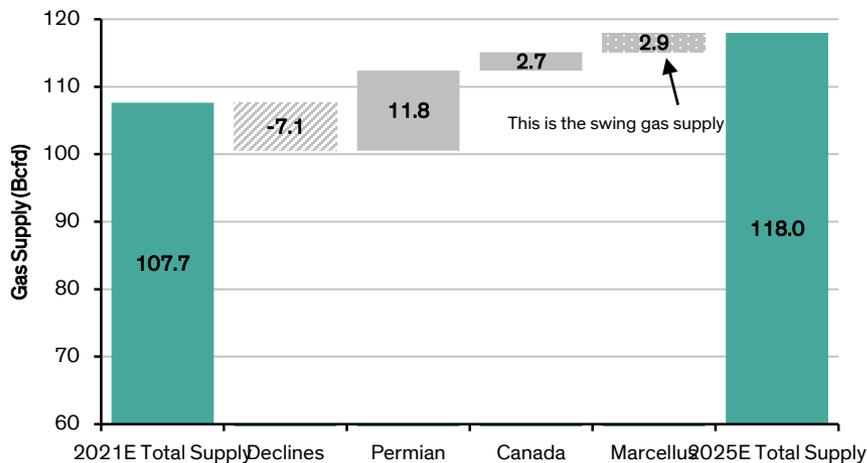
Supply Outlook to 2020: This healthy growth means that in addition to "free" associated gas, Haynesville and Marcellus growth are needed at the margin



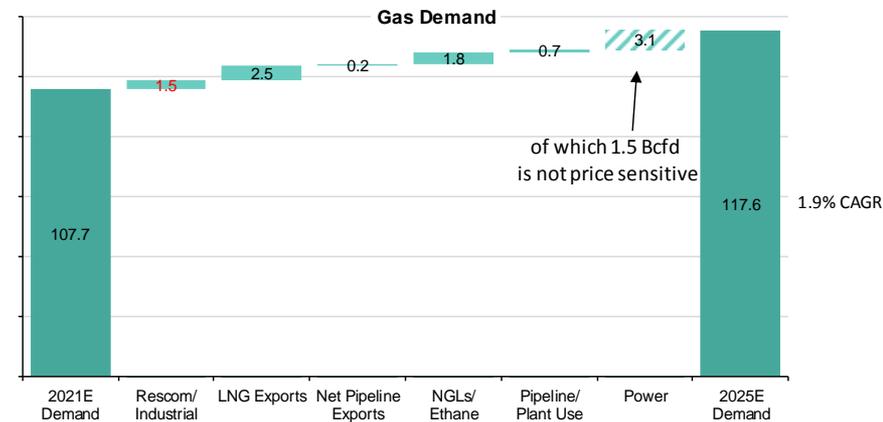
Natural Gas Demand Outlook to 2020: healthy growth, but led by LNG exports, Mexico exports, and ethane crackers



Natural Gas Supply Outlook 2021-25: Associated gas can meet almost all of this supply, with minimal growth required from the Marcellus



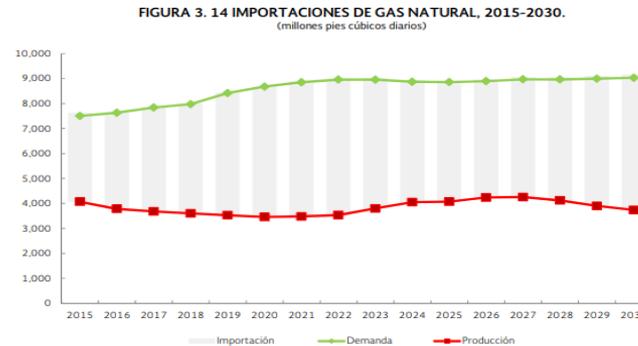
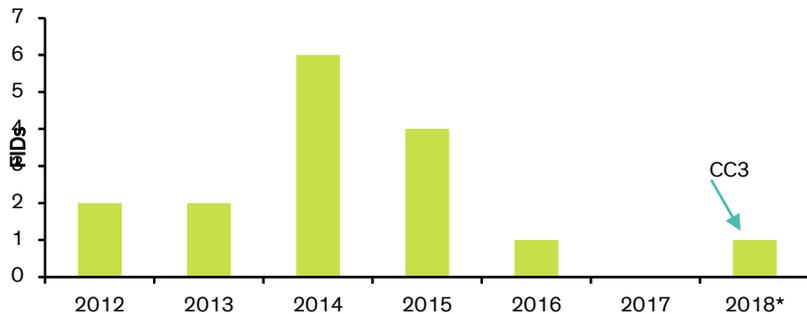
Natural Gas Demand Outlook 2021-25: demand profile slows as fewer LNG terminals are expected to be sanctioned & Mexico's gasification will be complete



Exports need LNG and Mexico...LNG waiting and Mexico full

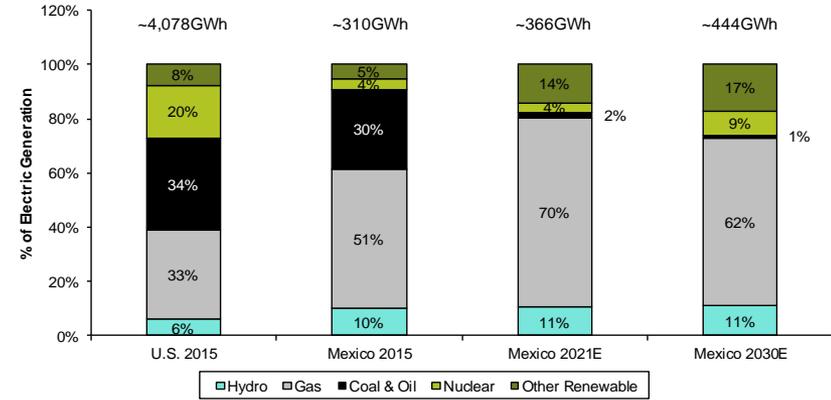
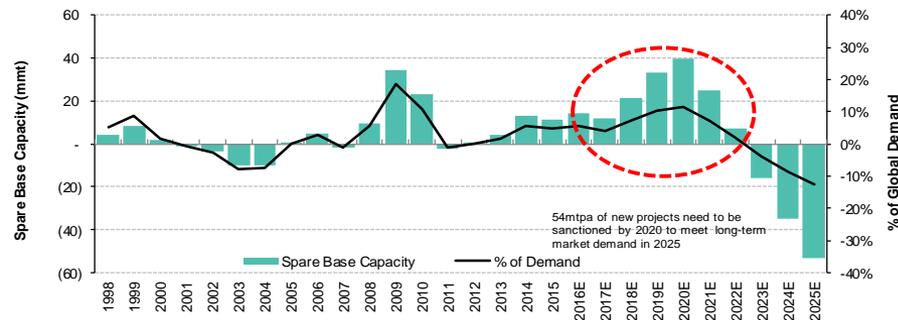
A wave of LNG FIDs in the US (and Australia) occurred from 2012-15, but they dried up after. It takes 4 years from FID to startup.

Mexican forecast suggests rising imports to 2020...then falling

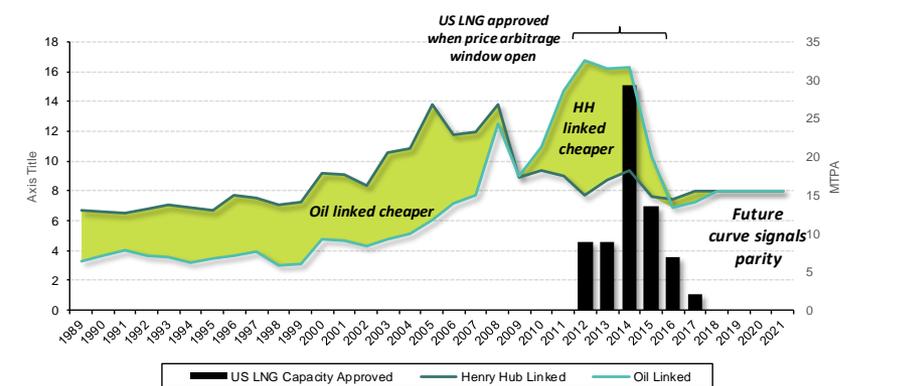


This is due to the oversupply that we see in the LNG market from 2019-22...but by 2023 we will need more

By 2021 gas will be as fully saturated into power demand as can be expected



Parity at the forward curve...but our deck suggests HH linked cheaper...

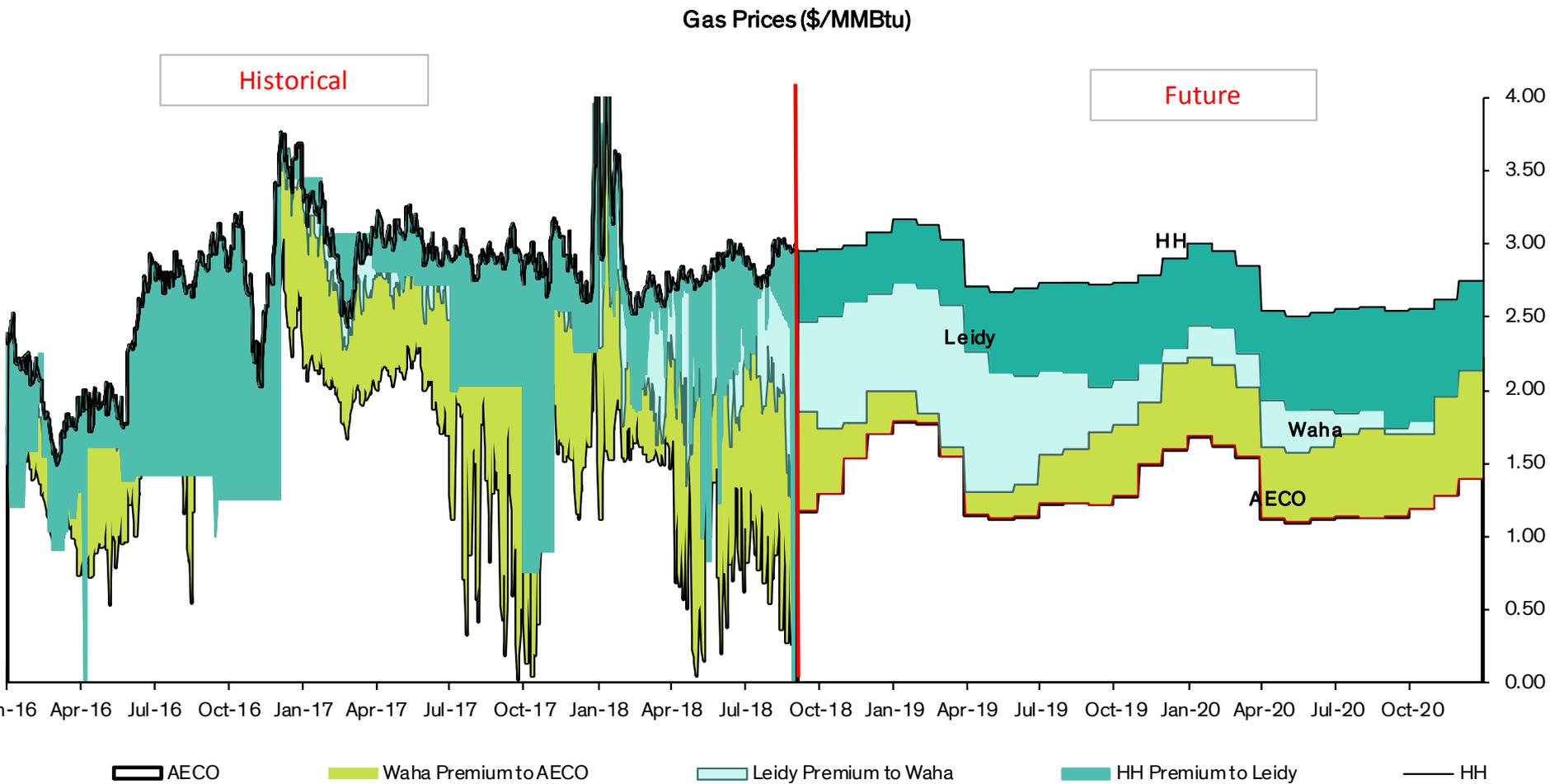


Next ethane cracker wave likely smaller than the one going on now

Company	City	Startup Date	Capacity MTA	Capacity kbd ethane
Oxy/Mexichem JV	Ingleside	3/1/2017	550	32
Dow	Freeport	3/1/2018	1,500	87
Indorama Ventures PCL	Lake Charles	7/1/2018	420	24
ExxonMobil	Baytown	7/1/2018	1,500	87
Chevron Phillips	Cedar Bayou	7/1/2018	1,500	87
FPC USA	Point Comfort	4/1/2019	1,250	73
Shin-Etsu	Plaquemine	7/1/2019	500	29
SASOL	Lake Charles	7/1/2019	1,550	90
LACC LLC	Lake Charles	7/1/2020	1,000	58
Exports	Enterprise/ETP	7/1/2018		200
BY 2020 total			9,770	767
Dow	Freeport	1/1/2021	500	29
Shell Chemical	Monaca	1/1/2022	1,500	87
Total	Port Arthur	1/1/2023	1,000	58
<i>Exxon/SABIC</i>	<i>San Patricio</i>	<i>6/1/2023</i>	<i>1,800</i>	<i>104</i>
Post 2020 total			4,800	174

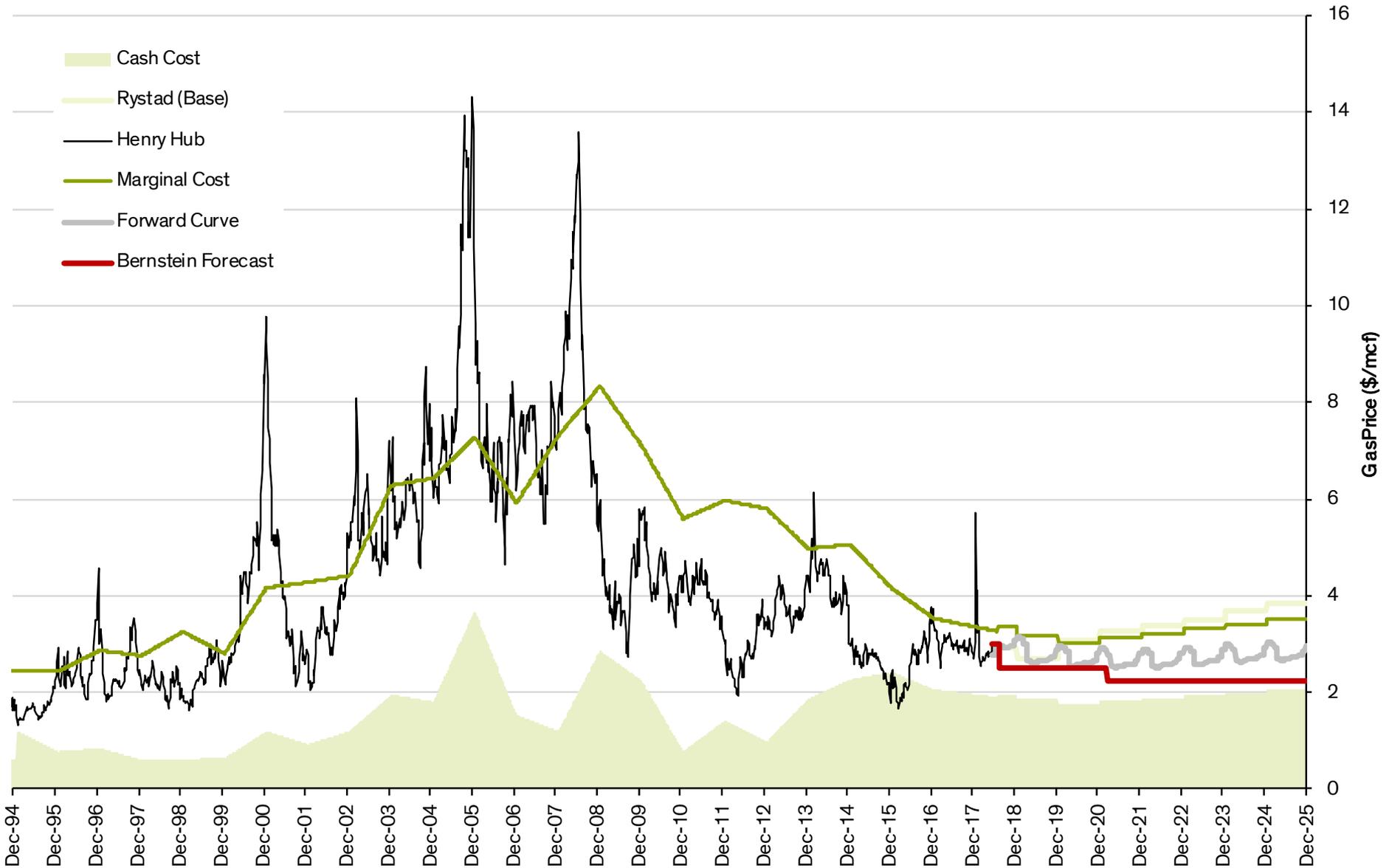
Source: EIA; SENER, Bernstein analysis

Comparing historical and projected gas prices



Comparing historical and projected gas prices

Gas Marginal Cost Curve



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Natural gas falls prey to oil market and lack of demand