

US Shale Oil - Relentlessly Resilient

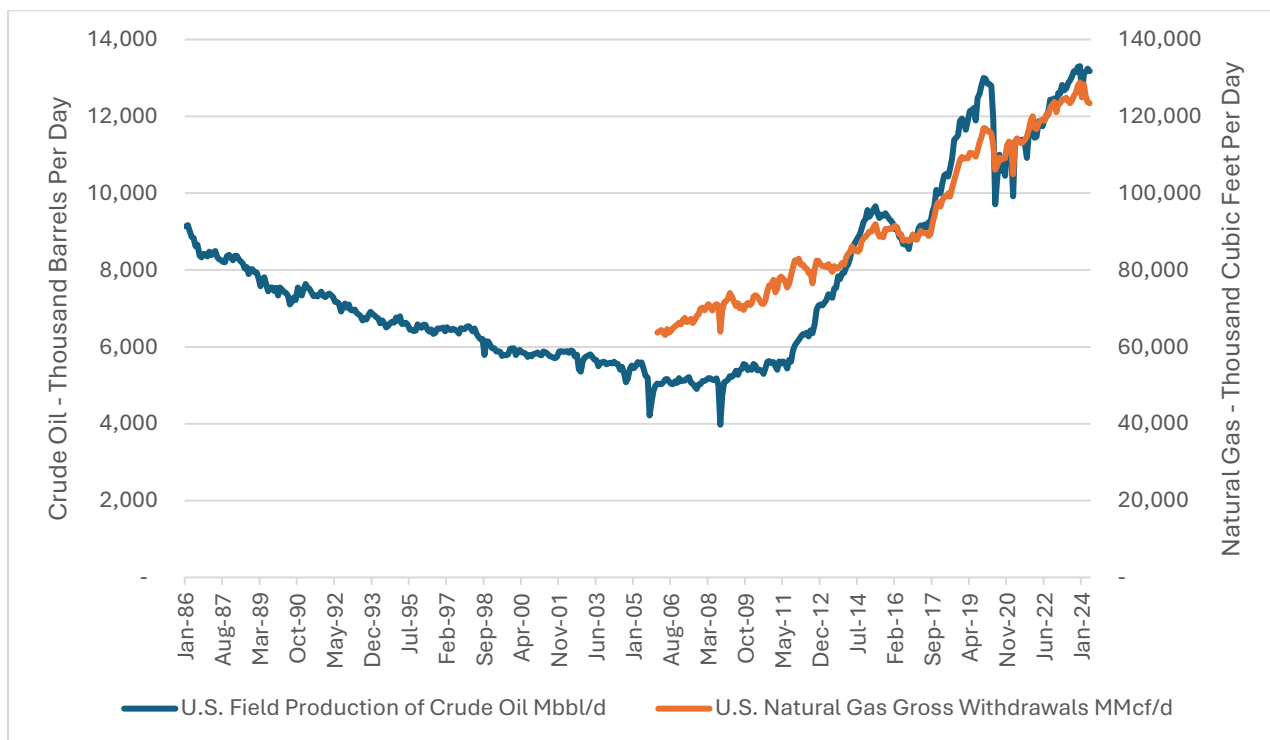
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Published in the September 2024 Issue of the Oxford Institute for Energy Studies Quarterly Report “Forum”

Introduction

The resiliency of US shale continues to confound skeptics. Despite fewer rigs drilling and fewer wells drilled, US oil production hit 13 million barrels per day (mbd) in July of 2023 and remained above 13 mbd for the last five months of 2023. These production levels, 12.97 mbd on average for full year 2023, are above the pre-Covid record highs of 2019. US oil production dipped slightly in January 2024 and is now back above 13 mbd despite a significantly lower rig count, which has fallen from an average of 687 in 2023 to under 600 in August 2024. This suggests the US Energy Information Administration (EIA), which has historically underestimated oil supply growth, may have again published production forecasts for 2024 (13.2 mbd) and 2025 (13.7 mbd) that will likely be exceeded.

Figure 1. US oil and gas production. Oil production is on the left axis and gas production is on the right axis.



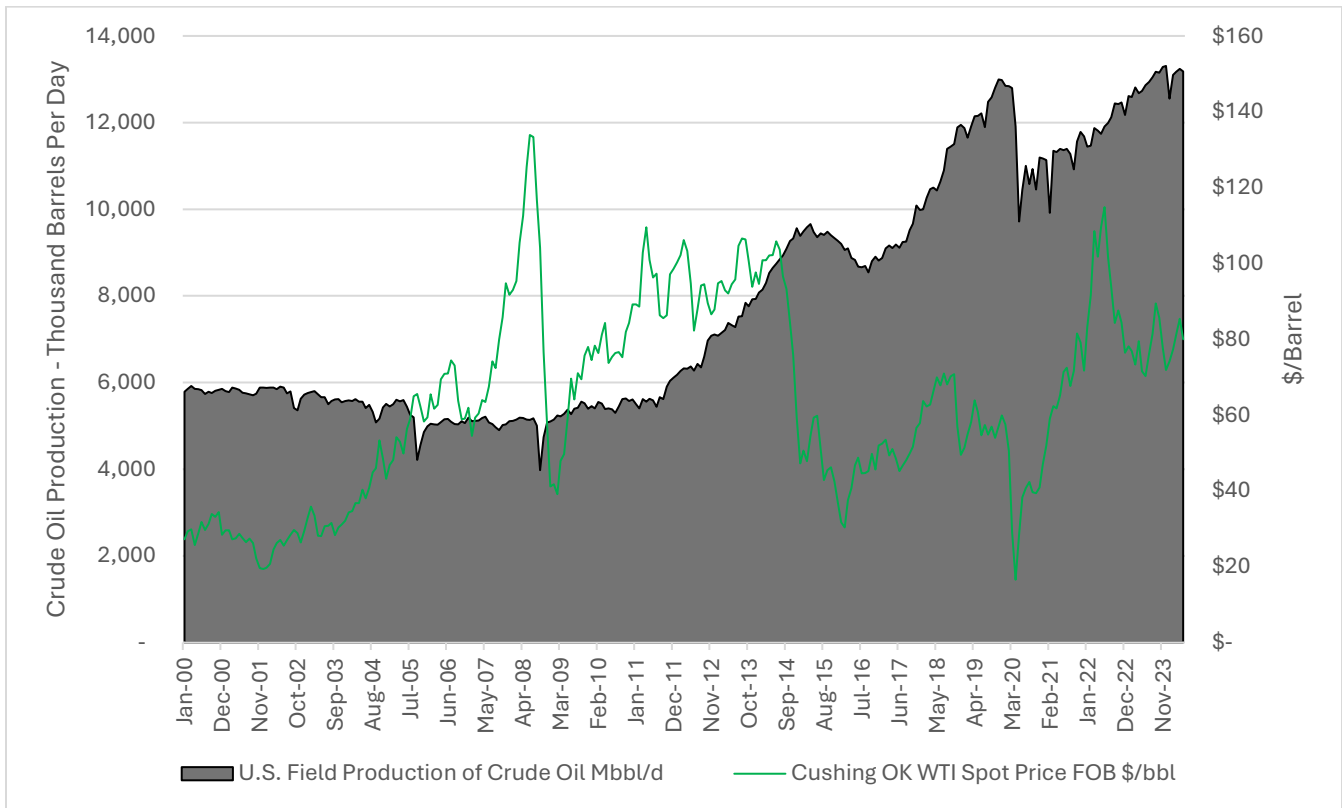
Source: EIA

US shale’s defiance of markets and prices since 2020 is all the more remarkable in light of market headwinds: soft oil prices, extreme movements and divestments in oil and gas by shareholders, the loss of the retail and generalist investor, US policies discouraging oil and gas production especially on Federal land,

increased capital discipline among operators, incredibly low natural gas prices and a materially lower rig count.

The charts tell the story. Despite declines in oil prices since early 2022, US oil production has largely moved upwards. Even with the Covid-related collapse of 2020, which sparked brief negative oil prices and unconventional well shut-ins, wells continued to be drilled and completed and production continued to increase. An abiding issue for US shale, especially from skeptics, is that of inventory. How much inventory is there? How many wells are actually left to drill? What about the quality of the acreage and the so-called “tiers”? Even if the shale story continues longer than most had expected, the conventional wisdom is that good inventory must be drilled up at some point and production will decline.

Figure 2. US oil production and oil prices 2000- April 2024



Source: EIA

Confluence of drivers for production growth

US shale oil has continued to defy the skeptics because of a combination of factors: The strength and growth of private operators, the spike in natural gas prices in 2022, service sector achievements and longer laterals; and now sustained high NGL prices in combination with high oil prices, all of which have incentivized incremental production growth. The incentives for incremental growth combined with operators showing greater costs discipline by prioritizing margins has produced better wells, a feature that is reflected by public

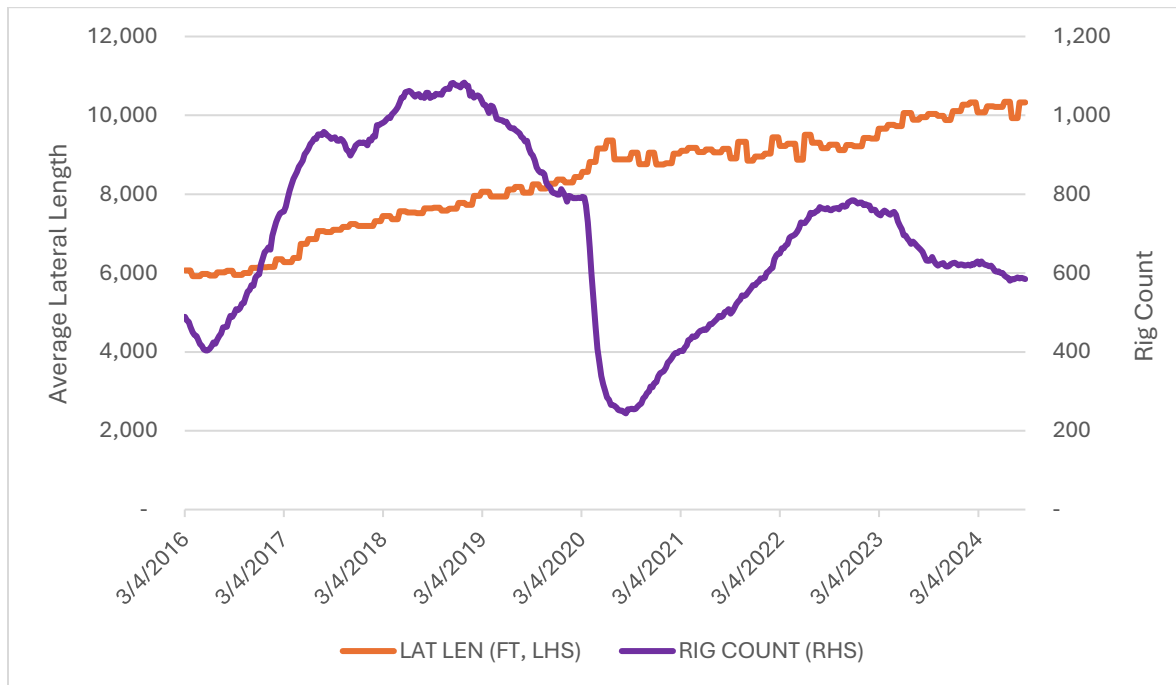
as well as private operators. Both operators (producing companies) and service companies involved in drilling and completing the wells are better at their jobs than they were only five years ago. The operators understand the rock better, drillers are drilling faster and staying in zone. Completions and frac crews are better at executing and extracting oil by deploying significantly longer laterals. The average lateral length for US horizontal wells has risen from 8,000 feet in 2019 to over 10,000 feet in 2024, as shown in figure 3. For these reasons US production continues to grow, with fewer wells and rigs and arguably lower tiered acreage.

The last five years of shale, which encompasses the post-COVID era, differ from the previous decade for US shale in that operations and operators are largely profitable, for both public and private companies. What has not changed from previous downturns and recoveries are the efficiency gains, increased knowledge of the rock, and the service sector which continues to allow shale production to increase, productivity to hold up, and previous limitations of US shale and unconventionals to be stretched. As operators have reduced activity and focused on profitability, the service sector has responded in kind, with incredible efficiency gains in the speed of drilling and completing wells. As operators have consolidated acreage, especially in the Permian Basin but also across the US, longer laterals can be drilled, greatly enhancing efficiencies and reducing costs, allowing more liquids production for fewer overall wells and rigs.

Rig count no longer a proxy for supply

The US rig count, often seen as a proxy for supply, is therefore no longer correlated with the growth of US shale production. The rig count continues to decline, but oil production growth has been maintained. The rig count has declined from nearly 800 rigs in November of 2022 to just under 600 rigs in August of 2024, while production increased by 1 mbd during the same period. After each major oil price drop and subsequent price recovery, the rig count drops and then recovers, but it recovers at significantly lower levels than previous highs. The dramatic decline in the rig count in 2020 wiped out the least efficient rigs when day rates for rigs plummeted. Then, as activity ramped up in 2020 and 2021, the best, most efficient, and most technologically capable rigs were put to work. This technological rig bump and concentration, along with lower oil prices and pressure for returns, meant that wells could be drilled faster, with execution key. Faster drilling times mean fewer rigs are required. The speed at which operators and drilling companies are drilling wells is continuing. Operators took a month to drill a two-mile-long lateral in the Delaware Basin several years ago and now drill those same wells from spud to total depth in roughly seven days, often less. Lateral lengths also continued to grow in 2020, especially in the most well-known and least risky plays such as the Midland Basin in western Texas, part of the Permian Basin. Lateral length growth for horizontal wells has continued to rise incrementally across US shale plays, but has risen substantially in the Permian Basin, leading to speed and efficiencies on the drilling side, as well as for completions. Longer laterals also mean fewer rigs are needed.

Figure 3. Total US rig count for oil and gas and average lateral length



Source: Baker Hughes Rigs, Enverus Lateral Length

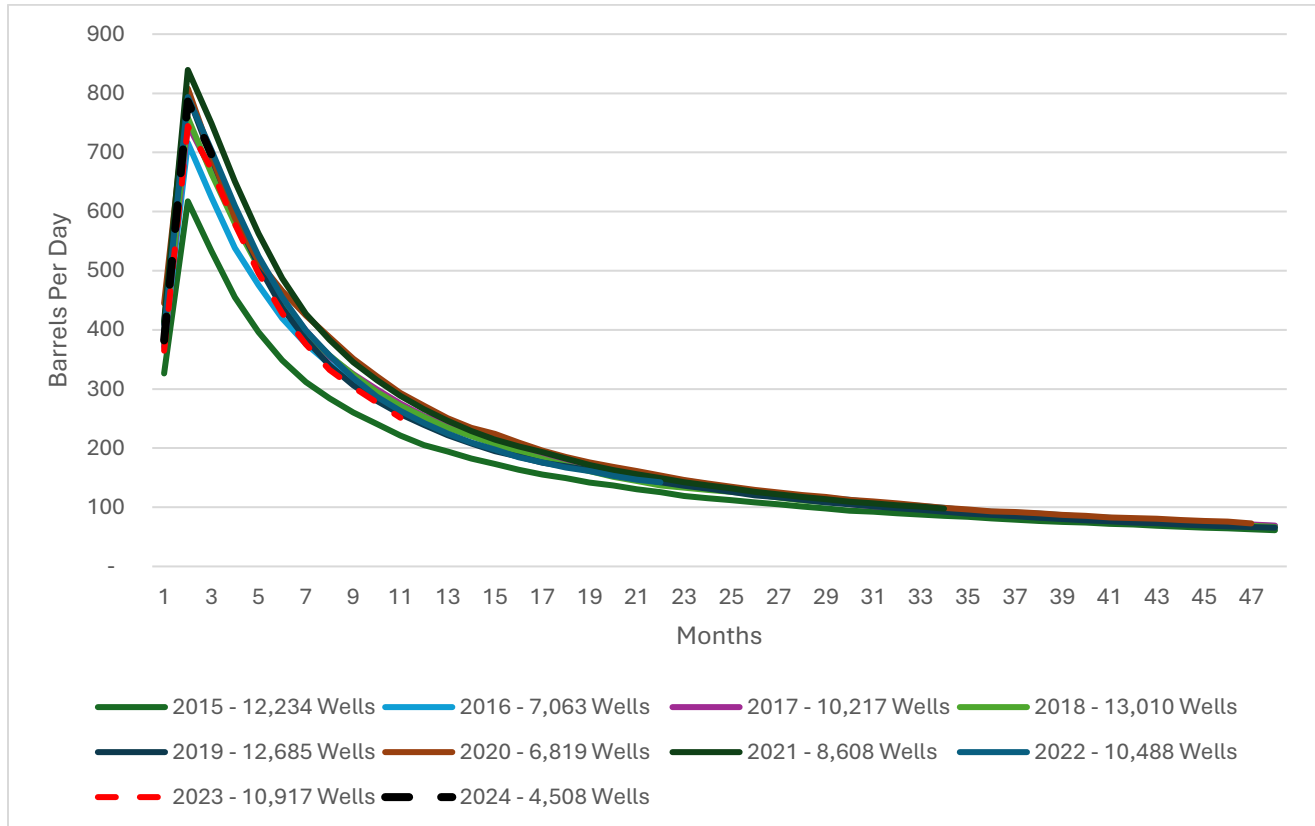
Longer laterals defines efficiency gains

Longer laterals have a cascading impact across the US shale sector, from completions to production. A few years ago, drilling a three-mile-long lateral would have been a riskier endeavor. Rigs and the drilling teams were capable of drilling that far, but there was concern about completing the end or “toe” of that well, making sure the last stretch was properly fraced and productive.

Operators and service providers have now become more comfortable with drilling out plugs and effectively completing laterals as long as three to four miles on a regular basis. The impacts to business include fewer rigs, but a heightened need for capable services companies on the drill outs. In addition, greater execution is required to complete the far toe of that well, ensuring the longer lateral contributes to overall production and does not diminish marginal returns.

The decline curves, normalized for lateral length, are not showing a material drop or decline in productivity despite these significantly longer laterals. This is evident in overall production growth and the incredibly low rig count compared to 2019 levels. The number of wells completed and brought online is also lower than pre-COVID levels and the 2019 high, which means the wells coming online are now longer and productivity is holding up. This achievement is even more impressive considering the pressure on oil and gas for returns, the volatility in natural gas prices, the so-called “lesser” or non-core acreage being drilled, and the growth and maintenance of private operators stepping out of the so called “core” acreage, largely held by the majors and largest independents.

Figure 4. Decline curves for all major shale oil basins in the US: Permian, Williston, Powder, DJ, Uinta, Anadarko, and Eagle Ford, normalized for lateral length at 10,000 feet

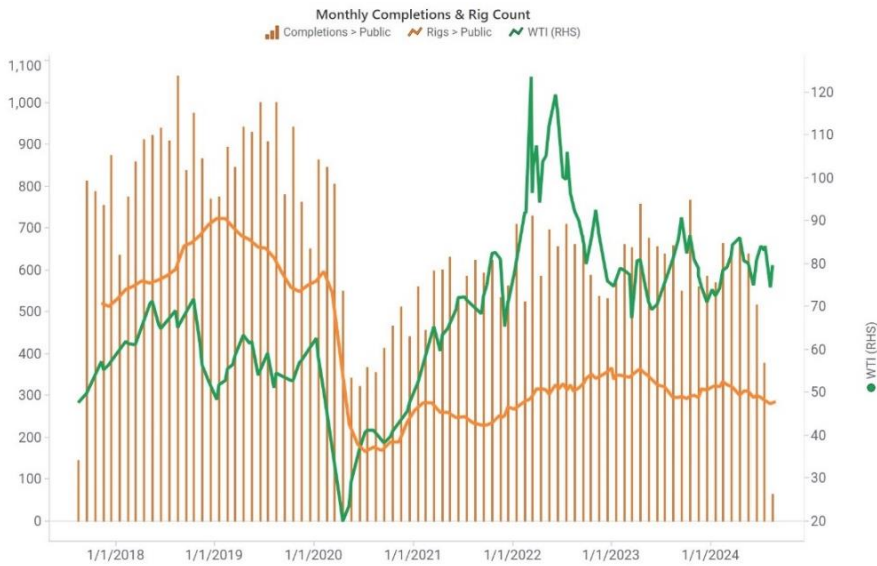


Source: PetroNerds, Eneverus Raw Data, Normalized for 10,000 feet

The role of private oil and gas companies, like much of the industry in 2020, proved not only resilient, but robust. As larger public oil companies felt the pressure of the political environment, the energy transition push, the policies of the current administration and US government, the vilification of the industry, and the public mood turned against the oil and gas industry, private operators raised capital and put the drill bit back into the ground. The result was a robust response by private operators to the oil price gains out of 2020 and significant private capital flowing into hundreds of private operators. The strength of private operators and their ability to access capital was unforeseen by many analysts. In 2019 certain large equity firms were convinced that the number of private operators would dwindle and 2020 turned that view on its head.

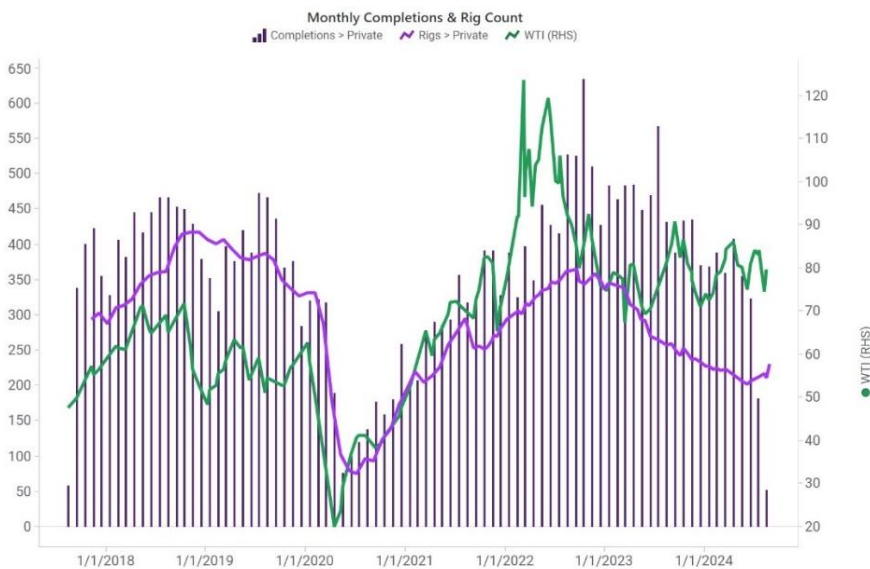
Figures 5 and 6. Horizontal wells completed, rig count for public and private operators and WTI oil price

Figure 5



Source: PetroNerds, Enverus Raw Data (Completions data (bars) lag several months)

Figure 6



Source: PetroNerds, Enverus Raw Data (Completions data (bars) lag several months)

Despite this resiliency and achievements made in the face of price volatility and 2020 headwinds, questions remain for many analysts and observers: how much oil and gas is left to be produced from unconventionals and how many wells are there left to drill? Can these production levels be maintained? Could production continue to grow? How much oil is left in the ground? How many laterals are there left to drill? These are valid questions, but the answers continue to evolve just as the US shale patch evolves. Production growth has continued and defied analysts, even those at EIA as the rig count declined, but lateral lengths increased, and productivity was maintained.

The number of wells left to drill continues to change as operators gain knowledge of their reservoirs and the rock. Inventory also changes and widens when a company sells acreage it does not want to a smaller player, often private company willing to take more risk, who purchases that acreage and breathes new life into the asset. This derisking and delineating is happening across US shale basins and has been prolific since covid as prices have risen. Operators in the Permian today will say there are tens of thousands of wells left to drill. This inventory means increased production, but it does not take into account the potential of maintaining production levels through secondary recovery, enhanced oil recovery, refracing wells, or simply tinkering with wells and working on basic production enhancements. There are tens of thousands of horizontal wells in the US with the potential for production increases and production maintenance. So much of the shale boom has been about drilling and completing wells and not about maintaining and enhancing production from existing wells.

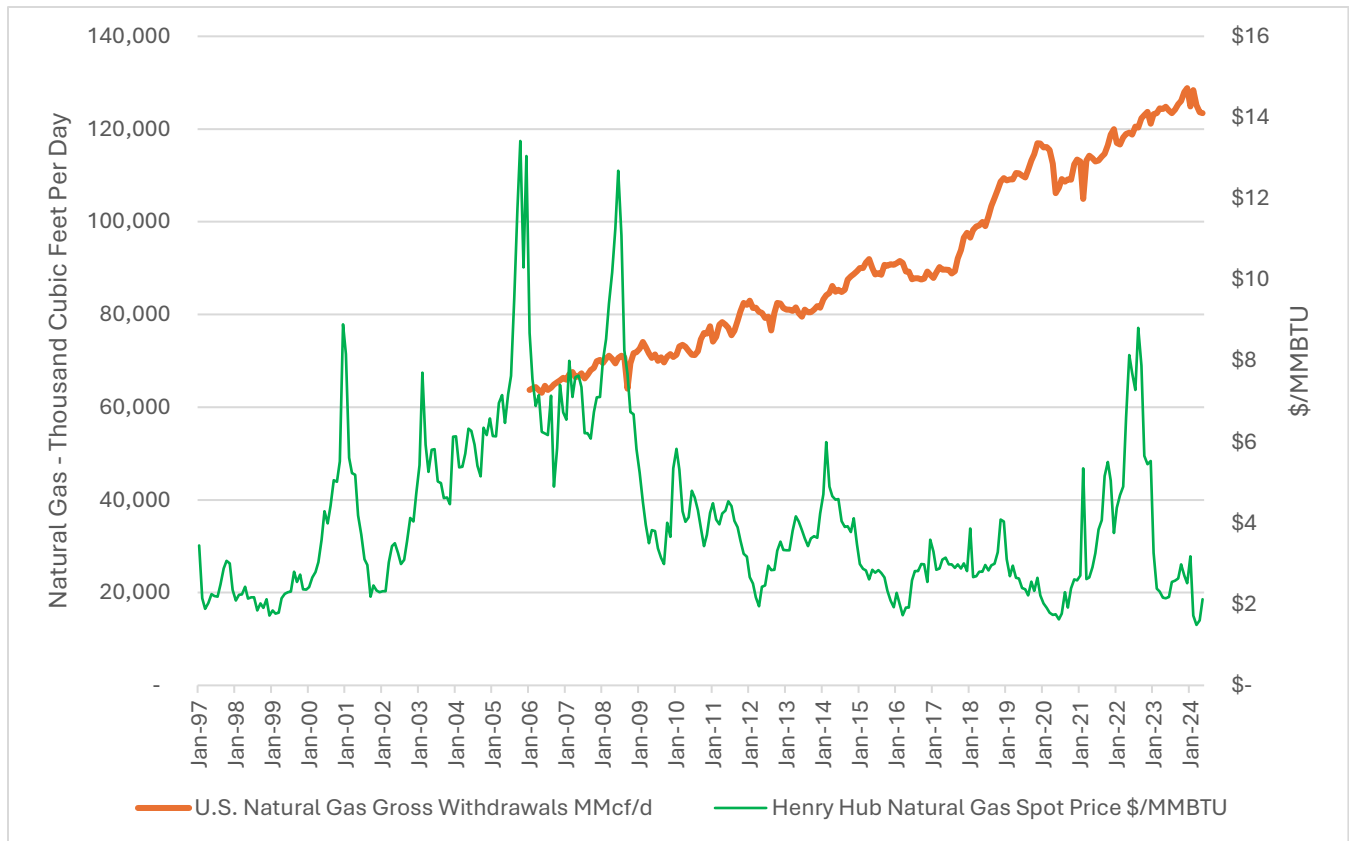
At present, US unconventional shale production is recovering under 10 per cent of the oil in place. Wells are relatively close together and laterals are wine racked across reservoirs and up and down stacked pay. This is maximizing the recovery and pay of acreage, but this spacing, timing of drilling and completion, and type of completion is still being tinkered with and adjusted. Unconventional production, like older vertical stripper well production, is something that can be nurtured and maximized at minimal cost. Smaller production companies are actively purchasing older horizontal wells and breathing new life into these assets. Refracing or essentially recompleting these wells in the future is another option. Why have there not been more recompletions or refracs to date? There have been some, but as long as an operator has plenty of inventory there is little incentive to refrac given the cost. In sum, operators still have a lot of inventory left to drill in their portfolios and this tends to increase not decrease as operators better understand their acreage and reservoirs and increase inventory and production through organic means rather than purchasing more acreage. When thinking about inventory and production potential in the US, a number of factors need to be considered, including the ability to get more from the rock at present than ten percent, refracing existing wells, and increasing production from current wells

Natural gas continues to grow despite price

Natural gas is another fundamental part of the US shale story. Some observers have underestimated the role of natural gas as the driver of oil production as well as the US' huge productive capacity for gas. Unlike oil production which is reactive to prices, US natural gas production has increased regardless of price – as a much smaller molecule than oil, it is relatively easy to frac and produce. When wells age they typically produce more gas when they hit the bubble point in the reservoir.

Natural gas also drives oil production. In the heart of the Delaware Basin, in the Permian Basin in southern New Mexico and far west Texas, the natural gas present in deep, thermally mature and pressured rock, provides oil wells with a robust production driver for bringing the oil out of the ground. Moreover, while gas production is not affected as much by weaker prices, price spikes have prompted operators to prioritize gassier plays. In 2022 when natural gas prices touched \$10/mcf (thousand cubic feet) in the US in August and averaged \$6.50/mcf, operators shifted to gassier areas of their oil plays, both to capture the gas price uplift, but also to gain additional support for the oil they were producing.

Figure 7. US natural gas production, gross withdrawals and Henry Hub price



Source: EIA

Production from natural gas plays with adequate egress (pipeline capacity) surged in 2022. Moreover, private operators were stepping out of known acreage to wildcat gas wells, something not seen since the onset of the unconventional revolution when high natural gas prices spurred the fracking boom in 2006. When private operators take risks on lesser acreage or new and unknown acreage, they are essentially derisking these assets and adding more meat to the pie, more wells and inventory to be drilled in the future.

Current natural gas production and gross withdrawals comprise over 123 Billion Cubic Feet per day, over one quarter of the world’s supply and demand, and more than double that of Russia, the second largest gas producer in the world. This production is coming from the major dry gas plays like the Marcellus and the

Haynesville, but also the associated gas in the Permian Basin, the Bakken in North Dakota, and elsewhere across the US. Such production levels combined with slightly warmer winters, have created a buildup in natural gas storage in the US and around the world. [The US consumes roughly 80 Bcf/day and exports 14 Bcf/day in LNG (exports roughly equal to Qatar and Australia) and an additional 10 Bcf/day via pipeline to Canada and Mexico. The balance goes into inventories, which drove the price of natural gas down in 2023 and 2024 as production continued to rise faster than consumption and exports.]

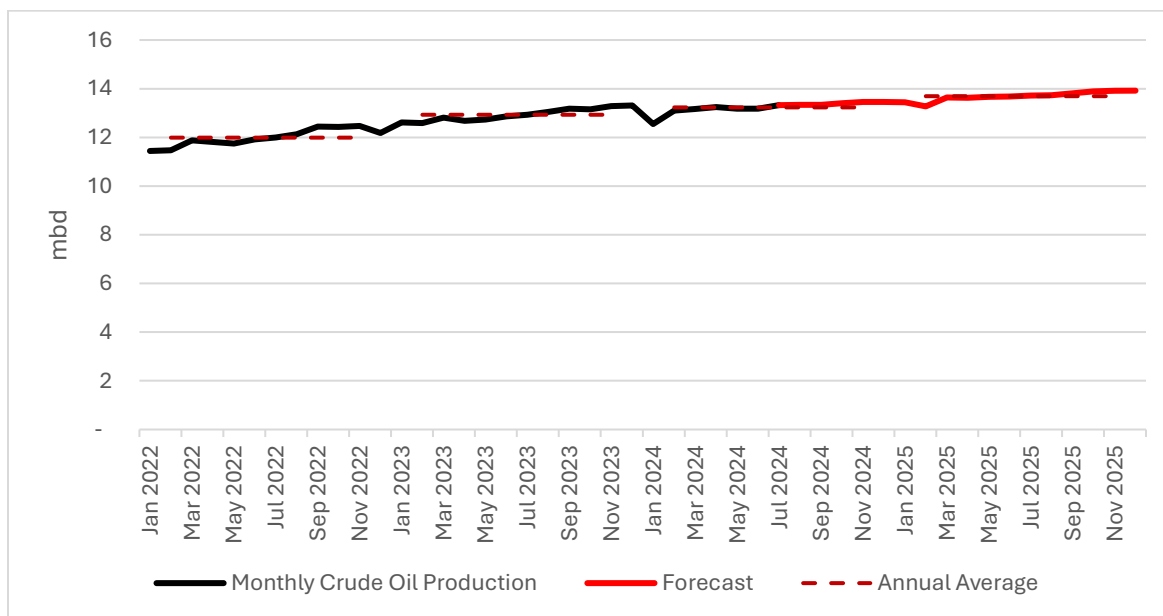
Due to the current dynamics of higher oil prices and low natural gas prices, this trend is largely set to continue unless there is a change or increase in U.S. demand from power generation, greater exports via LNG, or cold snaps which draw down inventory.

Healthy WTI prices around \$80 mean that oil drilling will continue, along with associated gas production growth. NGL prices, largely tied to oil, are holding up well and incentivizing liquids-rich natural gas production in richer gas areas with higher propane and butane content, also helping to keep natural gas prices depressed. This all supports higher production volumes in oil and condensate in the US and continued production growth in natural gas.

Conclusion

The EIA is forecasting modest US oil production gains in 2024 and 2025. These seem not only achievable but somewhat low given current production levels in the US of 13.2 mbd as of May 2024, continued pressure on the rig count, and incrementally longer laterals. The EIA was well under target in previous short-term energy outlooks and annual outlooks for 2023, suggesting it both underestimated and misunderstood the impact of longer laterals and productivity maintenance on production growth.

Figure 8. EIA's Oil Forecast – Short-Term Energy Outlook



Source: EIA August 2024 Short-Term Energy Outlook