Unconventional and Underestimated: U.S. SHALE

by

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ABOUT THE AUTHOR

Trisha Curtis is the President and CEO of PetroNerds, LLC. She founded the company in 2015 and began working full time at PetroNerds in January 2016. She was formerly the Director of Research, Upstream and Midstream, at the Energy Policy Research Foundation, Inc. in Washington, DC. Since 2010, she has led extensive research efforts and major consulting projects and authored several reports on the North American upstream and midstream markets. She was also the Manager for Strategy and Analytics at Anschutz Exploration in Denver, Colorado.

At PetroNerds, Trisha leads research and consulting services. She is a macroeconomist with an expertise in U.S. shale markets. She is globally recognized for her knowledge of U.S. shale and has been asked to speak and present at several forums including OPEC in Vienna, Austria, in Bahrain, and in Riyadh, Saudi Arabia, Stanford University, Chatham House, Oxford University, Denver University, and Colorado School of Mines. She is also the host of The PetroNerds Podcast.

Cover photo: ©Trisha Curtis, Permian Basin Petroleum Museum in Midland Texas.

FOREWORD

The production of oil and gas from unconventional geologic formations (generally called shale oil and gas) has lifted the U.S. into the world's largest oil and gas producer. In the midst of the Covid pandemic and the associated worldwide government initiatives to lockdown large segments of the world's economies, petroleum demand cratered. Analysts, academic researchers, and a large number of commentators viewed the reduction of petroleum demand accompanying the pandemic as a signal that a sustained decline in oil demand had finally arrived. But pandemics have a tendency to return to trend once infections run their course. According to the International Energy Forum (IEF), and referencing the authoritative Joint Organizations Data Initiative (JODI), world oil demand rose in December 2022 (year-over-year) by 1.3 million barrels per day (mb/d). The most recent forecast from the U.S. Energy Information Agency (EIA) points to rising petroleum requirements worldwide. The agency expects global liquid fuels consumption to increase by 1.5 million barrels per day (b/d) in 2023 from 2022 and by an additional 1.8 million b/d in 2024.

So does the U.S. have the capacity to raise domestic oil production to remain an important force in the global market? In this paper, Trisha Curtis, CEO of the PetroNerds consultancy and an EPRINC Distinguished Fellow, takes a deep dive into the unconventional petroleum space and examines its capacity to sustain the U.S. as a world leader in oil and gas production.

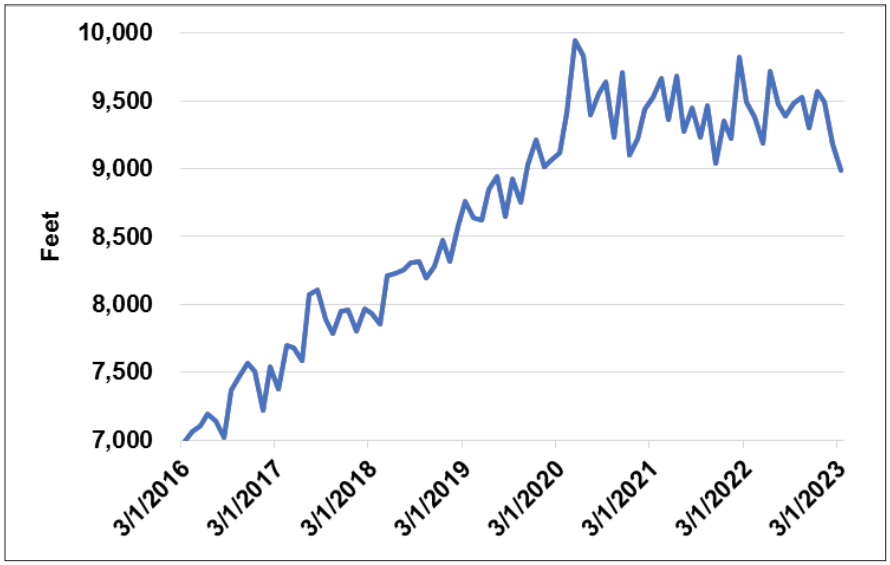
RESILIENT U.S. SHALE

Several factors over the past three years have contributed to the resiliency of U.S. shale production since the onset of COVID. Elevated prices are certainly at the core. But along with a favorable market, the industry has been nimble and benefitted from the flexibility in the oil services sector. Technical advances, including longer lateral lengths (Figure 1), efficient completions, and the rise of private operators and private capital, have enabled U.S. shale development to continue and prosper, despite numerous regulatory headwinds, investor pressure, and inflation.

US oil production hit a record high of 13 millon barrels/day (mbd) in 2019, then declined in 2020 due to the COVID-induced demand shock, negative oil prices, and subsequent field shut-ins (Figure 2). With the onset of COVID, the oil market experienced wide swings including negative prices. Oil prices slipped into negative territory in April 2020 and slowly recovered through the remainder of the year. In response to the market decline, operators (producers of oil and gas who control production) shut-in wells and reduced domestic oil and gas output. This was the first time U.S. unconventional shale wells were shut-in on a large scale across the country's petroleum provinces.

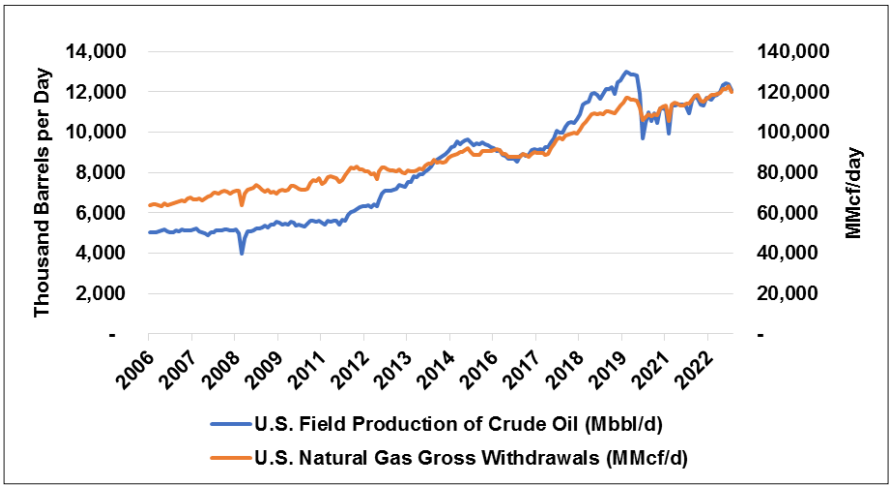
Many experts predicted production would not rebound given technical constraints and a sustained low oil price environment. Oil production was shut-in because operators often could not find a buyer for their crude.

Figure 1: Average US Lateral Length



Source: PetroNerds, Enverus raw data

Figure 2: US Oil and Gas Production



Source: EIA

Historically, even in markets where oil prices saw substantial declines, operators could move their oil, even if they experienced short-term losses. This time, due to the nearly 7 mbd refined product demand loss in the U.S., the barrels simply could not find a home and wells had to be shut-in. An unprecedented pandemic-related reduction in automobile use led the massive demand loss, resulting in storage facilities and pipelines hitting full capacity. When the wells were turned back online, production steadily began rising, many wells showing a short-term boost due to elevated pressures from being shut-in. This more than likely took some members of OPEC by surprise given widespread expectations by many experts that U.S. shale would either stay shut-in longer and/or would have suffered damage when producers turned the wells back online.

Over the course of 2020, many operators and service providers went bankrupt and left the business, but some held on and maintained operations or used the low-cost environment to expand operations. Expanded operations came largely from privately-held companies, free from some of the financial pressures prevalent in publicly-traded firms. During the depths of the pandemic, day rates for rigs were at all-time lows, as were frac and completion costs. Frac fleets dropped from over 200 to less than 50 within weeks and the rig count plummeted. When oil prices began increasing and the rig count began to climb, it was the private operators that led the activity growth. Public operators were paralyzed by a decade of poor returns, a low oil price environment, and the public sentiment that the oil era had ended.

ESG AND INVESTOR PRESSURE: ENABLING THE PRIVATE OPERATORS

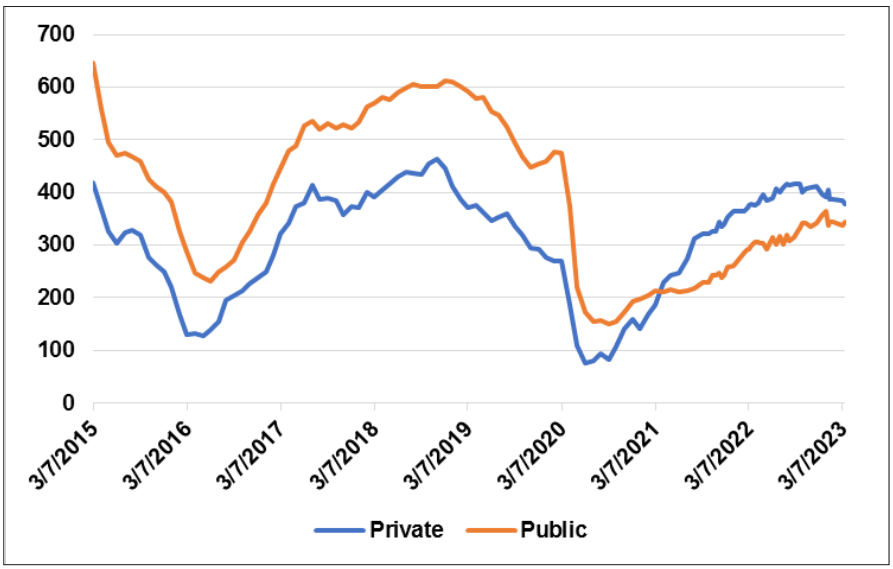
The COVID pandemic accelerated efforts by policy makers worldwide to reduce reliance on conventional forms of energy, particularly oil, natural gas, and coal. Efforts to accelerate the energy transition and the environmental, social, and governance movement (ESG) had already begun, but the pandemic catalyzed efforts to limit additional production of traditional fuels. The International Energy Agency (IEA), originally founded to address energy security concerns throughout the OECD (which is made up of countries with more extensive economic infrastructure), focused its efforts accelerating the energy transition and promoting greater deployment of so-called “clean energy technologies” and the IEA’s “Net Zero 2050” plan. In October 2020, the IEA released its World Energy Outlook, where it first mentioned the goal of reaching Net Zero by 2050. They then released its Net Zero 2050 report, originally presented as a “thought piece”. It has become a “flagship” report, and the backbone of the IEA’s policy for energy production and consumption. In the report, global demand for oil in IEA’s Net Zero scenario drops from 100 mbd in 2019 to 75 mbd in 2030, while natural gas demand plummets, and solar and wind demand increase exponentially.

These predictions and scenarios (and several others) were echoed further by many international oil companies who added their own voice and forecasts of a future rapidly moving towards “Net Zero.” Activist investor groups added to the pessimism on the future of oil and gas demand and gained support from large investor groups, such as Vanguard, BlackRock, and State Street Global Advisors.

RISE OF PRIVATE OPERATORS

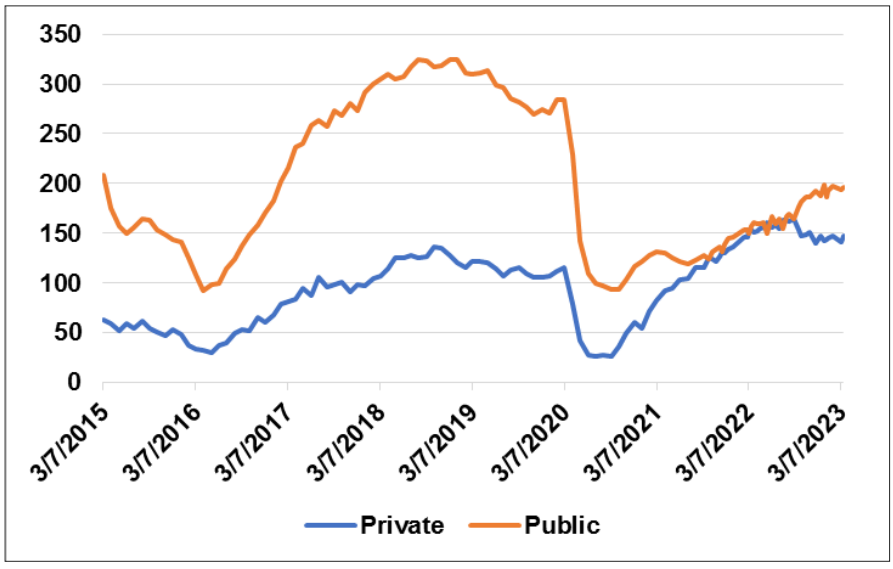
U.S. public company investor pressure, both ESG-related and return-related, paralyzed public operators and their willingness to bring rigs back online and increase oil output as oil prices began to rise. This is evident in both the rig count data and the well completion data (wells being brought online and into production). Private operators immediately responded to oil prices and began drilling and completing wells late in 2020 (Figure 3). This is most evident in the Permian Basin where private capital, including private equity, began flowing into the oil and gas sector. The rise in oil prices and the first signs of U.S. and global inflation further propelled this trend as it became apparent oil demand was more resilient than expected and production was not keeping up with demand. The first signs of inflation also helped propel many to invest in oil and gas as a hedge. This helped bring independents and public operators back to the market, especially in the Permian Basin (Figure 4).

Figure 3: US Public vs. Private Operator Rig Count



Source: PetroNerds, Enverus raw data

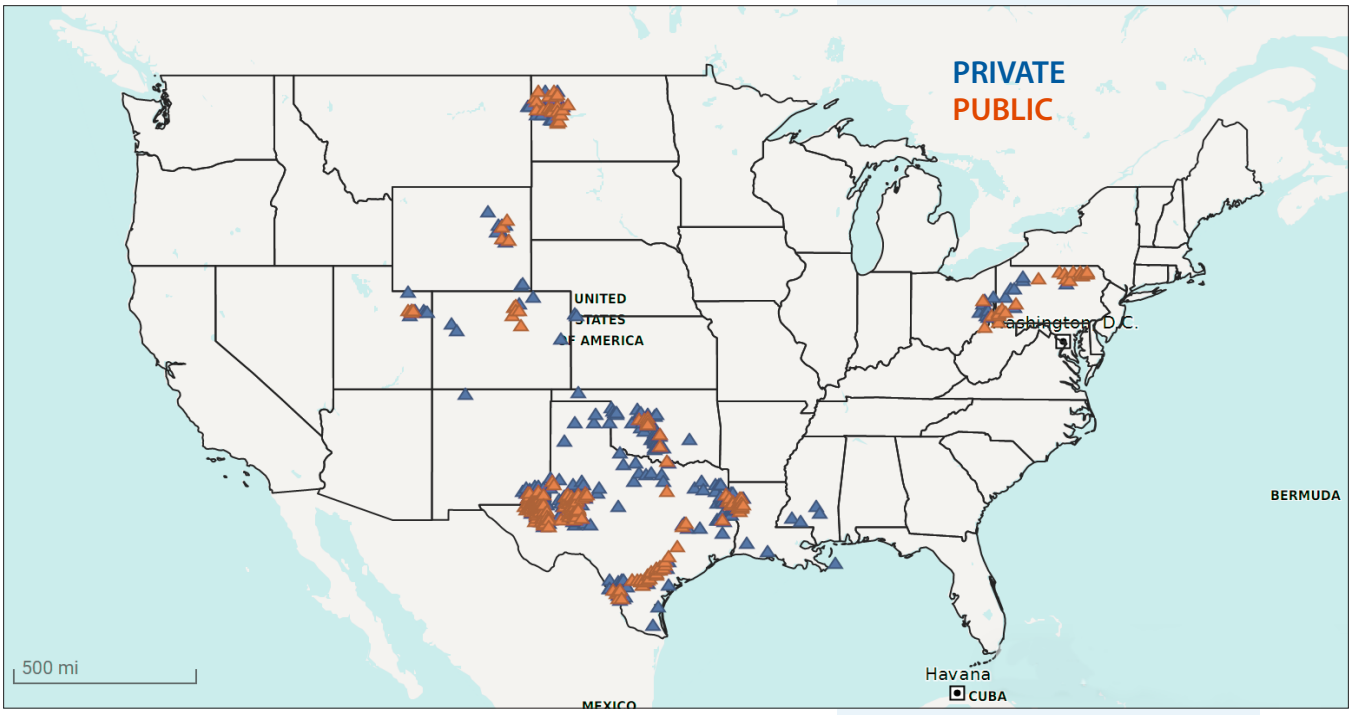
Figure 4: Permian Public vs. Private Rig Count



Source: PetroNerds, Enverus raw data

The steady rise in oil prices in 2020 and 2021 and the aggressive spikes in 2022 resulted in a sharp and dramatic rebound in the rig count, with private operators dominating the rig count. The split between private operator activity and public operator activity is stark across the U.S. and tells a unique story about each basin and area, as well as corresponding activity and production. Private operators have stepped out of the "core" areas and are drilling and completing wells aggressively, debunking skeptics talking about thinned out acreage and poor returns (Figure 5).

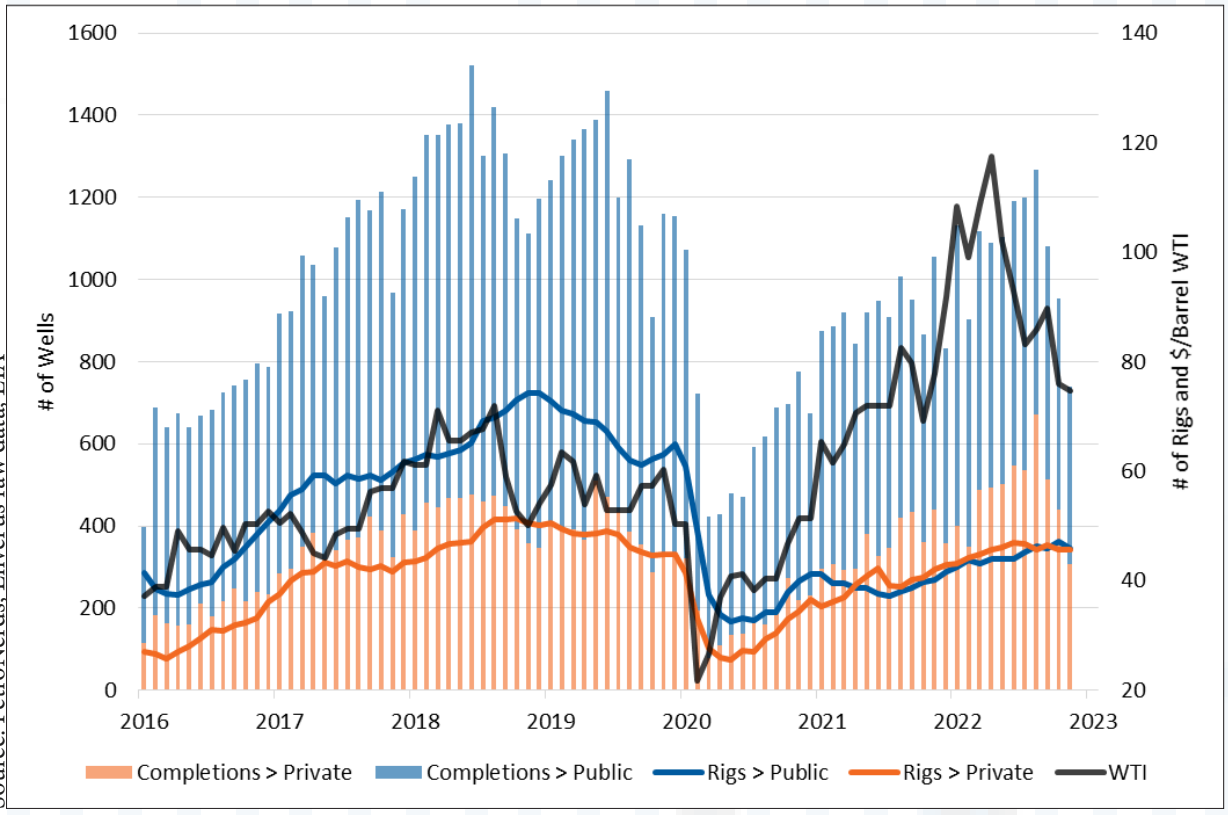
Figure 5: US Lower 48 Public and Private Rigs



Source: PetroNerds, Enverus raw data

As oil prices recovered, private companies in the Rockies moved aggressively to restore production, public operators did not (Figure 6).

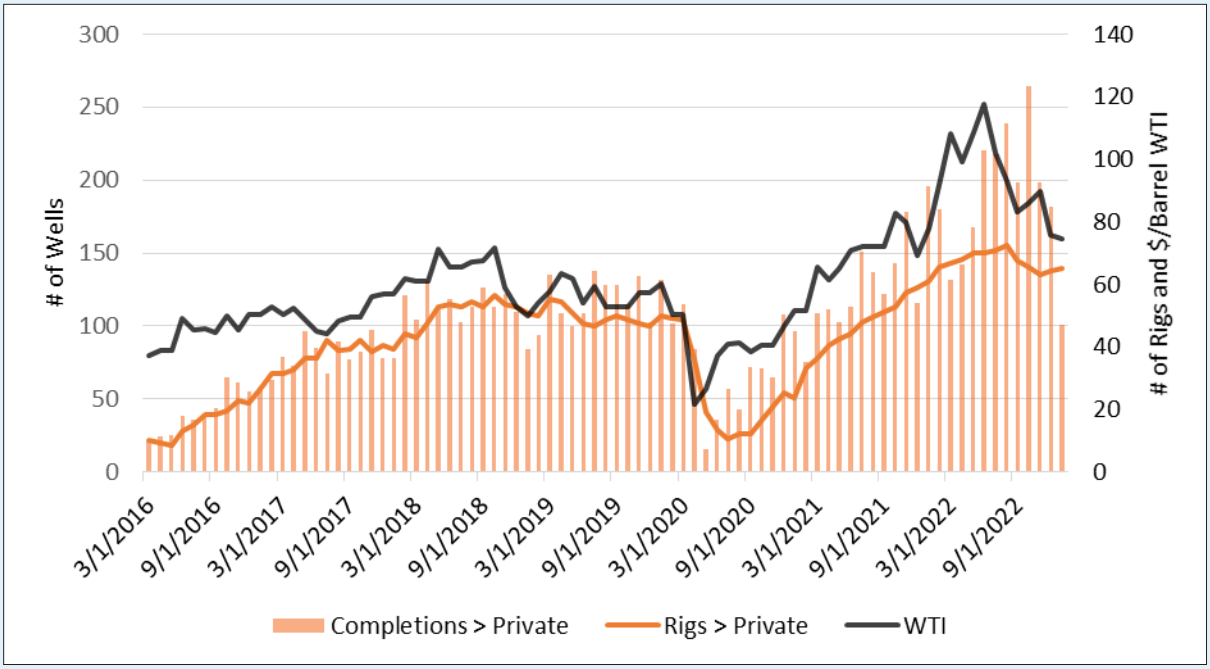
Figure 6: US Total Well Completions and WTI



Source: PetroNerds, Enverus raw data, EIA

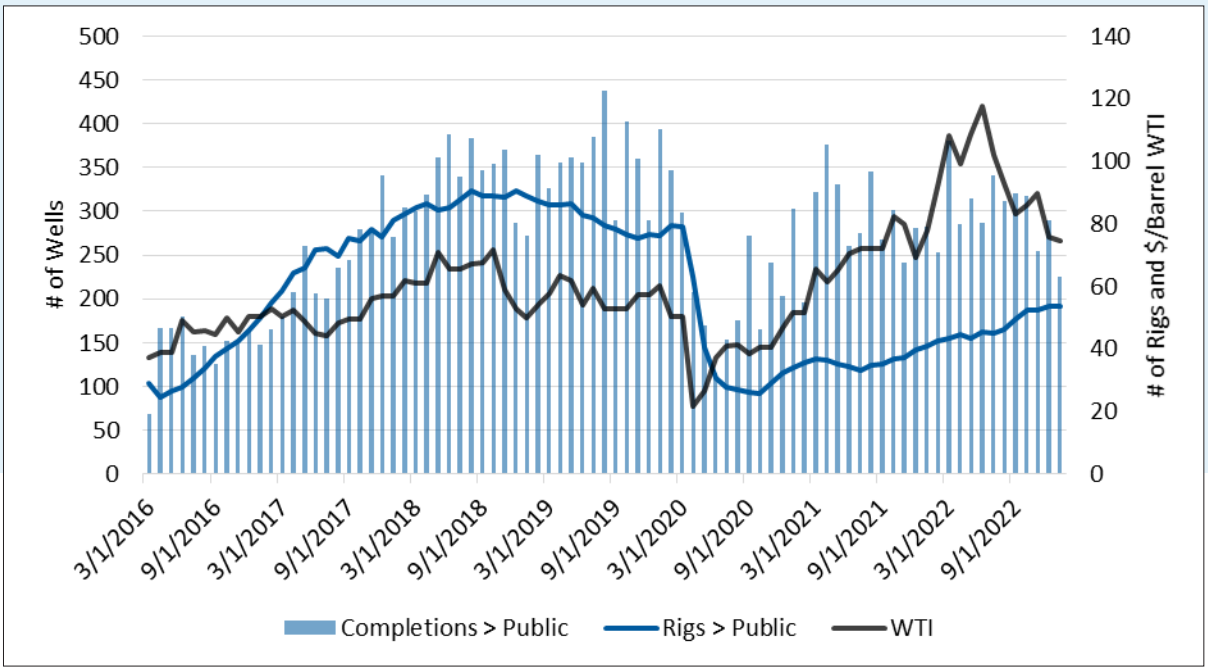
However, public operators are dominant throughout the Rockies, and this feature of the industry is largely why the region remains subdued in terms of well completions (Figures 7 and 8). Oil production is likely to remain well below pre-Covid levels. Of course, rising prices brings both categories of operators back out to the field, but across all the onshore unconventional plays, more rigs are being run by private operators than by public companies. The Permian Basin is a case in point as more private rigs are running now than the previous high in 2018.

Figure 7: Permian Private Well Completions



Source: PetroNerds, Enverus raw data, EIA

Figure 8: Permian Public Well Completions

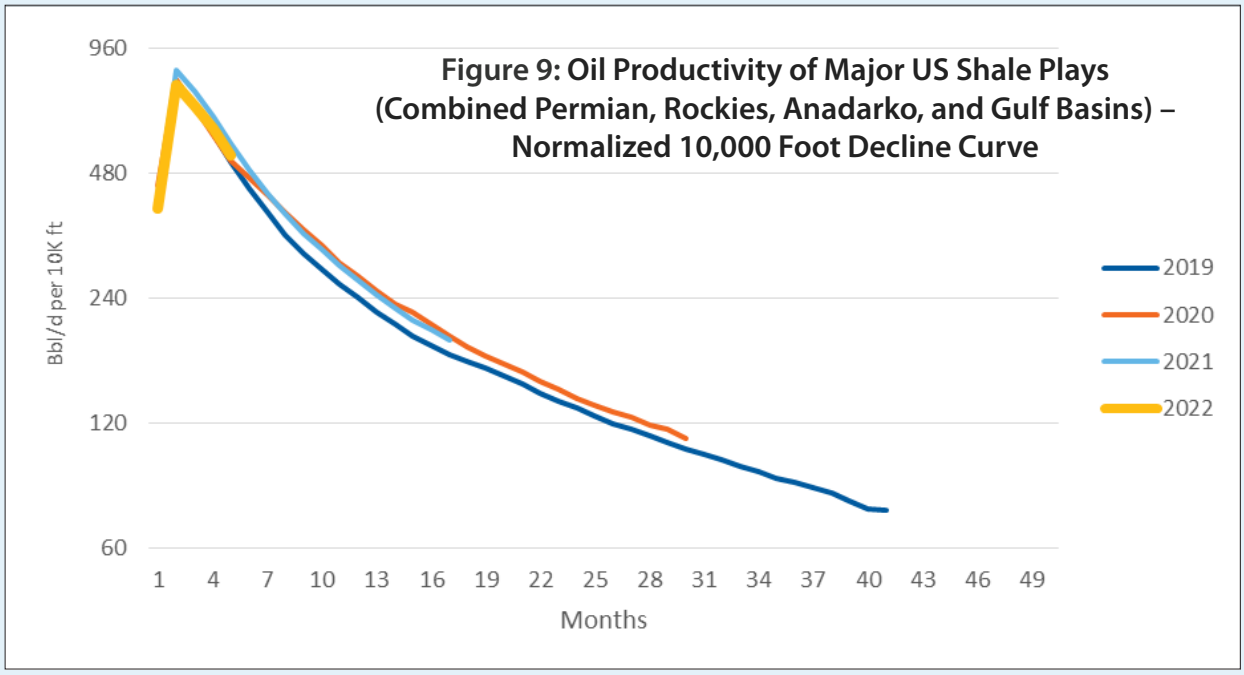


Source: PetroNerds, Enverus raw data, EIA

PRODUCTION, PRODUCTIVITY, AND EFFICIENCY GAINS

Oil production volumes and the question of productivity has always been a debated topic among shale skeptics. The theory or hypothesis is as follows: productivity cannot keep increasing because operators are running out of good acreage and when the "core" or the "good stuff" or the "Tier 1" acreage is drilled up, well performance will decline. Oil production will subsequently decline, so oil production can never get back to 13 mbd.

Production has not returned to 13 mbd and well performance has declined a small amount. However, production is clawing its way back and there is potential to hit 13 mbd again. Also, productivity did not decline by much, and in some areas like the Williston Basin (Bakken), performance has been maintained. It is important to note here that decline rates do not show a substantial reduction of productivity from the rock (Figures 9 and 10).



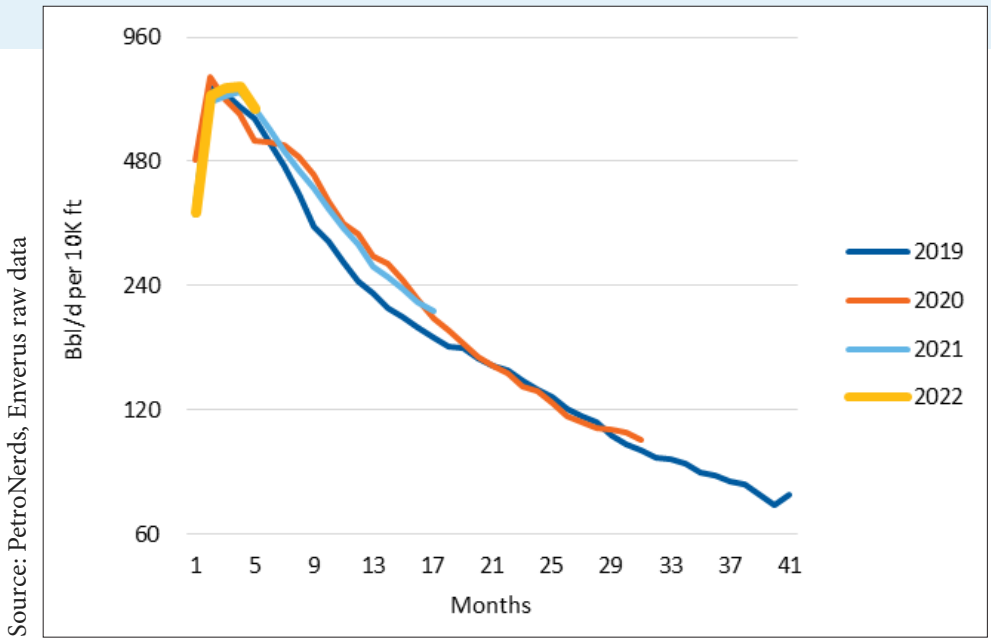
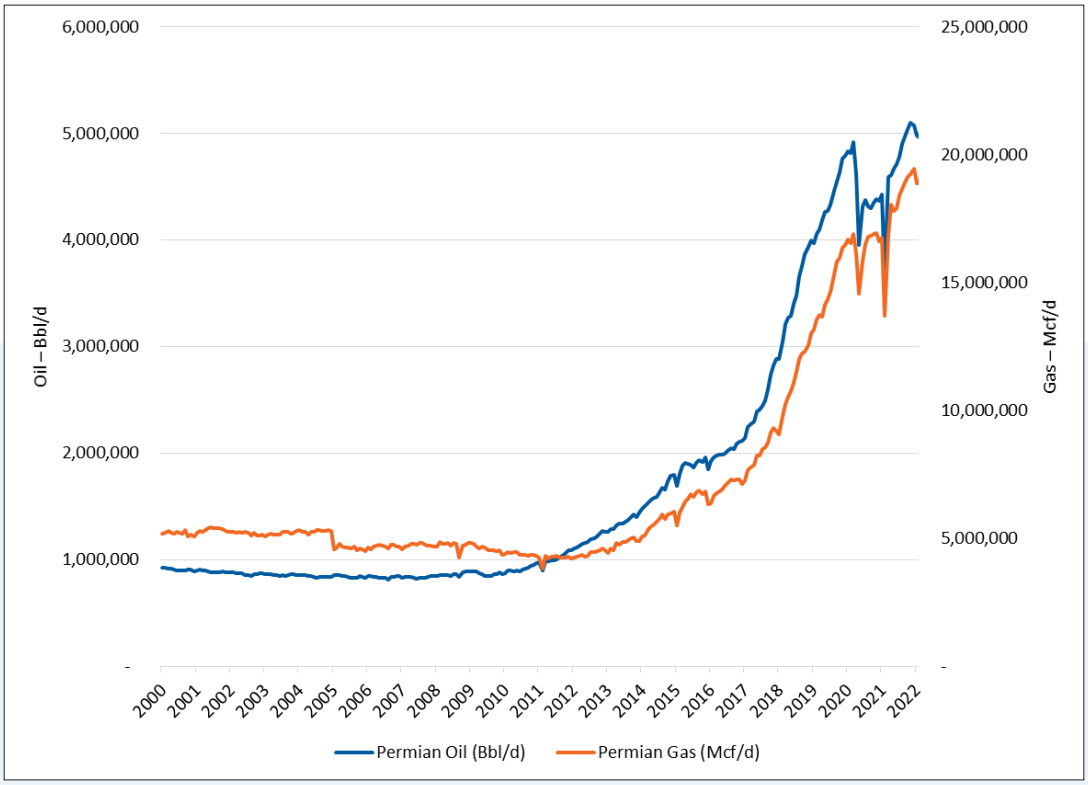


Figure 10: Williston Basin Oil Productivity – Normalized 10,000 Foot Decline Curve

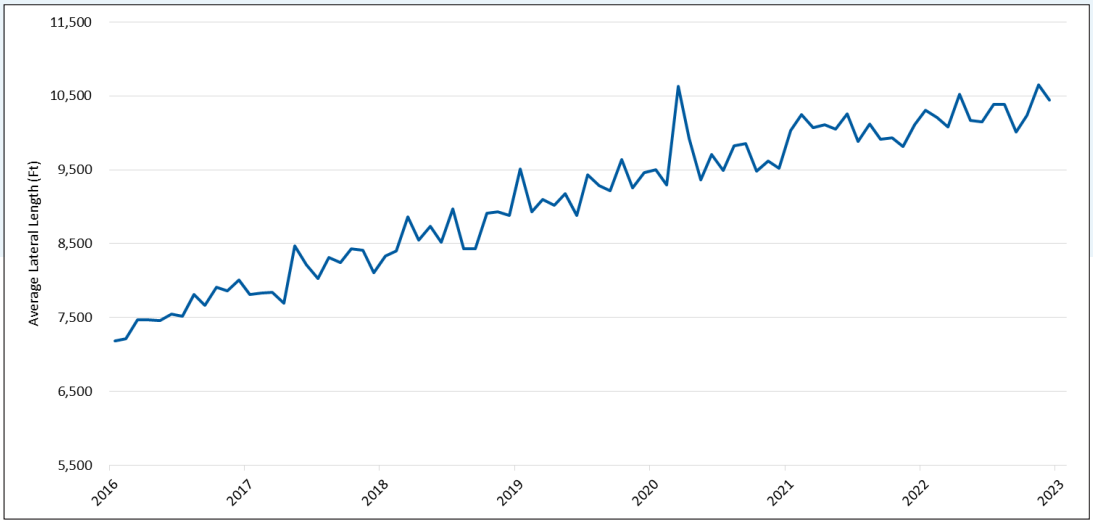
Higher oil prices, risk taking by private operators, continual growth in knowledge of the rock, widening spacing between wells, longer laterals and increased efficiencies, and continued advancements on completions have all helped debunk this hypothesis to a large extent. Productivity, when normalized for lateral length, should be declining considerably if there are a great deal of private operators who have stepped out of the "core" acreage areas and are drilling less-than-desirable rock. However, the reduced performance that has been seen makes sense in the context of operators favoring gassier areas, significantly increasing average lateral lengths, and drilling in newer and less known acreage. Yet all this has not resulted in a dramatic decline in well performance, and production growth is returning, especially in the Permian Basin (Figures 11 and 12).

Figure 11: Permian Basin Oil and Gas Production



Source: PetroNerds, Enverus raw data

Figure 12: Permian Basin Average Lateral Length by Sub Basin

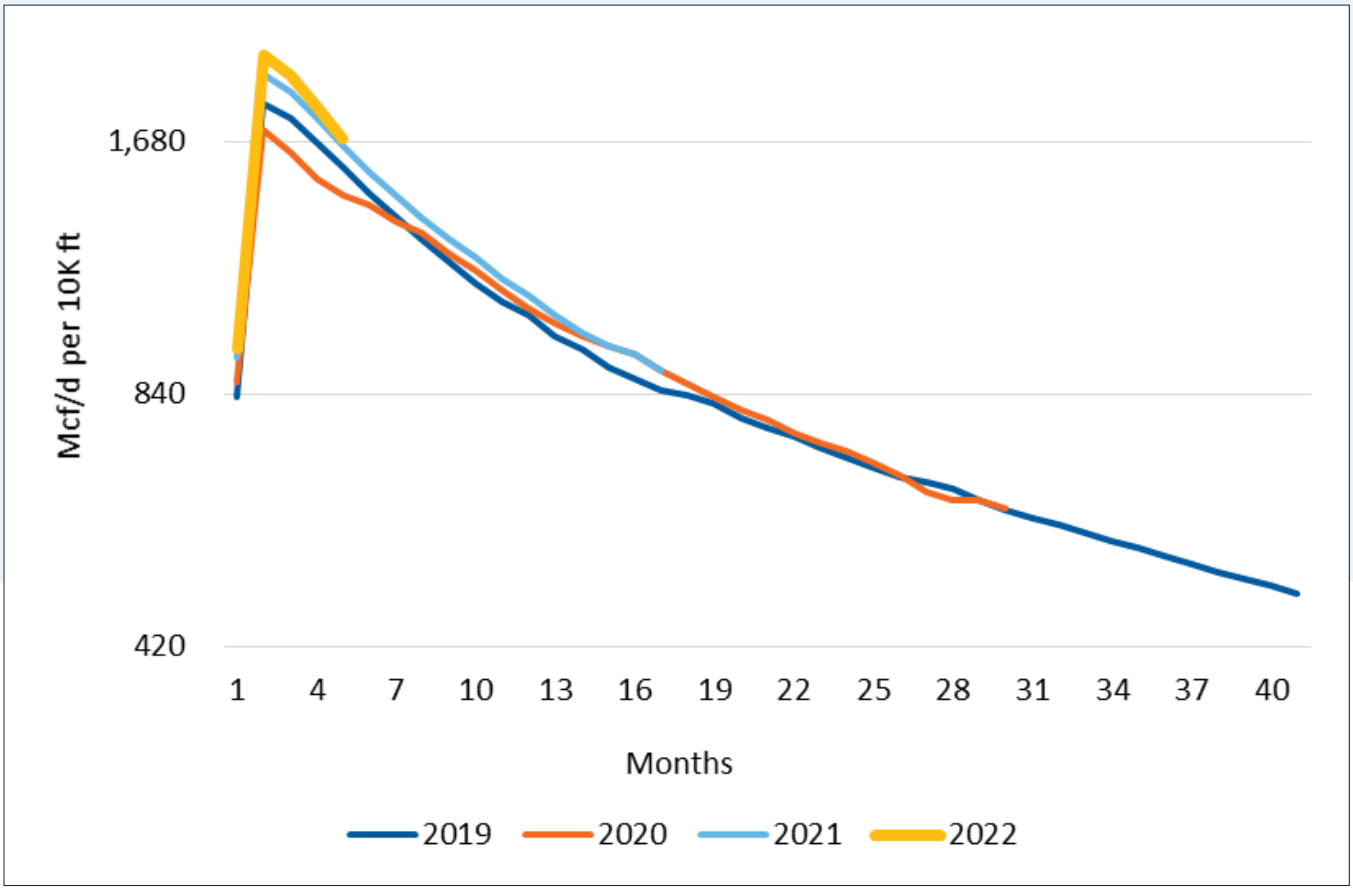


Source: PetroNerds, Enverus raw data

NATURAL GAS PRODUCTION AND HIGH NATURAL GAS PRICES

High natural gas prices in 2022, an average of $6.42/mcf, enabled operators in both gas plays and in oil plays to produce vast volumes of natural gas and natural gas liquids. The shale revolution has not witnessed sustained highs in natural gas prices, and $10/mcf in August of 2022 made natural gas attractive again and enabled operators, both public and private, to go after natural gas and utilize the gas drive in many oil plays. This can be seen in the normalized gas productivity curve in the major oil plays (Figure 13). The gas curve is up significantly. This outperformance suggests operators were targeting over pressured areas with substantial gas drives (and subsequent gas production) as well as targeting more condensate and gassier areas of oil plays. If the gas can be evacuated to consuming markets, higher prices provide an effective incentive to raise output.

Figure 13: Gas Productivity of Major US Shale Plays (Combined Permian, Rockies, Anadarko, and Gulf Basins) – Normalized 10,000 Foot Decline Curve Basins)



Source: PetroNerds, Enverus raw data

The Eagle Ford is an oil, condensate, and gas-rich play located extremely close to the Gulf Coast. The productivity curves and the production profile of oil and gas show the clear growth in gas performance and production in 2022 (Figures 14 and 15). The story of why gas prices are currently at $2/ mcf can be at least partially attributed to the production surge from high natural gas prices. High oil prices combined with the efficiency and ability for operators to produce massive amounts of this smaller molecule with ease have also contributed to rising natural gas output. Furthermore, gas production volumes are unlikely to decline considerably unless oil prices decline as well given the large volumes of associated gas production from major oil plays from the Permian Basin to the Rockies.

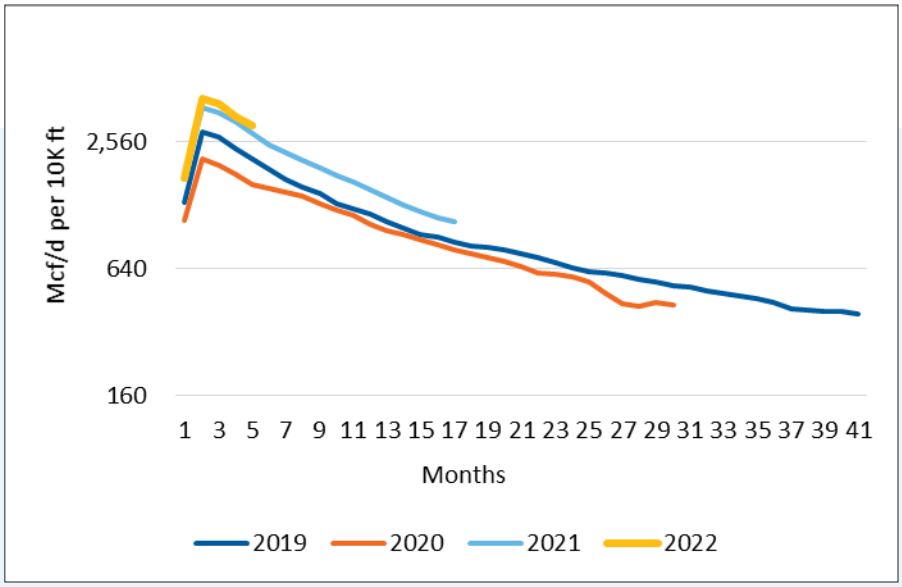


Figure 14: Eagle Ford Gas Productivity - Normalized 10,000 Foot Decline Curve

Source: PetroNerds, Enverus raw data

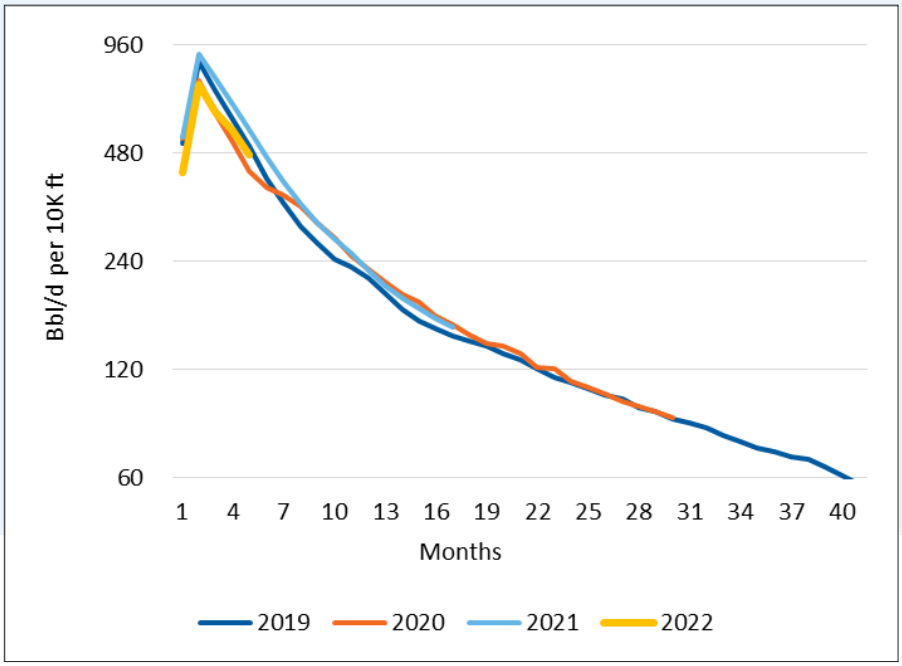


Figure 15: Eagle Ford Oil Productivity - Normalized 10,000 Foot Decline Curve

Source: PetroNerds, Enverus raw data

CONCLUDING REMARKS

The performance of the North American oil and gas production platform continues to bedevil a long list of forecasters and their pessimistic outlooks on both the capacity of the geology and the capability of technology. In 2006, EPRINC published a paper by Richard Nehring entitled "Does the Hubbert Method Provide a Reliable Means for Predicting Future Oil Production?" The methodology consistently underestimated future production. It underestimated ultimate recovery because it was incapable of estimating the appreciation (growth) in ultimate recovery that occurs in older fields. The Hubbert Method assumed, as did all the thinking at that time, that future additions to reserves come wholly from new discoveries and from the gradual completion of the development of recent discoveries. The history of reserve additions in the United States since 1970 clearly indicates that this assumption has not been valid for decades. The North American unconventional plays continue to outperform and all evidence indicates that with appropriate policies, the U.S. and the entire North American production platform can continue to provide additions to oil and gas production essential for affordable and secure energy supplies.

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